T.M. Vinod Kumar *Editor*

Smart Economy in Smart Cities

International Collaborative Research: Ottawa, St. Louis, Stuttgart, Bologna, Cape Town, Nairobi, Dakar, Lagos, New Delhi, Varanasi, Vijayawada, Kozhikode, Hong Kong

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Editor
T.M. Vinod Kumar
School of Planning and Architecture,
  New Delhi (SPA-D)
Calicut, Kerala
India

Foreword I

This publication, Smart Economy in Smart Cities, featuring four African cities comes at an opportune time when significant global agendas are being agreed. This includes notably the Africa Agenda 2063 in 2014, the Sustainable Development Goals, the 21st Conference of Parties (COP 21) in 2015 and the United Nations Third Conference on Housing and Sustainable Urban Development (Habitat III) this year. To take full advantage of the epochal agreements, there is an urgent need to strengthen the capacities of African countries and cities to engage with the preparatory processes in order to ensure their views are taken into account. For example, the preparation of the Habitat III Conference planned for October 2016 demands the empowerment of people and institutions with the right information and knowledge that helps to prioritize their needs in the global, national and local development agenda. Close engagement with the development of a global agenda such as the Habitat III process that will be endorsed by member states of the United Nations is critical because it happens every 20 years. Preparation and knowledge are therefore key to developing the framework to promote smart, sustainable, inclusive and prosperous human settlements.

The study of the four African cities draws on a robust set of concepts that include planning, housing, infrastructure development, economic development, environmental sustainability, social development, disaster exposure and resilience and peace and security. The planning of African urbanization must take into consideration and learn from the accumulated knowledge on various conditions that make cities smart, green, ecological, livable and healthy; and the progressive emergence of the ICT infrastructures and their correlates such as social media and in general data revolution. With the development of ICT infrastructures and their correlates, work places are becoming progressively spatially mobile. Walkability and public space provision have also increasingly become a central part of planning of the city of the twenty-first century. Furthermore, with the emergence of ICT infrastructures, the dichotomy between settlements, particularly between cities, towns and villages is becoming less relevant than it was traditionally perceived. Various comparative advantages traditionally associated with urban setting such as diffusion of ideas,

innovation, economies of scale and agglomeration of economies can now be achieved in sparse but connected settlements. This is indicative of the pervasiveness of the ICT revolution in the region and in a sense signals the deepening of the era of digital urbanization in Africa. Given the increasing penetration of digital technologies, all things being equal Africa's urbanization may well be accelerated and achieved well before the predicted year of 2035. Clearly, digital urbanization will help to address various urban issues that African cities are facing which result from certain foundational weaknesses characterized by three main factors: (a) poor urban planning; (b) insufficient provision of basic services; and (c) inefficient urban policies.

We recognize that ICT alone cannot make a city smart; it is the way it is integrated in the city fabric that will determine the city smartness. With an extensive use of ICT to access services, there will be few cars than before on the road making streets friendlier and healthy for walking and cycling. Streets can be planned and designed as public spaces to serve communities for social interactions as well as mobility. Hence, they can promote infrastructure development, enhance environmental sustainability, support high socio-economic development and promote social development, equity and social inclusion. In the long term, it will reduce emissions of CO_2, promote the creation of low-carbon cities, reduce land degradation and promote biodiversity.

Recently, African Ministers of Housing and Urban Development, convening in *Abuja, Nigeria, in February 2016, adopted the Abuja Declaration which spelt out Africa's position on Habitat III. The Declaration contains* six fundamental principles underlying the African perspective to the outcome of Habitat III which objective is to pursue an ambitious new, and transformative urban and human settlements agenda. It will make sense to harmonize at the practical policy level the lessons learnt from the smart economy in Smart City studies with the objectives of the Common African Position on Habitat III. In addition, we suggest that these studies be carried out in other African countries.

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Prof. Oyebanji Oyeyinka
Director, Regional Office for Africa
United Nations Human Settlements Programme (UN-Habitat)

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Foreword II

The Power of Sharing

Cities globally are positioned to identify, adopt and implement transformational solutions. Technologies are changing the way cities are built, how citizens interact and move throughout the city, and how city services from health care to safety and from water to waste are delivered. A city's livability, prosperity and inclusiveness are central to sustainable progress globally and smart solutions are paving the way.

One of the greatest challenges we face today is ensuring that the work and experience in building Smart Cities worldwide can be shared across cities globally. In order to share experience, we need a common 'language' and agreement on the definitions and practices that make up a smart community, so that we are all measuring the same dynamics. At that point, processes become transferrable and improvable. Standardized city data can become that common language ensuring city solutions can 'travel' globally.

Measurement is at the heart of the progressive Smart City. A new international standard now under development within ISO, *Indicators for Smart Cities*, will outline a set of indicators to enable cities to facilitate and promote the integration and interoperability of city systems and build upon a core set of city indicators, already standardized in ISO 37120 *Sustainable Development of Communities: Indicators for City Services and Quality of Life.* Standardized indicators for Smart Cities will enable cities to draw comparative lessons and facilitate city to city learning. This standard will help cities to innovate and find technological and knowledge-based solutions to address urban challenges.

One of the great attributes of this book is that it brings together respected authors from around the world, to help drive knowledge and exchange. This book describes programmes that experts have used with success in developing smart economies across a global array of cities. These 'beacons of success' can be emulated by other cities globally if a common language—data—is available to inform city to city learning.

There are in fact two levels of benefits that readers will find in these chapters:

- Specific examples of solutions that can be adopted in other cities globally; and
- An overall emerging theme highlighting common elements that are needed in order to plan a universal strategic direction.

Standardized information on cities, gathered on a global scale, builds a strategic base of knowledge for city leaders to act. It has the power to transform city building, to inform smart health care, allocate energy resources, achieve sustainable economic growth and raise incomes for all citizens. Although a great deal of hypothetical work has been done, there is little empirical study available on how Smart Cities generate urban economic development. This book opens that door, providing comparable information on what success looks like in different centres around the world.

Patricia McCarney
President and CEO of the World Council on City Data (WCCD)
Professor of Political Science and Director of the Global Cities
Institute at the University of Toronto, Canada

Foreword III

The 'Smart City' idea comes from a long line of urban innovations that attempt to re-imagine the city and imbue it with fresh vision and purpose. Garden cities, model neighbourhoods, new towns, national capital cities, techno-cities, socialist cities, sustainable cities, eco-cities, low-carbon cities, healthy cities and now Smart Cities are all attempts to specify more precise versions of utopia. They all bring organization to the otherwise spontaneous clustering of people, homes, jobs and services that we call cities. They are attempted to improve social order.

Garden cities focused on combining the benefits of town and country. Socialist cities focused on erasing inequalities. Eco-cities focus on minimizing ecological impact. Low-carbon cities narrow this objective even further. Healthy cities focus on improving health by design. There is always a utopian objective in the re-envisioning device. Smart Cities are a little different. And because of this, it may prove that they are a more viable and long-lived notion.

'Smart' is not an end in itself. Why would we strive for 'smart' for its own sake? The perspective of this interesting collection of writings is on 'smart' for the sake of 'smart economy'. Leaving the authors of the initial chapters to define what 'smart economy' means, the formula of the title illustrates that the notion of Smart Cities is essentially about means not ends. A Smart City is an IT-enabled city. This is the simplest way of understanding the idea. Expressed thus, it becomes less of a fad in urban planning doctrine or technology strategy and more of a phase of urban management whose time has come—a technological phase. Sensor technology; big data; inexpensive high-powered computing; pricing technology; and governmental, legal and other institutional innovations, all mean that technology can be applied to urban management in dramatically new ways. What happened in the factory several decades ago can now be applied to the city. The efficiency of many parts of the urban management system can be increased by automation. This has come gradually over the decades but has accelerated with nonlinear downward trends in the costs of computer processing; storage; communication and data capture; and upward trends in the speed, depth and scope of innovation in urban information and communications technology (ICT) applications.

Bridge and tunnel tolls became more feasible on high-volume highways with the advent, first of automatic barriers, then more so with auto-tolling scanners. Number-recognition and other scanning technology and accompanying innovations in payment collection technologies made it possible to reintroduce the ancient idea of the road toll to city neighbourhoods as an alternative to hard-engineering solutions to commuting 'rat-runs' and home-zone road safety. Innovations in pricing technology means congestion pricing can become more sophisticated, with fees adjusting to congestion levels at different times and places. Accompanying institutional and legal innovations allow experiments with the application of road pricing to different sub-markets and different spatial pricing boundaries, such as allowing retail owners in an urban block to set their own parking price to optimize parking congestion (setting the price regime so that parking lots are never too empty or completely full).

Construction waste, to take another example, has traditionally been a deadweight loss for contractors and developers and society at large. Demolition waste and expendable concrete formwork and other cast-offs in the building trade add costs to a construction project. If they end up in a landfill, they become a social cost to the city. ICT can turn this construction industry externality into consumer surplus by creating a market. Builders need rubble and a good proportion of waste can be reused. Set up a real-time market and you can probably halve the amount of waste going to landfill.

The editors and authors of this book call for a theory of Smart Cities and offer their case studies in the spirit of evidence building and theory building. Responding to their challenge, a theory of Smart Cities may be based on the idea of *missing markets*. Urban inefficiencies arise because of externalities—costs born by third-parties beyond the immediate parties to a transaction. Urban externalities such as congestion in housing and transportation markets, air, noise, light and water pollution, infectious disease risk, fire risk are typically addressed by regulation. Technology can fill a 'missing market gap', turning an externality into a commodity. The insurance industry is an example of how missing markets (in risk) can be activated through a combination of legal, organizational, financial and technological innovations. Risks that were once serious impediments to transacting in cities are turned into profit by the specialist skills of people working together in the insurance industry. A mobile app-based market for construction waste exchange turns waste from a deadweight loss to society and the construction industry into private and public benefit. All can gain if the market is structured correctly. Road pricing has the effect of reducing the volume of road-congestion externalities such as noise, fumes, danger and time-loss at the same time as generating revenue that can be used to further moderate travel-based externalities, such as constructing landscape buffers, widening or narrowing roads, introducing cycling lanes.

In an industry, corporation or factory, the efficiencies introduced by smart technology are justified primarily on the basis of reduced costs or increase sales or profit. In a city, they can be justified by achieving a better balance between the costs and benefits of living together in a city. This includes reducing externalities,

increasing social benefits, reducing the costs of urban management and raising the quality and effectiveness of urban management.

The basis of a theory of Smart Cities is found, therefore, in the application of technology to the business of city management. This can be taken a step further. A Smart City is one where ICT is used to reduce the costs of the transactions that are the heart of a city's life and economy. Cities exist because it is more beneficial for people to live in close proximity to each other. It is better to live together than apart. If that were not so, people would remain spread out evenly across the countryside. People live together for economies of scale in production and consumption. Transport communications technology (TCT) enabled people to move from the countryside as soon as the wheel was invented. TCT enabled the division of labour, which in turn produced even greater economies of scale as labour became ever more specialized. In a virtuous circle, more sophisticated TCT innovations led to more sophisticated city economies. When cities developed into production and consumption hubs that transported buyers and sellers, raw materials, goods, services, tastes and customs and knowledge from across ancient empires, the knowledge specialization, labour division, product differentiation, wealth and income of cities grew as a result. The role of technology-induced transaction cost reductions in making cities into the engines of economy and culture that they have been in every great empire is axiomatic to the history of civilization. ICT now plays a similar role. It reduces the costs of living and working in the city by making it easier to find a route to work, a suitable flat mate, supplier, customer, advisor, banker, factory site, shop premise, theatre, school, gym or even to find a marriage partner. ICT also lowers the transaction costs of getting things into the city and of distributing urban products and services away from the city. It enables cities to grow in relation to international and intercontinental as well as regional hinterlands.

Smart Cities and smart economies intertwine in cause and effect. It is more likely that smart urban management technology will be invented, trialled and adopted in a city that hosts an entrepreneurial industrial culture. On the other hand, Smart City technology can encourage smart economic development as explored in detail in the case studies of this book. The evidence from the literature on regional innovation systems points to a magic mix of strong and entrepreneurial government, low taxes, high incentives, skilled and flexible labour markets and good natural and cultural environmental conditions. The challenge to urban governments is to use Smart City technology in a way that blends into the background and that invisibly makes it easier to use the city for all that a city is good for. Governments have a historical tendency to oversupply public goods. The same is as likely to be true with ICT-based Smart City infrastructure as it is with TCT transportation infrastructure and other engineering interventions. This is certainly the case in large corporations, who since the start of the modern computer era have a well-documented history of failed multi-million dollar mega ICT projects. Urban governments would do well to focus not on grand systems that treat the city as a machine. We briefly went there in the 1960s and 1970s with comprehensive urban planning supported by the then-trendy ICT paradigm of cybernetics. Rather, we should be thinking about fostering many small and competitive innovations, preferably using app and cloud

technology and designed for specific sub-market players to fill very specific urban missing markets. If governments want to invest, they should think in terms of setting up the platforms for their citizens to create their own Smart City inventions to increase efficiency in a multitude of specialist domains. Such is the spirit of the spontaneous city of the past and such will always, hopefully, be the spirit of the city of the future. The alternative kind of utopia can also be facilitated by ICT, but it is not desirable and is bound to fail.

Cities across the regions of Asia are variously characterized by high density, poverty, high-speed development, massive size, strong government and a developmental state. Smart City technology can come from the top or bottom. It can enhance strong state planning and it can enhance spontaneous order. Asian cities need both and there is no reason why ICT should not increase efficiency of small and large settlements in political economies as different as India and China. To be successful, a Smart City application needs to match its context and those that work in China may not work in India. In the wild-west city Dongguan, in China's Guangdong Province, rural collectives have used village assets to become fabulously wealthy from poorly regulated capitalism. One Township, Chang'an, with a population of one million people, is building an urban big data centre for smart local governance across sectors and across its one hundred square kilometres. In other Asian settlements, massive investment at the city scale like this will not be possible and it will be small smart initiatives that will capture the power of Smart City apps to make things more efficient at the local level first. So we need to distinguish between big versus small Smart City technology as well as centralized versus decentralized, demand-side versus supply-side, market-enhancing versus market-creating, speculative versus mature, public domain versus proprietary, consumer-oriented versus producer-oriented, multi-sector versus single-sector, and city-intranet platforms versus open Internet platforms. In many parts of Asia, local government is fluid, being rediscovered in transitional post-socialist economies or adapted to informal governance and financing institutions in low-income countries. Smart City ICT has a crucial role to play in the evolution urban governance in Asia. It even holds the potential for discovering new and more efficient forms of urban order not open to Western cities that are encumbered with historic institutional structures that make technological innovation more difficult to implement.

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Chris Webster
Professor of Urban Planning and Development Economics
Dean, Faculty of Architecture and Hong Kong Urban Lab
University of Hong Kong

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Foreword IV

European Smart Cities: Current and Future Enterprises and Research Activities

It has been acknowledged that in 2010 more than half the world's population lived in cities; by 2050 that will have risen to 70 %. As a consequence, 80 % of the global gross domestic product (GDP) is generated in cities; as they grow, there is increasing pressure for them to become more sustainable. Around the world, Smart Cities are increasingly evolving and many nations are promoting and have started setting a Smart City agenda. According to politicians and financial analysts and experts, cities drive economic growth and prosperity. Sustainable, Smart Cities are where entrepreneurs, authorities and academia come together, using shared data and digital technology to improve urban living. In Europe, this has been further strengthened by Research Framework Programme-Horizon 2020, which has been broadcasted as the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014–2020). By taking great ideas from the laboratory to the market, Horizon 2020 promises more innovations and discoveries as well as attraction of enormous private investment on the top of the funds to be distributed in relevant partnerships between European countries (ec.europa.eu/programmes/horizon2020/). By launching this huge programme, it was noted that Europe will be presented in a changing world of inclusive, innovative and reflective societies (also present in current European Commission Decision C (2015)6776 of 13 October 2015).

Horizon 2020 is currently implementing the Innovation Union, a Europe 2020 Flagship Initiative aimed at securing Europe's global competitiveness. Thus, the programme has the political backing of Europe's leaders and the Members of the European Parliament; they agreed that research is an investment in our future and so put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs. This turns out to be evident in the publication of Regulation (EU) No 1291/2013 of the European Parliament and the Council of 11 December 2013, establishing Horizon 2020—the Framework Programme for Research and

Innovation (2014–2020) and repealing Decision No 1982/2006/EC. Whereas the European Council Decision of 3 December 2013 establishes the specific programme implementing Horizon 2020—the Framework Programme for Research and Innovation (2014–2020) by stating that: 'The general objective of Horizon 2020 should be pursued through three priorities dedicated to generating excellent science ("Excellent science"), creating industrial leadership ("Industrial leadership") and tackling societal challenges ("Societal challenges"). The general objective should also be pursued through the specific objectives "Spreading excellence and widening participation" and "Science with and for society"'. Thus, Horizon 2020 is open to everyone, with a simple structure that reduces red tape and time, so participants can focus on what is really important. This approach makes sure new projects get off the ground quickly—and achieve results faster.

The EU Framework Programme for Research and Innovation will be complemented by further measures to complete and further develop the European Research Area. These measures will aim at breaking down barriers to create a genuine single market for knowledge, research and innovation. Very recently research and international projects, such as the European Innovation Partnership on Smart Cities and Communities (EIP-SCC), envisioned bringing together cities, industry and citizens to improve urban life through more sustainable integrated solutions (ec.europa.eu/eip/smartcities/). The EIP-SCC consists of the High Level Group and the Smart Cities Stakeholder Platform; together, they are responsible for the Strategic Implementation Plan (SIP), which helps define how concepts promoting Smart Cities are put into practice. It also looks at how the European Commission can support these measures during the next Research Framework Programme—Horizon 2020. The EU Framework Programme for Research and Innovation will be complemented by further measures to complete and further develop the European Research Area by breaking down barriers to create a genuine single market for knowledge, research and innovation (Europe 2020 Flagship Initiative).

Eleni Tracada, Ph.D.
University Principal Tutor
Department of Mechanical Engineering and Built Environment
College of Engineering and Technology, University of Derby
Derby, UK

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Author's Biography

Femi Ola Aiyegbajeje hails from Kabba, Kogi State, Nigeria. He has a PhD in Geography, a Master of Science (M.Sc) degree in Geography and a Bachelor of Science (B.Sc) degree in Geography from the University of Ibadan, Ibadan Nigeria. He is currently with the Distance Learning Centre, University of Ibadan His research interests dwell on transport and communication geography, research methods, urban, and regional development.

P. Bimal holds a master's degree in city planning from Indian Institute of Technology Kharagpur and bachelors' degree in architecture from Kerala University. He had been working at JUSCO, Jamshedpur, before joining as assistant professor at Department of Architecture, NIT Calicut. He is currently pursuing PhD in urban modelling. He has presented papers on residential location modelling, development potential models, etc. in various international conferences. He has authored chapters in previous books of this series.

Jim Brasunas has 34 years of entrepreneurial, management, marketing and sales experience with technology-based companies. He has been involved with numerous start-up ventures, including telecommunications, IT, retail, manufacturing and a number of non-profit organizations. In April of 2008 he founded and became Executive Director of ITEN (www.itenstl.org) and served as the organization's leader until joining the board of directors in June of 2015. He holds a Bachelor of Science degree from The Massachusetts Institute of Technology. He pursued graduate studies in psychology and innovative management at the Institute for Comparative Studies, Gloucestershire, England.

Frank Brettschneider is the chairperson of the department of communication science at university of Hohenheim. His main focus areas are communication in large infrastructure and construction projects and its management. He specially emphasizes the link between theory and practice. He is the president of VDI-Guidelines Committee 7001 "Communication and the public participation in planning and construction of infrastructure projects- standards for the service phase of the engineers".

Antonio Caperna Antonio graduated from the Faculty of Architecture in Naples, he has been awarded a PhD from Roma Tre University. A visiting Professor at several universities, he had previously taught at the University of Rome "La Sapienza" and for 15 years at Roma Tre University (Italy). He is the President of the International Society of Biourbanism, and an academic consultant at the Portuguese Agency for Assessment and Accreditation of Higher Education. His latest research is mainly oriented to the emergent field of Biourbanism and to the application of complexity theory, evolutionary biology, Biophilia and Morphogenesis to define procedure/process and tools for a human-oriented architecture and urbanism.

Abhik Chaudhuri is an Enterprise Security Architect and Domain Consultant in Cyber Security, Privacy and Policy. As a Co-Editor of ISO/IEC JTC1/SC27 WG4 he is developing global standards in cyber security. His research papers on various aspects of IT and IoT Security, Privacy have been published in reputed journals like EDPACS (Taylor & Francis), ISACA Journal, Lecture Notes in Computer Science (Springer Verlag) and IGI Global. Abhik is a member of IEEE IoT Community, Editorial Board member of EDPACS Journal (Taylor & Francis, USA) and the Journal of Data Protection and Privacy (Henry Stewart Publications, U.K.).

Francis Chmelir has a deep history of contributing to the growth of scalable, technology startups over the last 12 years. Previous professional roles include having been the Director of Operations and founding member of the Technology Entrepreneur Center (TEC) and the Statewide Director for MoFAST, a part of the University of Missouri system program for technology commercialization. He currently serves as the Executive Director for ITEN, a catalyst of the tech startup ecosystem in the St. Louis region. At ITEN, he directs the fundraising, operations and overall strategy of the organization while also focusing on new client attraction, intake and business acceleration programs. Additionally, he works on enhancing mentor engagement throughout all of ITEN's services to its client companies.

Sorin Cohn received a Ph.D. in Electrical Engineering from McMaster University in 1976, following a M.Sc. degree in Physics from the University of Calgary and a Masters. in Electronics from the University of Bucharest. Presently, he is the President of BD Consulting and Chief Program Officer of i-Canada, driving Innovation Nation programs to help Canadian communities and industry enhance their competitiveness. He is also on the Board of Startup Canada and leads the Conference Board of Canada research on innovation metrics and management, following a 35 year career managing innovation developments in universities, research institutions, multinational companies and high-tech startups.

Bharat Dahiya An award-winning urbanist, Bharat combines research, policy analysis and development practice aimed at examining and tackling socio-economic, environmental and governance issues in the global urban context. Working with World Bank, UN-Habitat, Asian Development Bank and UNDP, he initiated, led and contributed to international projects on sustainable urban development in Asia-Pacific. He conceptualised and coordinated the preparation of United Nations' first-ever report on *The State of Asian Cities 2010/11*. He has held academic positions in Australia, Indonesia and Thailand. Reuters, China Daily, Inter Press Service and SciDev.Net have quoted his work. He holds a PhD in Urban Governance, Planning and Environment from the University of Cambridge, United Kingdom.

Momar Diongue is presently a Researcher and a Teacher at University Cheikh Anta Diop (UCAD) of Dakar. Dr. Diongue's research interests cover; Peri-urban and territorial governance; Metropolization of large urban projects; land prodution; real estate and local public services; international migration and res-idential mobility. He was also a Visiting Professor at the University of Rennes (France) where he taught Master students courses on Urban Development (Urban development in the peri-urban of large cities in West Africa); Architecture and Cities' Images (Emerging urban form in the peri-urban of Urban); Local Public Action and Territorial Solidarities (Local Public Services in West Africa).

Charles Duffett has held roles at the Office of the Auditor General of Canada, Revenue Canada, and Transport Canada where he oversaw a number of strategic air safety initiatives. He rejoined the Federal Government on an Executive Interchange upon being asked by the Privy Council Office to assist in the strategy for the cre-ation of Shared Services Canada. At SSC he led the Division responsible for development of current secret network and desktop standards. He has Chaired The Canadian Executive Development Series Advisory Board, and has been an Advisor to a local startup and the Canadian Advanced Technology Alliance. He has received numerous awards for merit.
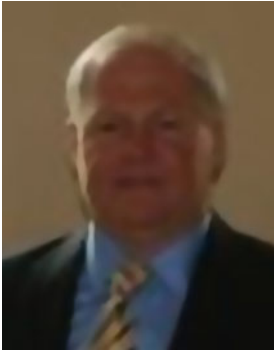
Ritch Dusome Ritch Dusome has over 25 years of experience in engineering, product management, and networks. Ritch studied at the University of Ottawa and completed a BSc in Physics and Mathematics. He has provided strategic guidance to clients on internet and network architectures, business transformation, and enterprise architectures. He worked at Cisco Systems in engineering and product management and network operations and analysis. As network analyst for Bell Canada, he worked closely on the original CANARIE network, one of the world's fastest research networks.

Dr. C. Mohammed Firoz is an architect and urban planner by profession. He holds a Ph.D. degree from IIT Kharagpur, postgraduation in urban and regional planning from CEPT University and B.Arch. degree from NIT Calicut for which he was as a university rank holder. He has been involved in teaching, researching and consulting at NIT Calicut since July 2004. He was also engaged as a visiting teacher at the Architectural Association London (AA London) for the term May–June 2015. His field of interest includes rural urban interface studies, sustainable urban design and planning, regional development and planning, etc.

Barry Gander has helped jump-start the development of advanced technology organizations in Canada and abroad. Working in both companies and in associations, with the public sector and academia, he has created initiatives that showcase the best of Canadian innovation to global markets. The i-CANADA program, which he co-founded, aims to create an "Intelligent Nation" by establishing a grass-roots movement of communities that network at ultrafast speed. He has authored several best-selling books including "Fast Lane", which crystallized growth ideas, and a landmark book called "SUCCESS", which highlights the views of 100 top executives.

Ken Harrington was the Founding Managing Director of the Skandalaris Entrepreneurship Center at Washington University in St. Louis. Prior to joining the university in 2001, he held senior management positions at seven startup technology companies. He serves on a number of boards of directors and is an author and speaker including (1) How Cities and Regions Can Become Thriving Entrepreneurial Hubs, an award winning submission to the Entrepreneur Innovation Exchange, (2) Entrepreneurship Education Comes of Age on Campus: An essay collection published by the Ewing Marion Kauffman Foundation, and (3) Rebuilding the American Dream, Restoring American Jobs and Competitiveness through Innovation and Entrepreneurship, a book authored by Robert Skandalaris.

Michael Hertwig Michael Hertwig is working researcher at university of Stuttgart. His mayor research fields are development of suitable IT support of production processes and the procedure development for manufacturing in urban environments. In 2005, he graduated in production technology at the University of Combined Studies, Thuringia. In 2013, he was awarded a diploma of mechanical engineering at the University of Stuttgart. He is member of the association of German engineers (VDI). He is a member of the committee of the initiative "VDI STADT:DENKEN".

He belongs to Competence Team »Digital Engineering« at Fraunhofer Institute of Industrial Engineering(IAO). He is responsible for the process development and know-how transfer. His researches are about the processes with the support of digital technology can be optimized and what the production of the future would look like. He is also a member of the German Engineers Association (Verein deutscher Ingenieure e.V).

Mark Hoddenbagh is responsible for engaging industry, government and community organizations in the activities of the College. Since 2007 when he joined Algonquin College he has accomplished this by developing strong internal and external networks with creative, driven and passionate people; leveraging the expertise of faculty and staff; engaging students in addressing real-world problems and opportunities; and collaborating closely with industry, government and

community organizations. He has a Ph.D. in Chemistry and worked in pulp and paper and biotechnology in technical and management roles for 15 years prior to joining Algonquin.

Suzana Jacob currently works as a research associate at National Institute of Urban Affairs (NIUA), New Delhi. She holds a master's degree in urban planning from National Institute of Technology, Nagpur, and a bachelor's degree in civil engineering from Cochin University. Prior to joining NIUA, she worked as a lecturer in Department of Architecture and Planning at National Institute of Technology, Calicut, and as a research assistant for a HUDCO-HSMI project on Cluster Level Sustainability of Nagpur City. Her research interests include anthropology, housing, Smart Cities, social planning, urban finance and urban land management.

Michael Kinyanjui is a Consultant with UN-Habitat. He holds a Masters in Urban Management and a Bachelor of Arts degree in Geography from the University of Nairobi Kenya. His previous professional experience includes working at the United Nations Center for Regional Development (UNCRD)—Africa Regional Office as a National Officer, providing technical expertise in preparation of Integrated Regional Development Plans (IRDP) for sub-national regional authorities in Kenya and as a Curriculum Coordinator for the Africa Training Course on Local Regional Development Planning and Management. He previously worked as the Research Consultant with the Policy Analysis Branch, Monitoring, and Research Division at UN-Habitat towards preparation of the Global Reports on Human Settlements (GRHS). He has also extensively worked and researched on Sustainable Urban Shelter Delivery Strategies and Urban Poverty with Intermediate Technology Development Group (ITDG) currently Practical Action.

Mark Kristmanson was appointed CEO of the National Capital Commission by Foreign Affairs Minister John Baird on Monday, February 3, 2014. In addition to numerous university degrees including a PhD [Humanities] from Concordia University, he was most recently director, capital interpretation and commemorations, at the National Capital Commission. From 2000 to 2003, he served as the founding executive director of the New Brunswick Arts Board and from 1982 to 1994 as technical director of the National Arts Centre. He held the 2011 Fulbright Visiting Research Chair in Public Diplomacy at the University of Southern California in Los Angeles. He was expert adviser to the Cultural Capitals of Canada Program from 2002 to 2010 and has served on federal government's Commemorations, Canada Remembers and War of 1812 Bicentennial interdepartmental committees.

Ashok Kumar has been working in the School of Planning and Architecture, New Delhi as a Professor since 1993. His research interests include Inclusive Planning, and Planning Epistemologies. He has published 90 papers, written and edited 8 books, and published 18 book chapters. He has been serving as the Editor of the *ITPI Journal* since 2002. In 2016 he has co-edited two books: one for Springer, and another one for Cambridge Scholars Press. A co-authored chapter was published by the Policy Press in April 2016. Another co-authored book chapter will be published in the *Routledge Handbook of Theory* in early 2017.

Dr. Deepak S. Kumar Assistant Professor, Amrita School of Business, Coimbatore and Fellow (IIM Kozhikode), MBA, B.Tech. (NIT, Calicut). His research interest areas include branding, service scape, aesthetics and green marketing and have published in journals such as The Marketing Review, IIM Kozhikode Society & Management Review. He has also presented papers in many conferences including Academy of Marketing Annual Conference; UK, International Marketing Trends Conference; Paris, Pan-IIM World Management Conference; IIMK. At ASB Coimbatore, he teaches marketing, services marketing and brand management. He is also an invited

faculty of NITC and undertakes skill development programmes for EDPs, of Technology Business Incubator TBI-NITC.

Bruce Lazenby After serving 20 years in the military, Bruce served in senior technology executive positions including CEO with Ottawa's FreeBalance Inc., Chairman of the Ottawa Software Cluster, and Vice President in Canada for Corum Group Ltd.—the world's largest software M&A advisory firm. He was also a Chair and executive coach with The Executive Committee – a global network of 15,000 chief executives in 16 countries. He is a frequent speaker at knowledge-based executive events across North America, and in 2005, he was voted Canada's Private Sector Technology Leader by the Canadian Advanced Technology Alliance.

Joachim Lentes is working as the head of the department of Digital Engineering at the Fraunhofer Institute for Industrial Engineering (IAO) and as a lecturer at the University of Stuttgart. He holds a degree in engineering from the University of Stuttgart. One of his key research interests is urban manufacturing, a field in which he leads public- and company-financed projects since 2011. He is the author of more than 50 publications and moderated the working group for urban manufacturing of the acatech—German National Academy for Science and Engineering concerning the work on urban manufacturing resulting in the volume with materials «city of the future—strategies of sustainable urban development». Joachim Lentes is the head of department and member of the management board at the Fraunhofer Institute for Industrial Engineering IAO and lecturer for Mathematical Methods for Production Planning at the University of Stuttgart. He acts as reviewer for international conferences and journals like International Journal for Production Research and International Journal for Production Economics as well as for Governments. His main research areas are the integrated engineering of products and production systems as well as strategies for next-generation development and production as they can be summarized as Industry 4.0 and urban manufacturing, a field where he is active since 2011.

Sarah Linkletter expertise is in providing psychometric solutions and comprehensive expertise to public and private sectors in Canada. She provides advice on competency-based assessments, human resourcing solutions, performance measurement strategies, and psychometric assessments. Her educational background specializes in psychology, philosophy and psychometrics. She is presently enrolled in a Master's program at the University of Ottawa with a focus on the objective measurement of ability, judgment, knowledge and personality within an organizational context.

Mouli Majumdar started off as an architect and worked for a year as a junior architect on several aspects of projects. Completed Masters in City Planning in the year 2015 that led to interest in physical planning, urban economics and community inclusive planning. Currently a research scholar at SIDM, IIT Kharagpur, she is working on a decision support systems for educational infrastructure design strategies. Her research work will try to integrate spatial data and algorithmic techniques to form a Spatial Decision Support System that would aid in better visualization of the alternatives by simulating real world scenario.

Lakshmi Manohar Adhoc Faculty—National Institute of Technology, Calicut, Associate Member (Indian Institute of Architects, Institute of Urban Designers India), Master of Urban Design (MUD—School of Planning and Architecture, New Delhi; Bachelor of Architecture (B. Arch.)—TKM College of Engineering, Kollam. Her research interest areas include trajectories of city development, gender neutral spaces and public place design and have presented papers in conferences including Residential Environments Network Intensive, EDRA, USA; South Asia Conference, University of Wisconsin, Madison, USA. She has been working with National Institute of Technology Calicut for last 11 months.

Gora Mboup Since 2014, Dr. Gora Mboup has been the President and CEO of GORA Corp after more than 25 years of international development experience. After ten years as a coordinator of the Demographic and Health Surveys funded by USAID, he joined UN-Habitat in 2004 as a Senior Demographer and the Chief of the Global Urban Observatory. In June 2014, UN-Habitat honored him with a plaque "in recognition of ten years of distinguished and dedicated service to the United Nations" including authoring the UN-Habitat's publication "Streets as Public Spaces and Drivers of Urban Prosperity" in 2013 and co-authoring four series of the State of World's Cities (2016-2012). In March-July 2016, Under the Global Sustainable Cities Programme of the Global Environment Facility (GEF), he conceptualized the Senegal's Sustainable Cities Initiative with the integration of climate changes on urban design, planning and management. In June 2016, he also contributed in the Future Earth international project with an article "The end of big cities and the rise of digitally served towns and villages—The digital urbanization".

Dr. Patricia McCarney was integral to the development of the newly published ISO 37120, the first International Standard for City Indicators, and is now leading the next ISO Standard on Indicators for Smart Cities.

Dr. McCarney is the president and CEO of the World Council on City Data (WCCD) which now hosts high-calibre city data driven by international standardization. She is a professor of political science and the director of the Global Cities Institute at the University of Toronto, Canada. Before joining the University of Toronto, between 1983 and 1994, Prof. McCarney worked as a professional staff member in a number of international agencies, including the World Bank in Washington, the International Development Research Centre in Ottawa, and the United Nations—HABITAT in Nairobi.

Patricia McCarney is currently a member of the ISO Technical Committee 268, sustainable development in communities, where she is chair of the Working Group on City Indicators. This ISO Working Group is building a 'family of international standards on global city indicators' for sustainable cities, resilient cities and Smart Cities.

Patrick McKeehan has 31 years of professional community/economic development experience. As a designed Certified Economic Developer by the International Economic Development Council (1992), he has worked at the state, regional and local levels, including employment with Missouri's Department of Economic Development and Leadership Council Southwestern Illinois. In 2103, he became director of the Illinois Small Business Development Center (SBDC) at Southern Illinois University Edwardsville serving the needs of small business owners and entrepreneurs through no-cost counseling and support. He has consulted on economic impact for a number of broadband deployment projects in both the United States and Canada.

Paida Mhangara is currently serving as the Manager for Research and Applications Development at the South African National Space Agency (SANSA) in the Earth Observation Directorate. Paida holds the following academic qualifications: PHD in Remote Sensing, MBA, MSc in GIS & Remote Sensing, BSc Honours in Remote Sensing and GIS (cum laude), BSc Geology & GIS (cum laude) and a National Diploma in Mine Surveying. He has extensive experience and expertise in remote sensing and geographical information systems and has been a principal scientist and project manager on a number of international earth observation science projects. In addition to his management responsibilities, Paida is currently a mission scientist on a satellite program and has led the scientific process of defining technical specifications for the upcoming South African earth observation satellite.

Guglielmo Minervino A PhD student in "urban regeneration and economic development" at the Mediterranea University of Reggio Calabria, holding an MSc in Urban Planning from Sapienza University of Rome. Researcher and practitioner in the field of urban regeneration and social innovation for the development of historical settlements in the Mediterranean area. Member of the International Society of Biourbanism (ISB), and International Network for Traditional Building, Architecture & Urbanism (INTBAU). In charge of "Progetto Artena"—a strategic design project and experimentation, to revive the Italian medieval city of Artena.

Naledzani Mudau is a remote sensing scientist at the South African National Space Agency. She is mainly responsible for the research on the extraction and use of human settlement data from satellite imagery. Her recent research projects focused on the extraction of human settlement data using medium to high resolution satellite imagery. She is currently participating in the Global Human Settlement Layer (GHSL) project and GEO-Global Human Settlement Working Group (GHS WG).

Dennis Mwaniki was the Associate Director for Urban Planning & GIS at GORA Corp. before joining GORA Corp in 2014. He worked for 3.5 years as a GIS and research consultant at the Global Urban Observatory (GUO) and the Best Practices Section of UN-Habitat. In GUO, he developed and implemented the methodology for calculating the amount of land allocated to streets for over 100 cities. He contributed to the State of the World's Cities report: Prosperity of Cities in 2012-13; and to the publication "streets as public spaces and drivers of urban prosperity". He has also worked as a GIS and urban planning consultant with the Slum Dwellers International—Kenya; the Center for Urban Research and Innovations at the University of Nairobi; and various private companies based in Nairobi. He holds a Masters in Environmental Planning and Management and a Bachelors degree in Urban and Regional Planning. He is a member of the Global Human Settlements Working Group of the Group on Earth Observations (GHS WG).

Samba Ndiaye is the Head of the Regional Service of Statistics and Demography of the Dakar region with the National Agency of Statistics and Demography (Agence Nationale de la Statistique et de la Demographie-ANSD). Since 2010, he works in Senegal National Agency of Statistics and Demography where he has held various positions associated to the production, processing, and analysis of population and household data. He was a senior officer at the Senegal 2013 Population and Housing Census. Since 2013, he was promoted as the Head of the Regional Service of Statistics and Demography of the Dakar region.

Robert Ndugwa is currently the Officer in charge of the Global Urban Observatory Unit in the Research and Capacity Development Branch at the United Nations Human Settlements Programme (UN-Habitat) in Nairobi, Kenya. He is primarily responsible for the UN-Habitat's global urban monitoring and reporting on the global targets for the agency: MDG prior to 2015 and SDGs post 2015. Prior to joining UN-Habitat, Robert worked with UNICEF as head of Research, Evaluation and Statistics in Kenya Country Office, London School of Hygiene and Tropical Medicine-UK, University of Heidelberg-Germany, African Population and Health Research Center, Kenya, and Makerere University Kampala. Robert holds a PhD in Epidemiology and Biostatistics. His research interests include: urbanization and health systems dynamics, urban inequalities and marginalization, urban spatial analysis, and mapping, mobile technologies for data collection in urban and remote areas, slums and demographic surveillance systems, urbanization and adolescents transitions. His articles have appeared in: Journal of Urban Health; International Journal of Epidemiology; Journal of Child Health; Malaria Journal; Studies in Family Planning; Bulletin of World Health Organization among others. He has also contributed chapters in books.

Omondi Odhiambo is the Regional Coordinator of GORA Corp in Africa based in Nairobi, Kenya. He has more than 30 years of international development experience in the fields of demography, monitoring, evaluation, and sustainable urban development. Prior to joining GORA Corp in 2014, Dr. Odhiambo worked with the Global Urban Observatory, UN-Habitat, as a senior demographer where he coordinated the production of urban indicators for monitoring of the Habitat Agenda and the MDGs. During his tenure at UN-Habitat, he coordinated projects on Urban Inequities Survey; coordinated the collection, processing and homogenization of global databases for building a Global Exposure Database for Global Earthquake Model Foundation (GED4GEM); coordinated the statistics for the State of the World's Cities report: Prosperity of Cities in 2012–13; and coordinated the processing, analysis, and production of a joint publication between UN-Habitat and UNAIDS detailing HIV in Cities in 2013–14. Before joining UN-Habitat in 2005, Dr. Odhiambo worked with research organizations such as the Family Health International and Kenya Medical Research Institute and consulted for agencies such as GTZ, USAID, DFID, JICA, DANIDA, AMREF, Care International, JHPIEGO, among others. Dr. Odhiambo holds a Ph.D. in Urban

and Regional Planning, a Master of Science degree in Demography, a Master of Arts degree in Geography (population studies), and a Bachelor of Arts degree in Geography and History.

Romanus Opiyo is a lecturer at the Department of Urban and Regional Planning and an associate researcher with Centre for Urban Research and Innovations, University of Nairobi, Kenya. He has ten years University teaching and research supervision experience, and more than fifteen years undertaking research work. His research experience and interests are on urban security, transportation and general land use planning, climate change and institutional governance and livelihoods for which he has published widely. Dr. Opiyo has also consulted at various capacities with the Government of Kenya, UNEP, UN-HABITAT, UNDP, UNCRD, World Bank, DFID, IDRC, SIDA, among other national and international NGOs. He is a member of the Kenya Institute of Planners (KIP), the Town and County Planners Association of Kenya (TCPAK) and Environmental Institute of Kenya (EIK). He is also a member of the Kenya Urban Sector Reference Group-which is supporting the Council of Governors Urban Development Committee, a Member of Kenya Civil Society Network for NMT and Road Safety (CIVNET) and a Member of Kenya Transport Research Network. He holds a PhD and Masters in Urban and Regional Planning and a Bachelors degree in Social Sciences.

Prof. Oyebanji Oyeyinka is the director of UN-Habitat's Regional Office for Africa and was the director of UN-Habitat's Monitoring and Research Division and senior scientific advisor to UN-Habitat's Executive Director. Prior to joining UN-Habitat, Prof. Oyebanji Oyeyinka was and remains a professorial fellow at UNU-MERIT until December 2006. He is also a visiting professor at the Open University, UK. A Nigerian national, he joined the former UNU-INTECH (UNU-MERIT) in March 2001 after working with the United Nations Conference on Trade and Development (UNCTAD) as a senior economic affairs officer coordinating the 10-yearly review of the least developed countries (LDCs).

Alanus von Radecki is from the competence team "Urban System Engineering" and Integration Manager of TRIANGULUM project at Fraunhofer IAO. Alanus von Radecki is project leader of the innovation network «Morgenstadt City Insights» and the smart city lighthouse project "Triangulum". He holds M.Sc. degrees in Environmental Governance and Urban Sociology and is a PhD candidate in technology management. He has working experience in private sector, research and public sector institutions and is developing solutions for integrating smart city systems on a business and stakeholder level, leading to new approaches of collaboration between public and private institutions.

Raktim Ray presently at the School of Planning and Architecture, Bhopal, as assistant professor, Raktim Ray has his postgraduation (2009) in geography from the Presidency College, Kolkata, followed by a master's degree in planning (housing) from CEPT University, Ahmedabad (2011). For past 3 years, he has been associated with academics as an assistant professor. Till 2015, he was associated with School of Planning and Architecture, Vijayawada. He has specific research interest in political economies of cities, critical urban theory and spatial transformation. Raktim Ray has 2 years of work experience in consultancy at various organizations such as Development Alternatives, Centre for Research Development and Consultancy, CEPT University.

Greg Richards has taught Organizational Behaviour, Human Resource Management, Organization Design and Change Management. Prior to his academic appointment, Professor Richards worked at Transport Canada and at Consulting and Audit Canada as well as with Cognos Incorporated. He also has over 20 years of consulting experience and is a Certified Management Consultant. He now focuses on the development of research and curriculum building initiatives for the newly created IBM Centre for Performance Management, the application of Business Analytics methods and technologies in enabling organizational high performance.

Deepanjan Saha Trained as an Architect-Planner, Deepanjan has served Delhi Development Authority (DDA) for its review of Master Plan for Delhi – 2021. It had given him valuable insights on public-participatory approach in planning. Since July 2014, he is a research scholar with the Department of Architecture & Regional Planning, IIT Kharagpur as part of its Science and Heritage Initiative (SandHI). His research work attempts at assessing the contribution of creative and cultural industries towards development. Previously, he has pursued his interest in architectural conservation and has briefly worked on various conservation projects in and around Kolkata.

David Sandel is the President of Sandel & Associates and an accomplished Smart or Gigabit City executive. David and his team work with cities and community organizations to accelerate the development of their Smart or Gigabit City initiative. In this regard, David has served as an advisor to the Google Fiber Mayors Bi-state Innovation Team MBIT and was also the co-author of Playing to Win - the Kansas City Google Fiber Playbook. David is also the founder of The Gigabit City Summit. David received his Bachelor of Science in Electrical Engineering degree from Washington University in St. Louis where he also attended graduate school.

Pradip Kumar Sarkar trained as a civil engineer, and transport planner, Pradip Kumar Sarkar is a Professor and Head, Department of Transport Planning, School of Planning and Architecture, New Delhi. He is engaged in teaching, researching and consulting since the last three decades. Before joining the School in 1993, he worked as a Scientist in the Central Road Research Institute for 14 years. His research is focused on sustainable transportation systems. He has contributed over 100 papers. His latest book is titled 'Sustainable Transport Systems in the Context to Indian Cities'. He also published a text book 'Transportation Planning: Principle, Practice and Policies' in 2015.

Joy Sen has authored several books on subjects ranging from 'India's contribution to Global systems of Sciences, Culture and Religion' (2006), 'Principles of Indian Architecture' (2009), 'Sustainable Urban Planning' (TERI, 2012). He has delivered addresses at various international forums: Sustainability Research Center (IR3S), University of Tokyo and Tokyo Metropolitan University, Japan (2008, 2010, 2012); ISOCARP Congress at Athens (2002), Bilbao (2005), and Istanbul (2007); Chinese Academy of Social Sciences, Beijing (2006); Sains University, Malaysia (2011, 2013); Department of Urban and Regional Planning, MIT (2015) to name a few. He is the Principal Investigator for the Govt. funded interdisciplinary project 'SandHI'—Science and Heritage initiative (2014–2017) at IIT Kharagpur.

Stefano Serafini Philosopher and Psychologist with a background as a medievalist, Stefano Serafini is a researcher in the field of Epistemology, with a special interest in Intentionality and Form. He devoted 10 years to the study of Evolution and self-organization, and has carried on an original research on the origins of Semitic alphabets, together with his master, the geneticist Giuseppe Sermonti.

As founder member and director of the Salingaros Group, he takes part in researches and debates about biophilia in architecture, urbanism, and net theory, in Italy and abroad. He is the founder member of the International Society of Biourbanism.

Satyendra Singh is a Researcher and Smart city Consultant based in Germany. He works as a Visiting Lecturer at the University of Applied Sciences in Stuttgart and has acquired a valuable 18 years of professional experience ranging from smart city advisory to managing Geo-enabled technologies across the city disciplines. With an education profile ranging from Architecture, Environment Planning, and Geoinformatics, he has developed synergies across disciplines through professional work and involvement in academic settings in Europe and India. He has developed cross-functional management experience which spans across diverse mapping and smart technologies.

Priyanka Singh Adhoc Faculty—National Institute of Technology, Calicut; Master of Planning (Environmental Planning), School of Planning and Architecture, New Delhi; Bachelor of Architecture (B.Arch.), Birla Institute of Technology, Mesra, Ranchi. She is an architect-planner and has been working with National Institute of Technology Calicut for the last 1.5 years. Prior to this, she has worked as senior architect in a reputed architectural firm in New Delhi where she was leading the green building projects. Her keen research interests include sustainable urban development and city dynamics. She has presented research papers on the same in various national conferences.

Aparna Soni an architect (graduation 2005–2010) and urban and regional planner (postgraduation 2010–2012) from CEPT University, Aparna Soni is currently an assistant professor at the RICS SBE, School of Real Estate and Urban Infrastructure. She was associated with the School of Planning and Architecture, Vijayawada, for the period of 2013–2015, as an assistant professor in the department of planning. She has contributed as a research officer to the European Union-funded research project, 'Chance 2 sustain' bringing out urban governance deficiencies in terms of 'reluctant decentralization' in the capital city Delhi. His research interests include urban and regional governance, Smart Cities and planning legislations.

Prof. Dr. N. Sridharan is professor in the Regional Planning Department at the School of Planning and Architecture, New Delhi, where he has been teaching since 1990. He served as the director of SPA Vijayawada for 2 years, 2013–2015. With more than 30 years of experience in the field of urban and regional planning, he has been an advisor to various state governments and central government. He has been a technical member of FICCI and a part of the think tank for Andhra Chamber of Commerce and Industry. His specialization includes urban governance and poverty, corridor development, regional development, infrastructure financing and coastal area planning. An economist by discipline, Dr. Sridharan has a Ph.D. from the Royal Melbourne Institute of Technology, Australia,

in urban planning, a master's degree in urban and regional planning, in addition to postgraduate diplomas in town and country planning and financial management. He has been the recipient of many prestigious scholarships, including the Polish Government Scholarships of UNESCO and Australian Government Scholarship. He is one of the vice presidents of the Regional Science Association, India. N. Sridharan has also been a visiting research fellow at the University of Amsterdam; Institute of Social Studies (ISS), The Hague; University of Paris-7; University of Cologne, Germany; and University of Queens, Belfast.

Dr. Eleni Tracada is a principal tutor in University of Derby in the Built Environment (Architecture), Chartered Member RIBA Part III and senior fellow of HEA. In 1980, she graduated in architecture at the Faculty of Architecture of Florence; she worked as a self-employed architect in Florence from 1983 to 1993. In 1996, she was awarded a master's degree in interior design at Manchester Metropolitan University, and in 2015, a Ph. D. by published works at the University of Derby. She is a member of the Scientific Committee of the International Society of Biourbanism and editor in chief of the Journal of Biourbanism (2011–2014).

Prof. T.M. Vinod Kumar is an urban planner with more than 45 years of experience in teaching, research and consultancies in India, China, Bhutan, Nepal, Pakistan, Indonesia and Malaysia. Academic positions he had held include Dean of studies, HOD, urban planning, head of centre for analysis and system studies, head of centre for RS and GIS; School of Planning and Architecture, New Delhi, and visiting professor, Institute of Technology, Bandung, and National Institute of Technology, Calicut. He worked with the Ford Foundation and also as regional program coordinator in International Centre for Integrated Mountain Development. He is author of many books and journal articles and his last two edited books are 'GIS for Smart Cities' (Copal: 2014) and 'E-Governance for Smart Cities' (Springer: 2015). He is the coordinator and editor of this book 'Smart Economy in Smart Cities' (Springer: 2016).

Chris Webster has degrees in urban planning, computer science, economics and economic geography and is a leading urban theorist and spatial economic modeller. He has published over 150 scholarly papers on the idea of spontaneous urban order and received over US$20M grants for research and teaching and learning projects. He was co-editor of Environment and Planning B for ten years. Books include Webster and Lai (2003) *Property Rights, Planning and Markets*, Cheltenham, Edward Elgar; Glaze, Webster and Frantz, (2006) *Private Cities*, London, Routledge; Wu, Webster, He and Liu, (2010) *Urban Poverty in China*, Cheltenham: Edward Elgar; and Wu and Webster (Editors) *Marginalisation in Urban China*. London: Palgrave McMillan; and Sarkar, Webster and Gallacher (2014) Healthy Cities: Public Health Through Urban Planning. Cheltenham: Edward Elgar. Professor Webster has five prize-winning academic papers on urban theory. His present professional mission is to change the way cities are planned in China and his current research agenda is to establish systematic evidence for the relationship between urban configuration (planned and spontaneous) and individual health. He is currently PI on a UK ESRC-funded 'Transformative Research' project that is creating 700 built environment morphometrics for each of the 500,000 members of the UK Biobank, the country's flagship epidemiological study.

Günter Wenzel is part of Competence Center Virtual Environments at Fraunhofer Institute of Industrial Engineering (IAO). He is involved in the research which explores communication methods with state-of-the-art visualization techniques. His research interests include Virtual Environments, Participatory Design, Augmented Reality, Visualization and Virtual Reality Applications.

Part I
Introduction

Chapter 1
Smart Economy in Smart Cities

T.M. Vinod Kumar and Bharat Dahiya

Abstract Emerging patterns of urbanization world over show differing scenarios in different continents, requiring diverse approaches, policies, and strategies. Amazing democratization of ICT around the world leads to a discussion on sustainable, resource-conserving, and resilient smart cities, and smart city economic development appropriate to different cities, countries, and continents. It can be possible that each city in a particular country and continent may possess differing challenges to smart city economic development. When ancient rural economy gives way to urban economy, which contributes a major share of national domestic product, the emerging question is what constitutes smart city economic development. How is it different from conventional urban economy? Is the theory and practice of conventional urban economy valid in a smart city economy or is it necessary to investigate newer theory and practice of smart city economic development? What is a food shed in a smart city economy in smart cities? What a smart city industry looks like? What constitutes smart city commerce services, transportation, and communication, and how they impact on smart city economy? How do smart cities fit in the urban dynamism and policy dialogue at the global, regional, and national levels? Can smart cities and smart economy be socially inclusive? How to strategize social inclusion in smart city development? What sort of governance and institutional support would smart cities require to fulfil their role with regard to smart economy? What may constitute a Sustainable Model of smart cities economic development, and what may be Smart Cities Standards? These are some of the questions addressed in this chapter.

Keywords Urbanizing world · Challenge of smart cities · Democratization of smart ICTs · Smart city system · Smart economy · Sustainable models of smart cities ·

T.M. Vinod Kumar
Department of Architecture, National Institute of Technology-Calicut, Kozhikode, India
e-mail: tmvinod@gmail.com

B. Dahiya (✉)
Social Research Institute (CUSRI), Chulalongkorn University, Bangkok, Thailand
e-mail: Bharat.D@chula.ac.th; bharaturban1@gmail.com

Smart cities standards · Smart economy unique in a smart city · Transition to smart economy in smart cities theory and practice · Collaborative research programme

1.1 Urbanizing World and the Challenge of Smart Cities

'We live in the times of a global urban transition' [1]. Historically, cities are considered as the highest forms of economic and sociocultural achievements in human civilization [2], and the location of non-primary economic activities. At present, cities are production centres for goods and services for both internal and external consumption. Cities embody a sense of unique human entrepreneurship, economic dynamism, and evolving multiculturalism—all aided by the incessant technological progress that we see unfolding every day. Today's city is a high-speed communication hub with strong modern information and communication technologies' (ICTs) infrastructure that connects the city with cities all over the world in real time. The communication devices are fast evolving from desktop computers to laptop and slate, and now they are moving towards wearable devices, such as mobile phones and other gadgets. Cities function as 'engines of economic growth' and dominate local and national economies [3–5]. Cities also act as 'magnets of hope' for a vast array of skilled and unskilled people who flock to them to find better livelihoods and lifestyles. Cities are able to perform these multifarious functions as they proclaim to have better infrastructure and services (compared to their rural counterparts), which aids their agglomeration economies and related creative and technology-driven production processes. City dwellers with comparatively higher Human Development Index of tomorrow can only survive if they are on the path of continuous learning, and can become never-exhausting storehouse of superior creativity and innovation to compete with their better-quality products and services around the world. It is due to all these factors that in recent decades cities-led economic growth has featured prominently in the national economic policies of many countries [3–7].

1.1.1 Urbanizing World

The first decade of twenty-first century has seen the world becoming 'urban' [8, 9]. *The Economist* declared in 2007, 'Wisely or not, *Homo sapiens* have become *Homo urbanus*' [10]. Seven years on, in 2014, 3.9 billion people or 53.6 % of world's population resided in urban areas (Fig. 1.1) [11]. Urbanization rates, i.e. proportion of population living in cities and towns, vary across the world's major regions. According to the most recent data available, urbanization rates in 2014 stood at 40.0 % in Africa, 47.5 % in Asia, 73.4 % in Europe, 79.5 % in Latin America and the Caribbean, 81.5 % in North America, and 70.8 % in Oceania [11]. With
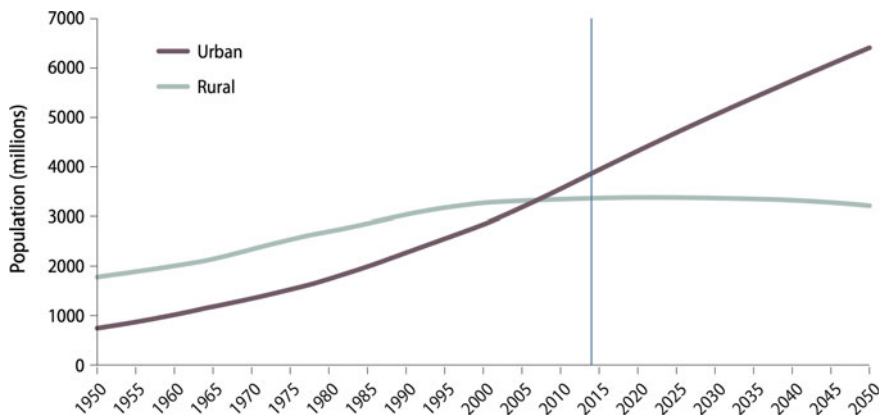
Fig. 1.1 Urban and rural population of the world, 1950–2050. *Source* United Nations, p. 7 [12]

positive urban demographic growth rates, the urbanization trend continues in all major regions. Among the three developing regions, urban demographic growth rates are highest in Africa and Asia followed by Latin America and the Caribbean.

Within our urbanizing world, the major regions show a diverse though converging trends with regard to urbanization process. Europe, North America, and Oceania already had crossed 50 % urbanization mark when demographic data keeping began by the United Nations in 1950; their urbanization rates in 2014 stood at 73.4, 81.5, and 70.8 %, respectively (Table 1.1; Figs. 1.2 and 1.3). Latin America and the Caribbean urbanized rapidly during 1950–2000 and, in 2014, reached an urbanization rate of 79.5 % that was much higher than that of Europe. These four regions are highly urbanized (over 70 %) with lower urban growth rates than the urbanizing regions of Africa and Asia.

In 1950, Africa and Asia started with less than 20 % urbanization rate, and this indicator measured 34.5 and 37.5 %, respectively, in 2000. Despite slow economic growth, Africa's urban population grew almost ninefold between 1950 and 2000. Although its urban population base is much smaller than that of Asia, Africa is growing rapidly and is estimated to reach 50 % urbanization rate by 2037. In recent decades, the urbanization process has accelerated in Asia on the back of sustained economic growth in the region. Between 1990 and 2010, Asian urban population increased by over 754 million, which was equal to the combined population of the European Union and the USA; no other continent has undergone such massive population growth in such a short span of time [4, 7]. With 47.5 % urbanization rate in 2014, Asia is estimated to hit 50 % urbanization mark in 2018.

Demographic record of the past 65 years confirms that the major regions have experienced diverse trends in the urbanization process. Looking towards the future, particularly from now in 2016, it is estimated that all major regions will undergo further urbanization until 2050 (Table 1.1; Figs. 1.2 and 1.3). This is mainly because cities are considered 'engines of economic growth' as they are able to

Table 1.1 Urban population (in million) and its proportion to total population, by major regions, 1950–2050

Major region	1950	1975	2000	2025	2050
Africa	32 *14.0*	103 *24.7*	279 *34.5*	659 *44.9*	1339 *55.9*
Asia	245 *17.5*	597 *25.0*	1,393 *37.5*	2,561 *53.9*	3313 *64.2*
Europe	283 *51.5*	443 *65.4*	517 *70.9*	562 *75.8*	581 *82.0*
Latin America and the Caribbean	69 *41.3*	197 *60.7*	396 *75.3*	567 *82.1*	674 *86.2*
North America	110 *63.9*	179 *73.8*	249 *79.1*	325 *83.4*	390 *87.4*
Oceania	8 *62.4*	15 *71.9*	22 *70.5*	32 *71.1*	42 *73.5*
World	764 *29.6*	1,535 *37.7*	2,856 *46.6*	4,706 *58.2*	6,339 *66.4*

Note Urban population is shown in millions. Proportion (%) is shown in *italics*
Source United Nations [11]
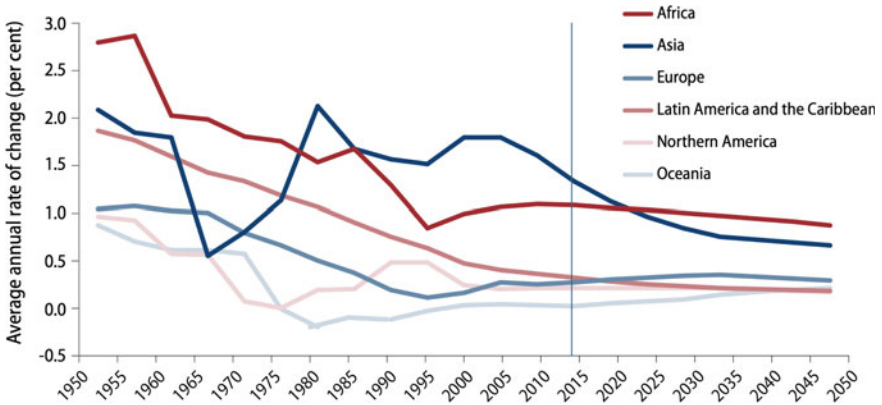
Fig. 1.2 Average annual rate of change of the percentage urban by major areas, 1950–2050.
Source United Nations [12]

attract secondary and tertiary activities, skilled people, domestic and foreign direct investments and, in turn, contribute to national economic output.

While urban economies grow in unprecedented ways, a significant proportion of urban workers in developing countries is engaged in vulnerable (often called informal) employment. Lack of skilled workers, especially with vocational education and training, inhibits the expansion of urban economies in a variety of growth avenues. Therefore, an environment of human transformation through continuous learning shall be inbuilt in cities to justify their very existence. By
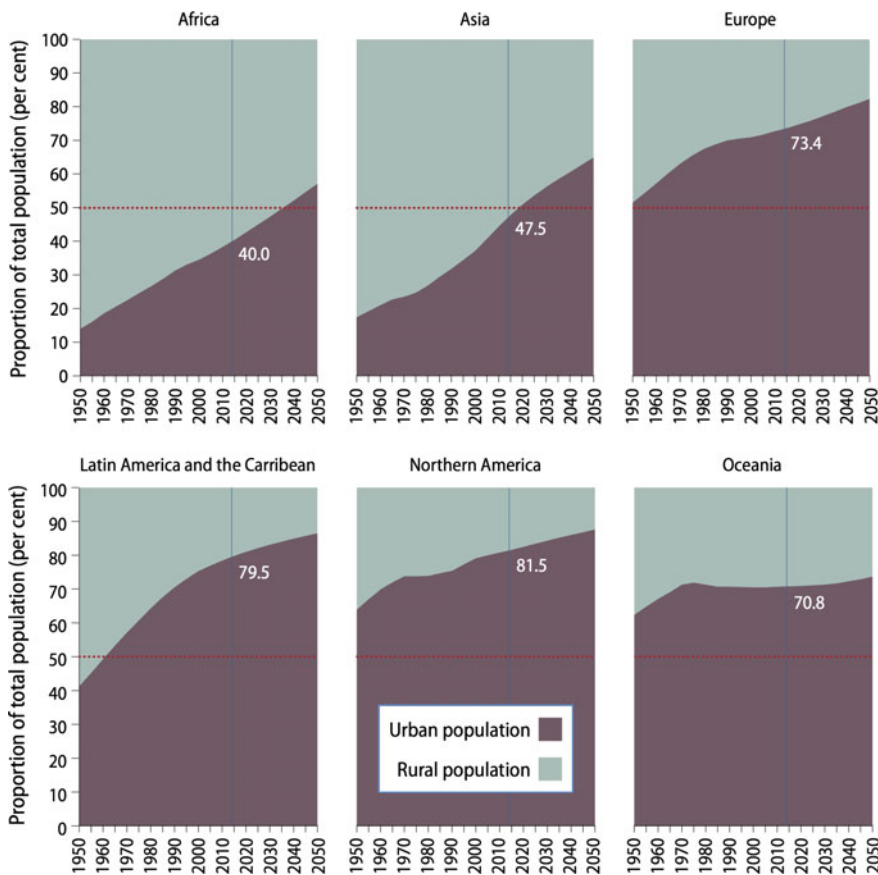
Fig. 1.3 Urban and rural population as proportion of total population, by major areas, 1950–2050. *Source* United Nations, p. 8 [12]

offering such learning activities in every city, skills of informal workers can be upgraded for them to become creative workforce with the capacity to innovate in all walks of life. There is vast scope for innovation in informal economic activities. Local businesses struggle to keep up with fast-evolving market conditions and new, tech-savvy competitors. Local entrepreneurs, keen to start new, small businesses, lack access to local or non-local customers. Relatively large, transnational corporations seem to benefit from social media rather than their smaller, local counterparts. In today's digital world, the economic losers seem to be those who are unable to capitalize on the modern ICTs.

The economic dimension of sustainable urban development is related to the overall challenge of sustainable development, which includes economic, social, and environmental dimensions. Sustainable development has been theorized and put in practice in many ways since late 1980s [13]. This concept has received renewed

attention due to the Rio+20 Conference held in Brazil in 2012, and the reformulation of 'Millennium Development Goals' into 'Sustainable Development Goals' (SDGs). Approved by the United Nations General Assembly in September 2015, the SDGs include '*Goal* 11—*Make Cities and Human Settlements inclusive, safe, resilient and sustainable*' [14, 15]. Economic development of cities and towns has huge implications for making cities safe, resilient, and sustainable. It is against this contextual backdrop that the idea of 'smart city' has been taking shape in recent years.

1.1.2   Information Age and Smart Cities

Since the late 1980s, almost parallel to the idea and practice of sustainable development, the world has seen the consolidation of the Information Age on the back of Internet and World Wide Web, the ever-expanding democratization of digital or ICTs, and the development of computer hardware and software industries. Although the earlier forms of Internet were in use since 1960s, its global usage received a boost after the invention of the World Wide Web (the Web) by Tim Berners-Lee in 1989. During the 1990s, the world witnessed a digital explosion in the use of Internet and the Web. As the practice of using e-mail spread, along with the advent of graphics-based Web browsers, Internet and the Web became part and parcel of people's daily lives. As large amounts of information started to be uploaded and made available on the Web, a series of search engines were designed and put to use, such as WebCrawler, Magellan, Excite, Infoseek, Inktomi, Northern Light, AltaVista, and Netscape, which were later joined by Google, Bing, and Yahoo! [16]. In 2001, Wikipedia was launched that added another, inclusive dimension to the use of the Web. The Internet and Web have become so commonplace now that for lots of people, especially youngsters, it is quite difficult to imagine how human life and the world were like without e-mail, Web search engines, online encyclopaedias and e-commerce, just to name a few!

The ever-increasing usage of the Internet and the Web has come hand in hand with the invention, development, and utilization of ICTs. Countless inventions have been made in the refinement of ICTs, such as personal computers (PCs), laptops and notebooks, far-away-Xerox (FAX) machines, digital and three-dimensional (3D) printers, scanners, and photocopiers. Wireless local area network (WLAN or Wi-Fi), teleconferencing, videoconferencing, and Web conferencing—including 'webinars' (Web seminars), webcasts, peer-level meetings—have become ordinary terms. Internet technologies support real-time, point-to-point communication that has transformed information flows, giving rise to new fields, for instance telemedicine. The consolidation of Information Age has been facilitated by the development of computer hardware and software industries, which have transformed the economies of cities and regions, particularly in the form of information technology (IT) parks and knowledge parks. Further, the Information Age builds on the continuing spread of—and facilitated by the progressive fall in the prices

of—ICTs, massive investments in the extension of IT infrastructure across nations, and the global spread of electronic literacy (e-literacy).

The arrival of smartphone in recent years has reenergized the Information Age and the world of ICTs. A combination of mobile or cell phone and handheld computer, smartphone is credited with creating the greatest technological revolution since the Internet [17]. A standard smartphone supports in addition to the basic telephone features such as Internet and Web access, e-mail and audio-visual communication, all sorts of digital applications (or apps), music and movie player, camera and camcorder, voice dictation, global positioning system or GPS navigation, among others. On the one hand, smart digital devices including smartphones, tablet computers, and phablets (PHonetABLET) are changing the ways in which people communicate, socialize, live, and work in villages, cities, regions, and nations. On the other hand, social media, which depends on mobile phone and Web-based technologies, has aided the spread of smart digital devices and their usage around the world and, in turn, demands further extension of IT infrastructure and development of ICTs.

All of this has led to a phenomenal growth in worldwide information flows on economy, society, culture, environment, and the like. Based on the analysis of such multitudinous flows, sociologist Manuel Castells proclaimed in the late 1990s the advent of *Network Society* through his famous trilogy on *The Information Age* [18–20]. More recently, Jeremy Rifkin has argued that the 'digitalized communication Internet is converging with a digitalized, renewable "Energy Internet" and a digitalized, automated "Transportation and Logistics Internet" to create a super "Internet of Things" (IoT) infrastructure' [21]. In Europe, IoT is increasingly viewed as 'the next revolution' [22]. For Rifkin, however, a super IoT—a combination of communication Internet, renewable 'Energy Internet', and automated 'Transportation and Logistics Internet'—goes further and is already acting as a harbinger of the 'Third Industrial Revolution' and a new economic paradigm of 'Collaborative Commons' [23]. An example of this is 'sharing economy' that has been expanding over the past few years [24], although the rules and regulations that govern it are yet to be fully devised. Further, sharing economy is understood to have interconnections with smart cities [25].

The notions of smart cities and smart economy have come when problems related to cities, their planned and sustainable development, efficient management, and effective and participatory governance abound, within the larger context of climate change [26] and global economic slowdown [27]. The smart city concept is built on a combination of ideas on how ICTs might contribute to improvements in the functioning of cities, improving their competitiveness, enhancing their efficiency, and finding new ways to tackle problems of poverty, social deprivation, and poor environmental management [28]. It is not surprising that the notion of smart city directly relates to the concept and international practice of sustainable urban development. It can therefore be surmised that the notion of smart cities and its implementation could potentially contribute to the concept and practice of sustainable urban development that includes economic, environmental, and equity concerns.

1.1.3 'New Urban Agenda' and Smart Cities

In October 2016, 'Habitat III' or the Third United Nations Conference on Housing and Sustainable Urban Development will take place in Quito, Ecuador. The United Nations General Assembly decided to convene the Habitat III Conference to reinvigorate the global commitment to sustainable urbanization, and to focus on the implementation of a 'New Urban Agenda' [29]. According to the 'Vision for Habitat III' document, the Conference will consider the following three key elements for creating a pattern of sustainable urban growth [30]:

(a) *National Urban Policy* that 'establishes a connection between the dynamics of urbanization and the overall process of national development'.
(b) *Laws, Institutions and Systems of Governance*, which 'create the normative basis of action, the operational principles, organizational structures, and institutional and societal relationships underlying the process of urbanization'.
(c) *Urban Economy*. 'While there is a strong positive correlation between economic growth and urbanization, this potential relationship is not spontaneous and self-generating. Habitat III could be the means to place the central pillars for robust urban economic development'. In today's urbanizing world and Information Age, this translates into an agenda for smart economy in smart cities, which will be detailed out later in this chapter. It will be a misconception that if governments beg and/or borrow, and pour billions of dollars in selected cities, smart cities will come up. It is again a misconception that if large capitalist and multinational companies locate industries in some cities smart economy will rise. On the contrary, the culture of Smart People in a smart city has to deliberately decide that they are changing over from conventional urban economy to smart economy and act in order to create a smart economy. The *sine qua non* for this transformation is the basic requirement of smart economy.

Habitat III will take into account three 'operational factors' that could help maximize the advantages of the urbanization process, which are (i) urban planning, (ii) local fiscal systems, and (iii) investment in urban basic services. Further, the Habitat III Vision document states that the Conference will offer the following [30]:

(1) 'Rethink the Urban Agenda. By embracing urbanization at all levels of human settlements, more appropriate policies can embrace urbanization across physical space, bridging urban, peri-urban and rural areas, and assist governments in addressing challenges through national and local development policy frameworks.
(2) Integrate Equity to the Development Agenda. Equity becomes an issue of social justice, ensures access to the public sphere, extends opportunities and increases the commons.
(3) Foster national urban planning and planned city extensions.
(4) Decide how relevant SDGs will be supported through sustainable urbanization.

(5) Align and strengthen institutional arrangements with the substantive outcomes of Habitat III, so as to ensure effective delivery of the new Urban Agenda.

(6) Revise and renew UN-Habitat's mandate to ensure that it is fit for purpose'.

In recent years, a large amount of literature has been generated on smart cities [31–45] as well as on how to understand them [46]. Habitat III Secretariat has brought out an Issue Paper on smart cities that provides an overview of the subject [47]. Scholars, practitioners, and policy makers are in the early stages of understanding smart cities and making policies and programmes to support their development, management, and governance. This is more so when it comes to smart economy in smart cities.

In view of foregoing discussion, there are nine pertinent questions and points that this international collaborative research programme aims to address:

(1) What is a Smart City System?
(2) What is the economic role of cities?
(3) What is the nature of conventional urban economy and local economic development models?
(4) What is current thinking on smart economy and smart cities?
(5) What can be a conceptual framework for smart economy in smart cities?
(6) Can smart cities and smart economy be Socially Inclusive? How to strategize social inclusion in smart city development?
(7) What sort of governance and institutional support would smart cities require to fulfil their role with regard to smart economy?
(8) Sustainable Model of Smart Cities, and Towards Smart Cities Standards?

These eight questions and themes are addressed in the next eight Sects. (1.2–1.9).

1.2 What Is a Smart City System?

1.2.1 Smart City System

A Smart City System comprises of six key building blocks: (i) smart people, (ii) smart city economy, (iii) smart mobility, (iv) smart environment, (v) smart living, and (vi) smart governance. These six building blocks are closely interlinked and contribute to the 'Smart City System', as illustrated in Fig. 1.4. Some authors treat the six elements of a Smart City System equally [35]. However, following Vinod Kumar [48], we give prominence to 'smart people' because without their active participation and involvement a Smart City System would not function in the first place. A Smart City System will risk its efficient functioning without Smart People (more on this in Sect. 1.7).

Fig. 1.4 Smart City System building blocks. *Source* Vinod Kumar, p. 19 [48]

1.2.2 Smart City System—Towards a Manifesto

As urbanization challenges continue to grow and further consolidation of the Information Age takes place around the world, it will become increasingly critical to utilize all possible ways to improve urban living along with social inclusion, economic development, and environmental sustainability. In this regard, it becomes pertinent to think through what constitutes and how to strengthen the various building blocks of a Smart City System. Below, an attempt is made to elaborate the six building blocks that could help develop a manifesto for a Smart City System.

1.2.2.1 Smart People

'Smart People', the fundamental building block of a Smart City System, require many crucial attributes as given.

(1) Smart people excel in what they do professionally.
(2) Smart people have a high Human Development Index [48].
(3) A smart city integrates its universities and colleges into all aspects of city life.
(4) It attracts high human capital, for example knowledge workers.
(5) A smart city maintains high Graduate Enrolment Ratio and has people with high level of qualifications and expertise.
(6) Its inhabitants opt for lifelong learning and use e-learning models.
(7) People in a smart city are highly flexible and resilient to the changing circumstances.

(8) Smart city inhabitants excel in creativity and find unique solutions to challenging issues.
(9) Smart people are cosmopolitan, are open-minded, and hold a multicultural perspective.
(10) Smart people maintain a healthy lifestyle.
(11) Smart people are actively involved in their city's sustainable development, its efficient and smooth functioning, its upkeep and management, and making it more liveable.

1.2.2.2 Smart City Economy

'Smart City Economy', the second building block, requires the following attributes.

(1) A smart city understands its economic DNA.
(2) A smart city is driven by innovation and supported by universities that focus on cutting-edge research, not only for science, industry, and business but also for cultural heritage, architecture, planning, development, and the like.
(3) A smart city highly values creativity and welcomes new ideas.
(4) A smart city has enlightened entrepreneurial leadership.
(5) A smart city offers its citizens diverse economic opportunities.
(6) A smart city knows that all economics works at the local level.
(7) A smart city is prepared for the challenges posed by and opportunities of economic globalization.
(8) A smart city experiments, supports, and promotes sharing economy.
(9) A smart city thinks locally, acts regionally, and competes globally.
(10) A smart city makes strategic investments on its strategic assets.
(11) A smart city develops and supports compelling national brand/s.
(12) A smart city insists on balanced and sustainable economic development (growth).
(13) A smart city is a destination that people want to visit (tourism).
(14) A smart city is nationally competitive on selected and significant factors.
(15) A smart city is resourceful, making the most of its assets while finding solutions to problems.
(16) A smart city excels in productivity.
(17) A smart city has high flexibility of labour market.
(18) A smart city welcomes human resources that enhance its wealth.
(19) A smart city's inhabitants strive for sustainable natural resource management and understand that without this its economy will not function indefinitely.

1.2.2.3 Smart Mobility

'Smart Mobility', the third building block of a Smart City System, includes the following features.

(1) A smart city focuses on the mobility of people, and not only that of vehicles [49, 50].
(2) A smart city will advocate walkability and cycling.
(3) A smart city has vibrant streets (at no additional cost).
(4) A smart city effectively manages vehicular and pedestrian traffic, and traffic congestion.
(5) A smart city has pleasurable (bicycle) routes.
(6) A smart city has balanced transportation options.
(7) A smart city will have mass rapid transit system, such as metro rail, light metro, monorail, or 'skytrain' for high-speed mobility.
(8) A smart city will have integrated high-mobility system linking residential areas, work places, recreational areas, and transport notes (e.g. bus/railway station/s and airport).
(9) A smart city will practice high-density living, such that benefit of high-speed mobility is uniformly available.
(10) A smart city has seamless mobility for differently-abled (often incorrectly called, disabled) people.

1.2.2.4 Smart Environment

'Smart Environment', the fourth building block, has the following attributes.

(1) A smart city lives with and protects the nature.
(2) A smart city is attractive and has a strong sense of place that is rooted in its natural setting.
(3) A smart city values its natural heritage, unique natural resources, biodiversity, and environment.
(4) A smart city conserves and preserves the ecological system in the city region.
(5) A smart city embraces and sustains biodiversity in the city region.
(6) A smart city efficiently and effectively manages its natural resource base.
(7) A smart city has recreational opportunities for people of all ages.
(8) A smart city is a green city.
(9) A smart city is a clean city.
(10) A smart city has adequate and accessible public green spaces.
(11) A smart city has an outdoor living room. Unlike the indoor living room in houses where we meet others, outdoor living rooms are aesthetically designed intimate, active, and dynamic urban realms where people meet face to face for a culturally and recreationally rich and enjoyable contact as part of living and work.

(12) A smart city has distinctive and vibrant neighbourhoods that encourage neighbourliness and a spirit of community.

(13) A smart city values and capitalizes on scenic resources without harming the ecological system, natural resources, and biodiversity.

(14) A smart city has an integrated system to manage its water resources, water supply system, wastewater, natural drainage, floods and inundation, especially in the watersheds where it is located, especially in view of the (impending) climate change.

(15) A smart city focuses on water conservation and minimizes the unnecessary consumption of water for residential, institutional, commercial, and industrial use, especially in the arid and semi-arid areas.

(16) A smart city has an efficient management system for the treatment and disposal of wastewater, and reuse of treated wastewater, particularly in the arid and semi-arid areas.

(17) A smart city has an efficient management system for the collection, treatment, and disposal of industrial wastewater.

(18) A smart city has an integrated and efficient management system for the collection, transfer, transportation, treatment, recycling, reuse, and disposal of municipal, hospital, industrial, and hazardous solid waste.

(19) A smart city has an efficient system to control air pollution and maintain clear air, especially in the air sheds where it is located.

(20) A smart city has an efficient and effective system for disaster risk reduction, response, recovery, and management.

(21) A smart city has and continually upgrades its urban resilience to the impacts of climate change.

(22) A smart city can create a low-carbon environment with focus on energy efficiency, renewable energy, and the like.

1.2.2.5 Smart Living

'Smart living', the fifth building block of a Smart City System, includes the following features.

(1) A smart city has strong and shared values.

(2) A smart city records and celebrates local history, culture, and nature.

(3) A smart city has a vibrant downtown, 24 h and 7 days a week.

(4) A smart city can provide the necessary safety and security to women, children, and senior citizens.

(5) A smart city improves the urban way of life.

(6) A smart city builds natural and cultural assets to build a good quality of life.

(7) A smart city not only understands the big picture of urban liveability, but also pays attention to small details.

(8) A smart city has high-quality open and accessible public spaces.

(9) A smart city has high-quality public services and amenities.

(10) A smart city is an ideal place of living, especially for women, children, and senior citizens.
(11) A smart city organizes festivals that celebrate people, life, and nature in city.
(12) A smart city has a ritual event (or more) that symbolizes the values and aspirations of the community.
(13) A smart city celebrates and promotes art, cultural, and natural heritage in the city.
(14) A smart city engages artists to improve and enrich the aesthetics of daily life of the city.

1.2.2.6 Smart Governance

'Smart Governance', the six and final building block, has the following attributes.

(1) A smart city practices accountability, responsiveness, and transparency (ART) in its governance.
(2) A smart city uses big data, spatial decision support systems and related geospatial technologies in urban and city regional governance.
(3) A smart city constantly innovates e-governance for the benefit of all its residents.
(4) A smart city constantly improves its ability to deliver public services efficiently and effectively.
(5) A smart city practices participatory policy-making, planning, budgeting, implementation, and monitoring.
(6) A smart city has a clear sustainable urban development strategy and perspectives known to all.
(7) A smart city utilizes creative urban and regional planning with focus on the integration of economic, social, and environmental dimensions of urban development.
(8) A smart city features effective, efficient, and people-friendly urban management.
(9) A smart city practices E-Democracy to achieve better development outcomes for all.
(10) A smart city embraces a Triple Helix Model in which government, Academia and Business/Industry practice changing roles in Governance.

1.2.3 Evolving Conceptualization

The conceptualization of a Smart City System has evolved, initially presented in 'Geographical Information System for Smart Cities' [43], through 'E-governance for Smart Cities' [44], and to this chapter. For this international collaborative

research programme, the conceptualization of Smart City System elaborated above has been used. It is quite possible that this conceptualization may further evolve in the future as new challenges to smart city and Smart City System emerge, new knowledge is generated, and further empirical research is conducted. Moreover, the elaboration of the six building blocks could help develop a manifesto for a Smart City System, as noted above.

1.3 The Economic Role of Cities

1.3.1 Urbanization, Cities, and Economic Growth

University textbooks often underline the positive correlation between urbanization and economic growth within national economies. Based on the analysis of long-term statistics World Bank [51], UN-Habitat [5] noted that 'while the share of urban populations worldwide increased from 33 to 51 % between 1960 and 2010, per capita income increased by 152 %—from US $2382 to US $6006—over the same period' (p. 43). Backing from such statistics has repeatedly confirmed the notion that urbanization and economic growth go hand in hand [7]. This is especially true when it comes to aggregate figures, such as those highlighted above by UN-Habitat [5]. However, there are exceptions to this. For example, despite slower economic growth compared to other regions, Africa's urban population grew almost ninefold between 1950 and 2000; some have termed this phenomenon as 'urbanization without growth' [52].

Following from the general and positive correlation between urbanization and economic growth, cities are now recognized as engines of economic growth [3–5]. For example, cities in Asia generate over 80 % of national gross domestic product (GDP) [3, 4]. This has led governments to include urbanization as part of national economic development policies, such as in China and India in recent decades.

1.3.2 Size of Cities and Economic Growth

Cities are abode of prosperity, but their wealth depends on their population size and other factors. Statistics show that the city size matters a great deal in GDP generation of a city in a country. The Economist [53] found that in the USA 164 million people live in 50 major metropolitan areas, while in Europe there are only 102 million inhabitants in metropolitan area. The GDP of European metropolitan areas is of smaller size in comparison with those in the USA. The European metropolitan areas produce 72 % of the GDP of 50 largest cities of the USA. Further, in 31 American states, one or two metropolitan areas account for the vast majority of a state's economic production, and in 15 other states, a large metropolitan area alone produces most of the GDP [54]. Seventeen major

metropolitan areas generate 50 % of the USA's GDP. An article in The Wall Street Journal [55] explains how US major metropolitan areas produce a higher GDP than the economies of entire nations. Urbanization is also different in terms of city size classes in these two areas. In Europe, 67 % of urban inhabitants live in medium-sized urban centres (i.e. smaller than 500,000 inhabitants), while just 9.6 % are located in cities having more than five million inhabitants. In the USA, one out of five urban inhabitants lives in major cities having more than five million people. Thus, there is a strong indication that population size of a city matters with regard to its urban economy.

In 2011, India had 53 metropolitan cities (Fig. 1.5). Large metropolitan cities do have capacity to generate more wealth than smaller ones, as noted above. However,
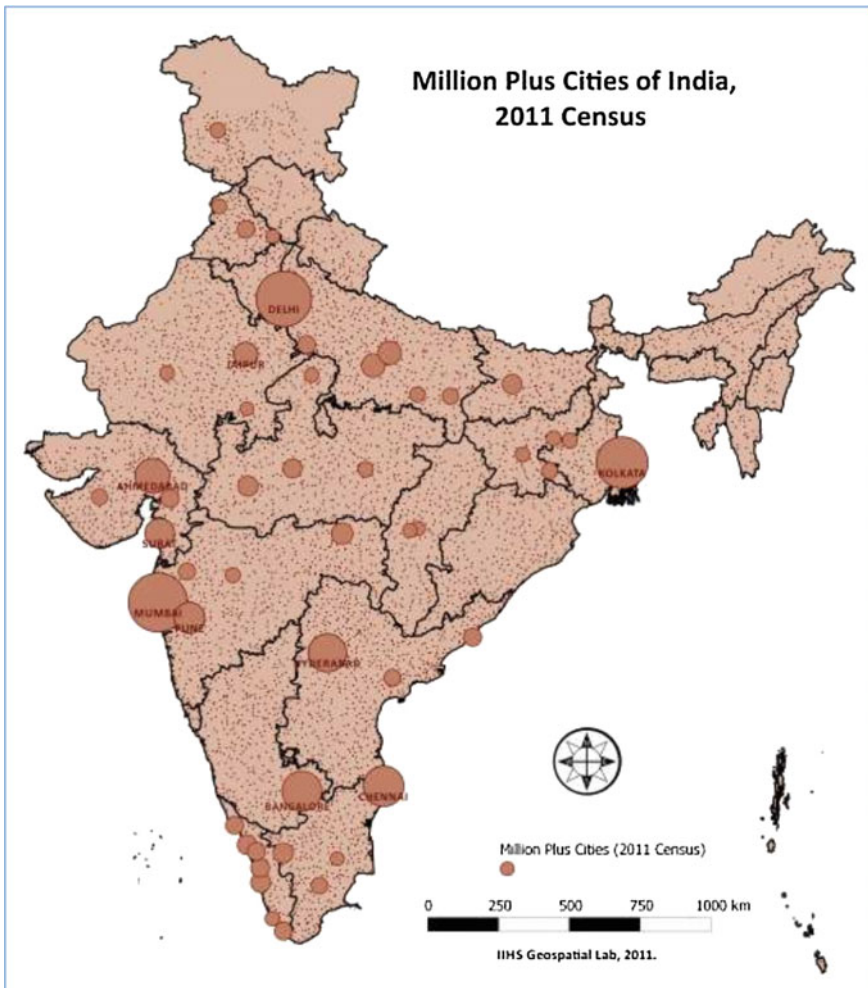
Fig. 1.5 Metropolitan cities in India, 2011. *Source* Indian Institute of Human Settlements [57, p. 10]

there are no or little data available in India on the GDP contribution of metropolitan (and other) cities. Mumbai and Delhi are two mega-cities in India. Delhi is growing fast and has already become the second largest populated mega-city in the world (after Tokyo). Mumbai generates more tax revenues for India through its vibrant economy than any other city probably because of its urban economy and population size. Delhi boasts of the highest per capita income in India.

It is also being documented in very limited scale that GDP creation of smart cities outpaces several times than of non-smart cities in many countries [36, 56]. These statistics are yet to be known to many.

1.3.3 Urbanization and Economic Development in India

Urbanization trend of India is given in Table 1.2. Urban India has grown at an unprecedented rate in the last two decades. A conservative estimate of India's population growth shows that by 2031 the total population is expected to reach about 1.5 billion, of which the urban population is estimated to be about 600 million, i.e. approximately 40 %. Growth of urban settlements as statutory towns, census towns, and urban agglomeration is shown in Table 1.3.

Until lately, it was believed that India lives in its villages. However, Census of India 2011 showed that more population addition took place in urban areas than in rural areas. It can be seen from Table 1.3 that greater number of settlements in India had transformed to Census Towns adding more of urban character to India. Also there is a rapid tendency to form urban agglomeration, and the decadal growth in urban agglomerations stood at 23.7 %. There are also instances in which two adjacent urban agglomerations merge into one big urban agglomeration. During the ten-year period (2001–2011), there was only 6.37 % increase in the number of statutory towns. This shows that in coming years urban agglomeration may become the unit of planning and replace the approach of preparing statutory plans for Municipalities and Municipal Corporations. More and more Metropolitan Planning

Table 1.2 Trends in India's urbanization: 1961–2011

Census year	Urban population (in million)	Proportion urban	Annual exponential growth rate (%)
1961	78.94	17.97	–
1971	209.11	19.91	3.23
1981	159.46	23.34	3.79
1991	217.18	25.72	3.09
2001	286.12	27.86	2.75
2011	377.10	31.16	2.76

Source Census of India, 2011 [58]
Note As the 1981 census was not conducted in Assam, and the 1991 census was not held in Jammu and Kashmir, the population of India includes projected figures for these states in those periods

Table 1.3 Number of urban agglomeration, towns, and outgrowths

No.	Type of towns	2001 census	2011 census	Percentage change (2001–2011)
1	Statutory towns	3799	4041	6.37
2	Census towns	1362	3894	185.9
3	Urban agglomerations	384	475	23.7

Source Census of India, 2011 [51]

Notes: The following definitions are based on Census of India 2011

1. All places within a municipality, corporation, cantonment board, or notified town area committee, etc., is reckoned as statutory towns

2. All other places which satisfied the following criteria (known as census town): a minimum population of 5000, at least 75 % of the male main workers engaged in non-agricultural pursuits, and a density of population of at least 400 persons per km^2

3. An urban agglomeration is a continuous urban spread constituting a town and its adjoining outgrowths (OGs), or two or more physically contiguous towns together with or without outgrowths of such towns

4. An outgrowth is a viable unit such as a village or a hamlet or an enumeration block made up of such village or hamlet and clearly identifiable in terms of its boundaries and location
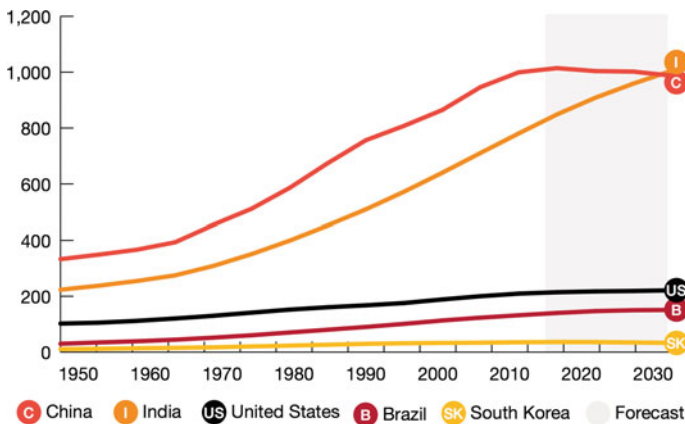
Fig. 1.6 Working-age population (15–64 years) in select countries. *Source* PwC [59, p. 20]

Committees (MPCs), with greater executing capacity, shall be formed for such urban agglomerations in the future.

Working population of India is growing as shown below in comparison with a few major economies (Fig. 1.6). China and India contributed maximum numbers of workers to their respective urban economies, and in all likelihood India will surpass China with regard to the number of workers by 2030.

Western and industrialized countries already have an urban population near 80 %, while developing countries to date come in at 47 %. Asia and Africa are expected to surpass an urban population of 50 % in 2020 and 2035, respectively. The global urban population is forecasted to increase by 72 % by 2050, growing from 3.6 billion people in 2011 to 6.3 billion in 2050 [11]. By 2020, China's urban population will reach 60 %, and more than 100 million people will migrate to metropolitan areas or contribute to the creation of new urban centres.

It has been observed in time series national statistics that contribution to GDP by urban centres in India is progressively increasing because of high generation of income and employment in cities and towns. Concurrently, the share of GDP creation in rural centres is diminishing in comparison with that of urban centres. Table 1.4 summarizes the performance of urban economy in India from 1970 to 2005.

As can be seen above, urban share of total NDP has grown from 38 % in 1970–1971 to 52 % in 2004–2005. The NDP share of industry is showing deceleration like agriculture, but there is some acceleration in NDP share of services. Availability of highly skilled workers and investment in skills and higher education as well as opening up industrial development and the ease of starting business can create more urban wealth in urban industries. Time series data and growth of urban share of GDP are shown in the graph (Fig. 1.7).

The contribution of urban areas to the national GDP is expected to increase from about 63 % in 2009–2010 to about 75 % in 2030. This 12 % increase in the urban share of GDP in 20 years is only possible with high investment in human resources for industrial skills, urban environment with highly efficient infrastructure—as shown in the benchmarking for smart cities in India (Sect. 1.9.2), and the ease of doing business. This in turn calls for reform in the Indian Administrative Service insisting on timely delivery of regulatory services for establishing new industries. A case in point is the sanction of industrial licenses often gets delayed due to red tape and corruption. In response to this phenomenon, for instance, the State of Telugu Desham (Is this Telangana now or Andhra Pradesh?) came out the policy of right for timely sanction of industrial license, and any official responsible for delay will be fined Rs 1000 for every day of delay. This shows signs of extreme dissatisfaction of the elected political leaders with the present administration system in the State of Telugu Desham (Is this Telangana now or Andhra Pradesh?).

The estimated increase of 12 % in the urban share of GDP needs to be looked against the targeted growth rate of India as projected by PricewaterhouseCoopers [59] (Table 1.5; Fig. 1.8). It can be seen that if we have to reach 9 % annual growth rate in GDP in the long run, we have to invest in urban centres aimed at creating more smart cities that can act as 'engines of smart economy'.

Table 1.4 Size of national domestic product (NDP) by sectors and per capita NDP in India

Year	Urban NDP as % of total	Value at current price (Rs in million)			(In Rs)		Value at (1999–2000 price) (Rs in million)			(In Rs)	
		Agriculture	Industry	Service	Total GDP	Per capita GDP	Agriculture	Industry	Service	Total NDP	Per capita GDP
1970–71	37.65	6.5 (4.7)	51.74 (37.4)	80.26 (57.9)	138.5 (100)	1294	74.34 (4.9)	594.2 (39.4)	839.8 (55.7)	1508.3 (100)	14142
1980–81	41.09	22.5 (5.0)	170.9 (37.7)	259.9 (57.3)	453.4 (100)	2888	114.8 (5.4)	801 (37.4)	1225.7 (57.2)	2141.6 (100)	13951
1993–94	45.73	139.4(4.4)	1046.9 (32.8)	2005.7 (62.8)	3192 (100)	13525	222.4 (4.6)	1583.9 (32.5)	3069.7 (63.0)	4875.9 (100)	20997
1999–00	51.7	291.4 (3.5)	2097.9 (25.3)	5911.1 (71.2)	8300.4 (100)	30183	291.4 (3.5)	2097.9 (25.3)	5911 (71.2)	8300.4 (100)	30183
2004–05	52.02	308.7 (2.2)	3649.7 (26.5)	9808.2 (71.2)	13766.5 (100)	44223	279.7 (2.4)	2942.1 (25.6)	8258.3 (71.9)	11480 (100)	37245

Note Figures in the parentheses are shares in per cent
Source National Accounts Statistics (various years)
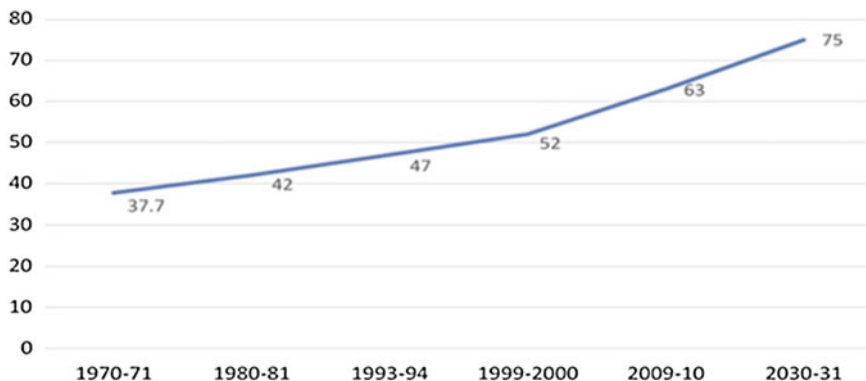
Fig. 1.7 Urban share of GDP in India, 1970–71 to 2030–31. *Source* Government of India [60]

Table 1.5 Three economic growth scenarios for India, 2014–2034

Scenario 1	Scenario 2	Scenario 3
Pushing old ways faster outlines a focus on investment in education, health, and other dimensions related to human capital. Our analysis suggests that in this scenario, India's GDP could see a 6.6 % compound annual growth rate (CAGR) between now and 2034	*Turbocharging investment* outlines the impact of rapid and significant investment in physical infrastructure and envisions a 7 trillion for GDP leading up to 2034.	*The Winning Leap* includes investment in both human and physical capital (as in the previous two scenarios), but also focuses on investment in R&D and innovation and envisions a 9.0 % CAGR for GDP between now and 2034. This scenario forecasts the most aggressive growth and is the only scenario that will generate the 240 million new jobs that India's growing population needs over the next 20 years

Source PwC [59, p. 15]

1.3.4 Urbanization and Urban Economy at Sub-National Level in India

As India is a large country with a big population, it is more meaningful to look at the state and, if possible, at urban agglomeration level. Unfortunately, economic data are not computed for urban agglomerations, but only up to the administrative unit of district, which has little relationship with urban agglomeration boundary. In India, there is wide variation in the level of urbanization of the various states and union territories, as shown in Fig. 1.9. It can be seen that Kerala, Tamil Nadu, Maharashtra, and Gujarat located in the south and west are highly urbanized states along with Manipur in the east. Adjacent to these regions are Karnataka and
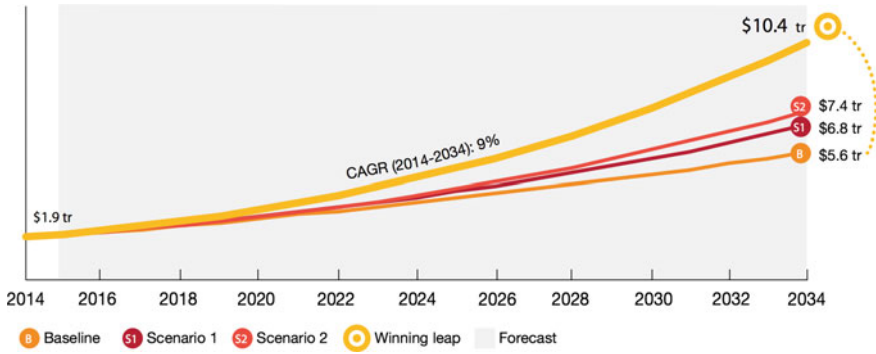
Fig. 1.8 Three economic growth scenarios for India, 2014–2034. *Source* PwC [59, p. 15]
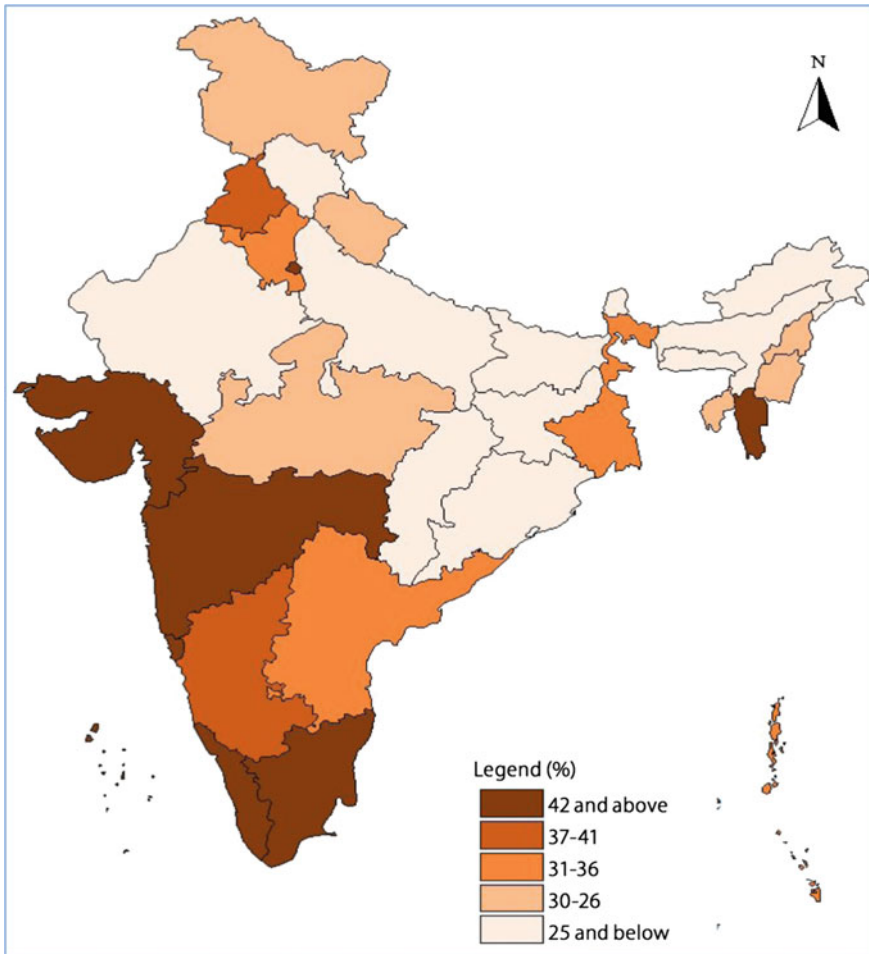
Fig. 1.9 Level of urbanization in India, 2011. *Source* Bhagat [61, p. 11]

(old) Andhra Pradesh with slightly lower proportion of urban population. Other states follow random distribution in the level of urbanization.

1.3.4.1 State Economy and Urbanization Level

State contribution to national domestic product and per capita income is plotted in Fig. 1.10. The graph plots the states into high-performing state, laggard state, and others. It can be seen that Delhi has highest per capita income and there are many states above mean per capita income. Maharashtra is the biggest contributor of GDP. Other southern states, such as Kerala, Karnataka, Gujarat, Tamil Nadu, and Andhra Pradesh, are above the average per capita income. States are again graphed based on state highway density and contribution of national domestic product (Fig. 1.11).

It can be seen that high-performing states feature more national and state highways per square kms of their land area. Now all these states are mapped based on economic performance indicated by the share of state income to national income as below (Fig. 1.12).

If this map is compared with the map of urbanization, it can be seen that there is correlation between the two. This clearly states that the share of National Income is highly correlated with urban percentage of the state. The more urbanized a state, the higher the likelihood of its percentage share to increase in National Income.

The theory of smart city economic development is not known today. However, it is observed that the dynamics of smart city GDP creation take a 'different path' which needs empirical study, hypothesis testing, and mathematical modelling to understand the urban dynamics of smart city economic development. A research
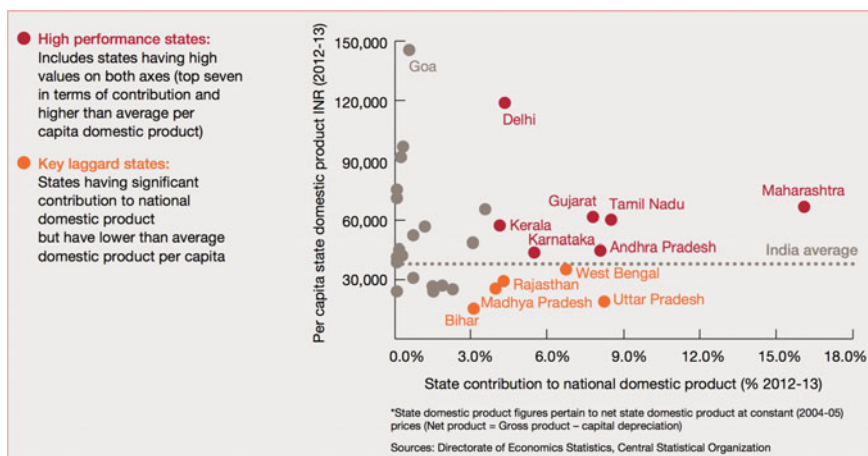
Fig. 1.10 State contribution to national domestic product and per capita income in India, 2012–13. *Source* PwC [59, p. 23]
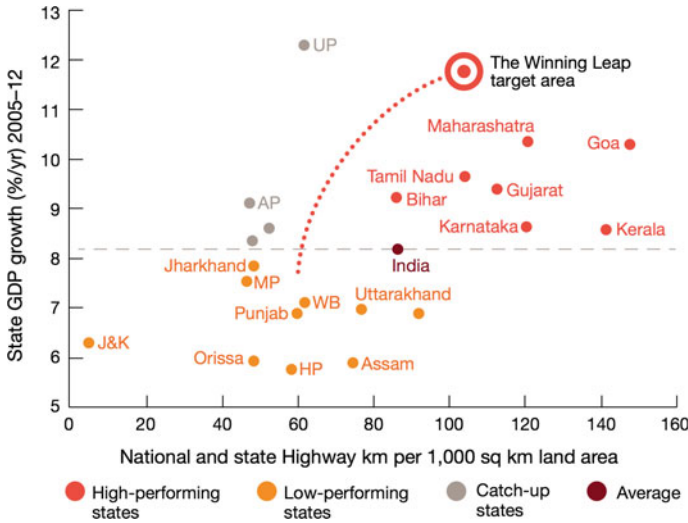
Fig. 1.11 Correlation between highway connectivity and growth. *Source* PwC [59, p. 59]

report by Bank of Boston in 1997 sent shockwaves when it noted that innovative, knowledge-based companies created by the Massachusetts Institute of Technology (MIT) alumni would collectively rank as the 24th largest world economy because the US $232 billion in world sales was (then) 'roughly equal to a GDP of $116 billion, which is a little less than the GDP of South Africa and more than the GDP of Thailand' [62]. More recently, another study noted that Stanford University alumni headquartered an estimated 18,000 firms in California State alone, 'generating annual worldwide sales of about $1.27 trillion and employing more than 3 million people' [63]. Therefore, it is important to do empirical quantitative research on some of the emerging smart cities.

1.3.5 Smart Cities Mission of India

The Government of India launched its Smart Cities Mission with focus on 'sustainable and inclusive development' in order to 'create a replicable model which will act like a light house to other aspiring cities' [64, p. 5]. Under the Mission, the core infrastructure elements of a smart city would include: (i) adequate water supply, (ii) assured electricity supply, (iii) sanitation, including solid waste management, (iv) efficient urban mobility and public transport, (v) affordable housing, especially for the poor, (vi) robust IT connectivity and digitalization, (vii) good governance, especially e-governance and citizen participation, (viii) sustainable environment, (ix) safety and security of citizens, particularly women, children, and the elderly, and (x) health and education. The mission has indicated an illustrative

Fig. 1.12 State-level performance in income and disparity in India. Source: PwC [59, p. 15]

list of 'Smart Solutions' to be supported: (a) e-governance and citizen services, (b) waste management, (c) water management, (d) energy management, (e) urban mobility, and (d) others, such as telemedicine and tele-education, incubation/trade facilitation centres, and skill development centres. Further, the Smart Cities Mission focuses on four strategic components of 'area-based development' that are: (i) city improvement (retrofitting), (ii) city renewal (redevelopment), (iii) city extension (greenfield development), and (iv) pan-city initiative in which smart solutions will be applied covering larger parts of a city. With an initial endowment of Indian Rupees 3205 crores [65], the Smart Cities Mission is 'meant to set examples that

can be replicated both within and outside the smart city, catalysing the creation of similar smart cities in various regions and parts of the country' [64, p. 5].

1.4 Local Economic Development Models in the Twenty-First Century

1.4.1 Conventional Urban Economy

Like in cities of the twenty-first century, the conventional urban economy in the past was built on secondary and tertiary activities. But a careful look shows that the urban-based secondary and tertiary activities have been changing and evolving over time. The evolution of urban economy is briefly discussed under the two historical phases of pre-industrial age, and industrial age.

1.4.1.1 Pre-industrial Urban Economy

The pre-historic remains of Dholavira, Harappa, Lothal, and Mohenjo-daro cities of Indus Valley Civilization show the possibility of an open urban economy with outside trade connections along with the importance of citizens in the town as against king and priests in medieval times when walled cities came up for security reasons. In the medieval times, urban economy was contained within its the physical boundaries of a human settlement. Most of the manufacturing was undertaken by artisans and managed by their respective guilds wherever necessary. Artisanal manufacturing used local materials and resources and those from the immediate countryside. The planned medieval city of Shahjahanabad, which is part of Delhi now, had different quarters and even streets specializing in artisanal manufacturing and trade, some of which still thrive. Thus, cities and towns specialized in the production of unique goods and artefacts. However, geography played an important role in restricting the growth of manufacturing over a multi-centric urban system as it is today. In addition to the affairs of the state and religion, tertiary activities included trade and commerce. Apart from local barter and exchange, manufactured goods were traded within countries and abroad, such as silk and precious stones. Natural products, such as spices, were also traded across countries and continents. Cities and towns thrived on maritime trade routes such as Óc Eo in lower Mekong delta region (in modern-day Vietnam), Zanzibar (Tanzania), Kozhikode (also called Calicut in Kerala, India), and those along Silk Road such as Turfan (China) and Bukhara (Uzbekistan). Trading and commerce prospered as far as the limits of wind-powered ships allowed. Geography and technology had limits on trade and commerce too.

1.4.1.2 Industrial Urban Economy

The advent of industrial age revolutionized the way in which goods were manufactured and transported, giving rise to the so-called modern cities and industrial landscapes that we see today in most places. Steam-powered manufacturing produced cheap goods that could be transported over land by steam-powered trains. In the industrial age, economies of those cities developed which were located near sources of raw material, such as iron ore. Coal could now be transported over long distance using trains. All of this led to some unprecedented developments. First, industrial production led to urban demographic growth and the expansion of cities. Industries needed labour and people migrated from rural areas to work in cities and towns. Larger population base of cities resulted in increased demand for industrial products. This was the case of cities and towns in the industrial belts and regions that developed in Europe in the nineteenth century. Second, as central city areas became congested with growing population and increasing industrial pollution, a polycentric, nature-based, and people-friendly urban system was invented. Thus, the 'garden city movement' was born in 1898, with Ebenezer Howard's book *Tomorrow: A Peaceful Path to Real Reform*, which was reissued in 1902 as *Garden Cities of To-morrow* [66]. In other words, this gave rise to the modern town and country planning (or urban and regional planning) that emphasized a polycentric urban system with focus on infrastructure development, satellite towns, locational specialization, green belts, and so on, as it is practiced now. Third, the international trade of industrially manufactured goods, aided by colonialism, destroyed the traditional artisanal manufacturing in the pre-industrial societies around the world. This led to the spread of industrial development as demand grew for modern manufactured goods, which went hand in hand with urbanization of rural societies in countries around the world, a process that is still ongoing. This has further added to the replication of industrial age economic and spatial planning in the so-called developing countries continued to the present day.

1.4.2 'Supply-Side' Approaches to Local Economic Development

The industrial age economic and spatial planning evolved to focus on economic specialization. The principle of *comparative advantage*, originally developed with regard to international trade, was brought into urban and regional development planning. The state was expected to support the process of local economic specialization, based on comparative advantage with regard to natural resources, labour, capital and infrastructure. This approach to local economic development is termed as 'supply-side approach' and focuses on building infrastructure and

industrial estates, keeping production and labour costs low, and attracting investment [67]. Drawing on the review framework used by Choe and Roberts [67], the following provides a brief overview of the 'supply-side' spatial planning approaches to fostering economic development of urban regions.

1.4.2.1 Spatial and Economic Planning

In order to promote urban and economic development, the use of national, regional, urban master, or strategic plans has become a common practice. While economic plans help in allocating and tracking funds for economic development, spatial plans support the process of land use and management. However, there is often little connection between spatial and economic plans. In Asia, for example, master planning has often failed due to the following reasons: 'Most plans are unrealistic or overly optimistic. They assume that the resources needed to implement the plans will be available; Planning is not backed by solid economic and financial analyses; Most master plans lack mechanisms for implementing projects for financing or through public-private partnerships (PPPs)' [67, p. 34].

Some cities use urban master planning, as their governments understand the relationship between planning and economics of development, such as Singapore and Hong Kong in Asia. They are able to enforce building byelaws and land use regulations through their well-organized planning and development systems.

1.4.2.2 Growth Poles

The 'Growth Pole' theory [68] considers that economic development is not uniform over a region, and it is concentrated around one or more centres or 'growth poles'. A growth pole may comprise of a major industry or a cluster of industrial units. Supported by spatially focused incentives, industrial development in growth poles would lead to the expansion of economic output and increase in employment, which may further attract more investments and trigger industrial diversification. It was argued that the development of such industrial centres might also result in the emergence of 'secondary growth poles' where secondary industrial sector and its linked industries may be located. Many countries used the growth pole theory to provide spatially focused incentives to stimulate or support industrial development in economically backward or lagging regions, for instance in India [69, 70]. In recent years, growth poles have been promoted in Kratie in the northeast Cambodia [71], Savannakhet in the south Lao PDR [72], and Chu Lai in Quang Nam Province of Vietnam. A common critique of growth poles is that they are not demand-oriented, but are supply-driven policy tools to correct regional economic imbalance.

1.4.2.3 New Satellite Towns

Satellite towns have become part and parcel of the urban and regional planning vocabulary. As part of the polycentric spatial strategy, they are proposed as part of urban and regional plans to deconcentrate central city areas, decentralize industrial and commercial activities, and create specialized economic zones. Pudong in Shanghai urban region, Noida in Delhi national capital region, and Cyber Jaya near Kuala Lumpur are some of the successful examples of new satellite towns in Asia. The key to their success is diversity of economic activities. However, when the economic base of satellite towns is a single, large industry, for instance automobile or steel manufacturing, they become vulnerable to economic cycles, such as the Asian financial crisis of 1997. Particularly vulnerable are those new towns that are focused on export-oriented growth industry.

1.4.2.4 Economic Enterprise Zones, Industrial Estates, and Business Parks

Thanks to globalization, export-oriented growth policies are important to promote urban economic development. Many central governments have built economic enterprise zones to attract foreign direct investment through reduced land costs, subsidized infrastructure, and tax rebates. Often called special economic zones (SEZs), they provide state-of-the-art infrastructure and services required to support a wide range of manufacturing-related enterprises. In Asia, SEZs have been built in China, India, the Philippines, Thailand, and Vietnam. Two sets of problems confront the development of economic enterprise zones. First, some of the SEZs were planned without much economic analysis. Built hurriedly, their development lacked proper implementation of construction standards or environmental and safety regulations. Some of them lacked important infrastructure, business support services, or even affordable housing [73, 74]. Second, some of the SEZs function simply as islands of factories. 'Companies in economic enterprise zones in Asian cities tend not to innovate, often because they are part of larger multinational companies that do the R&D [research and development] elsewhere. Neither do many companies seek to join clusters that could add value to their supply and distribution chains… They fail to see the benefits of sharing common services with competitors to bring down local transaction costs' [67, p. 37].

1.4.2.5 Technopoles

The idea of 'technopolis' or 'technopoles' goes back to 1958 when Tsukuba originated as a satellite Science City of Tokyo [75]. In 1994, Castells and Hall [76] argued that technopoles had become 'a key feature of national economic development worldwide'. They conducted a systematic survey of technopoles that are 'planned centres for the promotion for high-technology industry'. As 'mines and foundries of the Information Age', technopoles are built as science parks, science

cities, technobelt programmes, or national technopoles [Castells and Hall]. They are 'designed to promote interactions among high-tech firms, research centres, and often universities to create synergy that generates knowledge, innovation, products, firms, and thus regional growth and development' [77]. Technopoles have been developed worldwide, for instance in Brazil, China, Germany, India, Italy, Japan, Republic of Korea, Malaysia, the Netherlands, the UK, and the USA [75, 76, 78–81]. Many technopoles have succeeded, such as the famed Silicon Valley in the USA. However, several others have had limited success as: (i) they aimed at importing technologies instead of developing them locally; and (ii) with the goal of generating higher value-added and employment multipliers, they promoted manufacturing and processing industries as in growth poles [67, p. 39].

1.4.2.6 Provision of Infrastructure

The State of Asian Cities 2010/11 report noted that Asian cities will require close to US $10 trillion over 10 years in order to meet their requirements for physical and institutional infrastructure [3]. According to an estimate by the Asian Development Bank, annual infrastructure needs in the ASEAN (Association of South East Asian Nations) region between 2010 and 2020 are US $60 billion, not taking into account additional national projects with significant cross-border impacts such as airports, seaports, and roads to borders [2]. Neither are many governments able to make such investments in urban infrastructure nor do exist international banks able to lend such large amounts of capital. Private sector investment, especially in the form of PPPs, is expected to fill the infrastructure investment gap. However, it is easier said than done. For instance, during the 1990s, 219 projects were initiated at the World Bank to provide urban water supply with private capital flows of US $37 billion. Between 2001 and 2010, while the number of new projects at the World Bank climbed to 533, the private capital flows to urban water sector declined to US $25 billion [82]. In Asia, these are some of the reasons that have resulted in the establishment of the Asian Infrastructure Investment Bank.

This brief overview shows that the 'supply-side' spatial planning approaches to fostering economic development of urban regions focus on comparative advantage of cities and regions to unlock which they emphasize urban master planning and the development of growth poles, new satellite towns, economic enterprise zones, industrial estates, business parks, and technopoles to be supported by extensive infrastructure development. Some of these approaches support public policies for balanced development across regions, while others aim to trigger and sustain export-led growth. In all these approaches, the policy intervention with regard to investments, technological progress, and physical development are *external* to the urban and regional locations. Many of these approaches focus on economically exploiting the *comparative advantage* with regard to land, labour, infrastructure, natural resources, or geographical connectivity. The conceptualization of smart economy in smart cities will take into account the lessons learnt from the implementation of 'supply-side' spatial planning approaches to fostering economic development of urban regions (Sect. 1.5).

1.4.3 'Demand-Side' Approaches to Local Economic Development

There are a number of strategies and approaches to and factors behind what is called 'demand-driven economic development'. These strategies and approaches include endogenous growth approach; industry attraction approach; science and technology, and innovation policy; and growth triangles [67]. The factors behind demand-driven economic development include: knowledge-based economies, catalysts for collaboration, strategic infrastructure, living standards, and good governance as the foundation of enabling business environments [67]. While all these strategies and factors are relevant, the two most relevant to smart economy in smart cities are discussed here.

Endogenous Growth Approach. Developed during the 1980s, the 'endogenous growth theory' argues that economic growth is governed by internal factors within a national economy [83]. This theory came in response to criticism from the neoclassical growth model that considers technological progress as 'exogenous' to economic progress. The endogenous growth theory argues 'the enhancement of a nation's human capital will lead to economic growth by means of the development of new forms of technology and efficient and effective means of production' [84], which is relevant to (the conceptualization of) smart economy. This approach emphasizes the role of innovation and, therefore, is also called 'endogenous innovation growth theory' [85].

Knowledge-based Economies. In the Information Age, the importance of knowledge in economic growth cannot be overemphasized. What is more significant is the way in which knowledge is generated, shared, and utilized for local economic development. The key to the success of knowledge-based economies is knowledge networks and learning communities. For regional knowledge development, the mass participation of employees is considered important for which cities and sub-national regions must develop a learning infrastructure [86]. Knowledge itself has been classified into two: *tacit knowledge* that people gain from experience and collegial learning, which is carried in people's minds, and *explicit knowledge* that can be documented and shared using print and/or audio-visual media. 'Cities and urban regions that have high explicit and tacit knowledge tend to lead in ICT and innovation' [67, p. 47].

1.4.4 Theory of National Competitive Advantage

Michael Porter's theory of 'national competitive advantage' [87] is of direct relevance to the conceptualization of smart economy in smart cities. The competitiveness of local firms and industries directly contributes to economic vitality. Thus, a nation's competitiveness is based on local conditions, but these are not simply related to factors of comparative advantage, such as availability of natural resources or low costs of land and labour. According to Porter, the four-pointed *diamond model of competitiveness* is characterized by as many broad determinants of the

competitive environment for business: (i) *factor conditions*: skilled labour, resources, technology, and infrastructure; (ii) *demand conditions*: local and overseas demand for products and services; (iii) *related supporting industries*: suppliers and distributors in support of the industry sectors or clusters; and (iv) *firm strategy, structure, and rivalry*: conditions that govern how companies are created, organized, and management, and the nature of domestic rivalry. As part of a system, these four elements shape the competitive elements of the strategy that helps to gain competitive advantage:

> These determinants individually, and as a system, create the context in which a nation's firms are born and compete: the availability of resources and skills necessary for competitive advantage in an industry; the information that shapes where opportunities are perceived and the directions in which resources and skills are deployed; the goals of the owners, managers and employees that are involved in and carry out competition; and most importantly the pressures on firms to invest and innovate. The determinants in the 'diamond' and interaction amongst them create the forces that shape the likelihood, direction and speed of improvement and innovation by a nation's firms in an industry [87, p. 321].

In addition, two other factors in the 'diamond model' affect competitive advantage. First is 'government' that formulates and implements public policies. For example, in the development of ICT Cluster in Bangalore, government granted tax exemptions for five years to export-oriented software firms. Second is 'chance'—unforeseen or unanticipated opportunities, such as a sudden and favourable change in international currency exchange rates.

1.4.5 Principles of Competitiveness in New Urban Economies

Asia has become the engine of economic growth in the world. To support the cities-led economic growth process, the Asian Development Bank detailed out its urban development agenda, which is broadly divided into three areas of focus: competitiveness, environmental sustainability, and inclusiveness [88]. Choe and Roberts [67] have outlined the Asian Development Bank's 'competitive cities' agenda along with three rich case studies. In this major work, they discuss the three principles of competitiveness in new urban economies as follows.

A Long-term, Strategic Vision for Urban Economic Development is the first principle. To sustain development of the local economy, an economic vision should be agreeable to the civil society, inspire collective effort by those involved, and build and strengthen confidence to outcompete the rivals. Such collective understanding can go a long way in energizing cities and their economic clusters to achieve their development goals. Identification and agreement on local economic development goals, and how they should be achieved will guide government policy, business strategies, investment, and development decisions.

Endogenous Growth and Industry Cluster Development. In order to engender endogenous economic growth, governments need to promote innovation. This in

Table 1.6 Elements of competitiveness: comparative, competitive, and collaborative advantage

Comparative Advantage	Competitive Advantage	Collaborative Advantage
Land costs	Research and development	Networks
Infrastructure	Technology	Industry clusters
Taxation	Regulation	Strategic alliances
Labour costs	Labour productivity	Public–private partnerships
Proximity to raw materials	Skills base	Intermodalities
Transport	Core competencies	Trust and empowerment
Cost of capital	Quality of life	Open governance
Location of markets	Social capital	Smart systems
Economies of scale	Economies of scope	

Source Choe and Roberts [67, p. 6]

turn requires public policies aimed at clustering competitive industrial units that will create rivalry and therefore stimulate innovation. Putting together intellectual (research and innovation), human and physical capital in industry clusters will catalyse localized form of *competitive advantage* (Table 1.6). In this process, attention needs to be paid to labour productivity, skills base, and core competencies. Efforts must be made to strengthen social capital across local communities and sustain a good quality of life for all. Thus, clusters can contribute to the expansion of 'economies of scope' and, in turn, to endogenous growth.

Collaboration and Partnerships for Local Economic Development. Globalization and global competition has changed the ways in which local economic development takes place. Governments are increasingly realizing that *comparative advantage* has limitations when it comes to inviting foreign direct investments. Similarly, private companies face the fact that *competitive advantage* is not always enough when it comes to developing successful a business. 'Former rivals are seeking to collaborate through alliances, partnerships, and other forms of cooperation to win and expand their business. The new theory of *collaborative advantage* has thus emerged' [67, p. 7; emphasis original]. The elements of collaborative advantage include business networks, industry clusters, local government associations, and public–private partnerships. It is argued that greater collaboration among governments, businesses, and local communities will result in 'more competitive business and enabling environments, and hence more sustainable economic growth'.

1.5 Smart Cities, Smart Economy—Contours of Current Thinking

1.5.1 Towards Smart Cities

There is no unanimous definition on smart city or smart economy. The interrelationship of smart economy with smart city is also difficult to decipher. It is not clear whether a city is smart because of its smart economy or smart city is the reason

behind the workings of a smart economy. It is also unclear from literature surveys how spatial system of a smart city can be designed in such a way that a smart economy may start functioning.

The first view of city is that it is an *urban* area that presents itself as a homogeneous entity with a territorial boundary. This homogenous 'urban' character of a human settlement defines it as a *city*. For example, Census of India defines a city with certain minimal set of characteristics. On the one hand, all human settlements that satisfy the following criteria are considered census towns: (i) they have a minimum population of 5000; (ii) at least 75 % of the male main workers are engaged in non-agricultural pursuits; and (iii) a population density of at least 400 per km^2. On the other hand, an urban agglomeration is a continuous urban spread constituting a town and its adjoining outgrowths (OGs), or two or more physically contiguous towns together with or without outgrowths of such towns. An 'outgrowth' is a viable unit, such as a village or a hamlet or an enumeration block made up of such village or hamlet that is clearly identifiable in terms of its boundary and location.

A second view of city is an area with a definite administrative boundary, such as a Town Committee, Cantonment, Municipal Corporation, Municipality or Metropolitan Area defined by government on its discretion. Sometimes election statistics combine areas to a municipality so that it becomes a winning area for a (ruling) political party. This is to illustrate that such administrative areas are often subjective, and not based on rigorous spatial analysis.

The third view of city is that of a functional system or urban region that is based on and supported by connectivity and linkages among its constituent parts. For example, the daily interaction, movement of goods and people, telecommunication flows, and transportation connectivity combine to create a functionally connected region. When such a spatial system has urban characteristics, it may be termed as a metropolitan region. It may or may not be an urban agglomeration. This visualization of a city, if elaborated logically, can lead us to smart cities.

The above narrative leads us to visualize a smart city. Here a city is a digitally interconnected system where sensors of different kinds exist for different purposes and goals. They can be electronic devices with definite function to perform in an urban system or even human beings with biological, sociocultural, ecological, and economic goals. These sensors have unlimited capacity to establish functional linkages with outside world for social, cultural, environmental, and economic purposes that may create necessary conditions to enable the flow of communication, goods and services, and monies. ICTs enable sensors to be intelligent, which can be part of a control system—such as 'Supervisory Control and Data Acquisition' (SCADA), and that can be used for desired functions. Installing such sensors all over the city makes for an open big data of immense capacity and regulation by governance, which strives for common good of all people against petty, individual goals.

Compared to their rural counterparts, cities and towns boast better IT infrastructure and higher usage of ICTs and smart digital devices. Thus, cities generate vast amounts of data related to people, economy, infrastructure, culture,

environment, urban living, and decision-making. When such data are collected and recorded in an information system, such as geographical information system, it becomes available for decision-making in real time to resolve urban issues using city analytics; the primary user of the total smart city information is SCADA, a computer system for gathering and analysing real-time data [48]. SCADA is conventionally used for management of infrastructure, such as energy, oil and gas refining, nuclear reactors, telecommunications, transportation, and water and wastewater management. In terms of IT, when the use of SCADA is expanded to support the functioning of small or large urban systems, it gives rise to the notion of 'smart cities'.

In order to develop a better appreciation of and conduct research on smart economy in smart cities, we need to understand what a smart city is, to which we now turn.

1.5.2 Definition of Smart Cities

A literature survey shows there is no unanimous definition of smart cities. As the various scholars and practitioners view and understand them differently, there are several definitions of smart cities, which are listed below.

(1) The use of smart computing technologies to make the critical infrastructure components and service of a city—which include city administration, education, health care, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient [89].

(2) A city well performing in a forward-looking way in economy, people governance, mobility, environment, and living built on the smart combination of endowments and activities of self-decisive, independent, and aware citizens [90].

(3) A city striving to make itself smarter, more efficient, sustainable, equitable, and liveable [91].

(4) A city that monitors and integrates conditions of all of its critical infrastructure including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens [21].

(5) An instrumented, interconnected, and intelligent city instrumentation enables the capture and integration of live real-world data through the use of sensors, kiosks, meters, personal devices, the Web, appliances, camera, smartphones, implanted medical devices, and other similar data acquisition system including social networks as networks of human sensors interconnected means the integration of those data into an enterprise computing platform and the communication of such information among the various city services intelligent refers to inclusion of complex analytics, modelling, optimization,

and visualization in the operational business processes to make better operational decision [92].

(6) A city that gives inspiration, shares culture, knowledge, and life, a city that motivates, its inhabitant to create and flourish in their own lives [93].

(7) A city where ICTs strengthen the freedom of speech and the accessibility to public information and services [94].

(8) A city that monitors and integrates conditions of its entire critical infrastructure [92].

(9) A city connecting the physical infrastructure, the IT infrastructure and social infrastructure, and the business infrastructure to leverage the collective intelligence of the city [95].

(10) A city combining ICT and web 2.0 technologies with other organizational design and planning efforts to dematerialize and speed up bureaucratic process and help identify new innovative solutions to city management complexity, in order to improve sustainability and liveability [96].

(11) Smart cities are 'systems of people interacting with and using flows of energy, materials, services, and financing to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of information and communication infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society' [97].

(12) In the book "Geographic Information System for Smart Cities" [43], authors defined smart city as a 'knowledge based city that develops extra ordinary capabilities to be self-aware, how it functions 24 h and 7 days a week and communicate, selectively, in real time knowledge to citizen end users for satisfactory way of life with easy public delivery of services, comfortable mobility, conserve energy, environment and other natural resources, and create energetic face to face communities and a vibrant urban economy even at a time there is National economic downturns'.

This international collaborative research programme uses the definition of smart cities given by Vinod Kumar et al. [43].

1.5.3 Smart Economy—A Survey of Definitions

Smart economy, an essential building block a Smart City System (as noted above), has been defined in many ways. A review of literature reveals diverse definitions of smart economy.

(1) Smart economy involves the knowledge economy, where innovation and technologies are considered as the most important driving force [96].

(2) Smart economy involves the establishment of innovation clusters and mutual cooperation between enterprises, research institutions, and the citizens in order to develop, implement, and promote innovation through these networks [98].

(3) Smart economy combines the enterprise economy and innovation or the 'Ideas' economy. Smart economy is characterized through the use of human capital—knowledge, skills, and creativity, transforming ideas into valuable processes, products, and services. Smart economy also focuses on the creation of the 'green economy' by developing 'green companies' (promoting the employment of renewable energy sources, increasing the energy efficiency, based on its needs and reduction of costs) [34].

(4) Smart economy is an ability to employ the existing resources for the development and implementation of innovative solutions [99].

(5) Smart economy is a networking economy, developing new cooperation models in production, distribution, and consumption [100].

(6) Smart economy is the economy that is flexible and able to compete globally [openness], generating high added value, based on knowledge, innovations entrepreneurship [creativity] and social responsibility, and 'green' growth [responsibility] [101].

(7) Smart economy includes a favourable environment for economic growth and a high value-added-oriented integral economy [101].

(8) The economy of a smart city distinguishes the ability to overcome economic challenges, create new jobs, establish new businesses, and increase regional attractiveness and competitiveness [102].

(9) Urban efficiency is identified with the city's intelligence, as an effectively operating city attracts and maintains a skilled work force, new businesses, students, tourists, and residents [103].

(10) Smart economy is competitive in the spheres of innovation, entrepreneurship, intellectual property, efficiency, and the labour market flexibility and integrates in global markets [104].

(11) Smart economy is a green economy; it encourages reduction of the amount of carbon dioxide in industry and suggests investing in the 'clean economy' [105].

(12) Smart economy is related to economic competitiveness and involves innovation, entrepreneurship, economic image, efficiency and the labour market flexibility, integration in local and international markets as well as the ability to transform [106].

(13) Smart business (economy) includes the employment of information technologies and telecommunications in the companies' activities, new smart business processes, and a smart technology sector. Smart business is characterized by business growth, job creation, improvement of the staff's qualification, and efficiency gains [107].

(14) A city is smart when 'investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance' [108].

(15) Smart economy involves the economy, which is characterized by businesses-leaders, creating a favourable business environment in the city in order to attract new and retain the existing businesses. An important role in the long-term urban growth is played by high-technology and creative industries and a 'soft' infrastructure (knowledge networks, voluntary organizations, free of crime environment, after dark entertainment economy) [109].

1.5.4 Smart Cities and Internet of Things

As more and more devices are connected to the Internet, they expand IoT that is already bursting at the seams. According to a report released in April 2016 by DIGITALEUROPE, which represents the digital technology industry in Europe [110], the linking of physical and digital worlds is supporting a 'new digital revolution':

> The billions of connected things around us are helping drive a new digital revolution. Nearly 5 billion connected things today, reaching 25 billion by 2020, open the doors to entire new ways of living, thinking and operating. This revolution is transforming every part of society, every sector in industry and the entire government apparatus. Interactions in the value chain of a business, interactions amongst citizens, interactions between the government and citizens and interactions between businesses and citizens are changing forever. The IoT has arrived… [111].

The emergence of IoT and its continuing expansion is highly relevant for cities in general and smart cities in particular for four key reasons. First, the linking of physical and digital worlds starts in cities which, given their technological advancement and infrastructural development, are places where the digitalization of devices and gadgets precedes that in other, rural or remote areas, especially in the developing countries. Second, the expansion of IoT in urban settings enables the creation of smart cities that are able to communicate in real time with themselves and the rest of the world on a 24 h/day and 7 days/week basis. The creation of 'super IoT infrastructure', to use Rifkin's term, is taking place as the digitalized communication Internet converges with a digitalized, renewable 'Energy Internet' and a digitalized, automated 'Transportation and Logistics Internet' [21] is, therefore, highly relevant for smart economy in smart cities. Third, the emergence of IoT provides unprecedented opportunities to city governments to develop their infrastructure management systems in order to improve service delivery. Fourth, the continuing development of digital applications (apps) that are able to build and harness networks, which had not existed before, has opened up possibilities of new areas of urban economic expansion or smart economy in smart cities, for instance sharing economy.

1.5.5 Smart Cities and Sharing Economy

Within the digitally networked society of today, 'sharing economy' has emerged as a new economic or business model [112], which goes hand in hand with smart cities. 'Cities are already natural "sharing economies"—the space constraints and population density of urban living favors consumption that involves access to shared resources over asset ownership', noted Sundararajan [113]. This 'natural' feature of cities is important for the development of sharing economy in smart cities. As for smart cities, there is no firm definition of sharing economy. A couple of formulations, however, give insight into the nature of sharing economy:

> Sharing economies allow individuals and groups to make money from underused assets. In this way, physical assets are shared as services [114].

> The sharing economy can be defined as the (economic) model in which demand and supply are immediately in contact through an online platform, in order for the supply side to directly provide services and/or products with an underlying aim to improve the use of assets and to reduce transaction costs [25].

Two distinct sharing economy models are in operation: (i) *asset hubs* where 'a single company owns the goods or assets and sells access to users on a temporary basis' (by hour or day), and (ii) *peer-to-peer networks* where 'various would-be suppliers are connected with various would-be users' using an online platform [25]. While asset hubs evolve from traditional business models, peer-to-peer networks constitute new business models. These new and emerging business models provide useful perspectives and examples to promote and develop smart economy in smart cities.

1.5.6 Emerging Features of Smart Economy

The above survey of definitions and relevant developments reveals a set of key words that are essential to smart economy in smart cities. Accordingly, a smart economy can be said to have these emerging characteristics: competitiveness; knowledge-based economy; creativity and innovation; establishment of innovation clusters; innovation through networks; IoT; sharing economy; mutual cooperation between enterprises, research institutions, and citizens; entrepreneurship; job creation; social responsibility; green economy; Triple Helix Model in which governments, businesses, and academia have changing roles; and the use of ICTs.

1.6 Smart Economy in Smart Cities—Towards a Conceptual Framework

In developing the conceptual framework on smart economy in smart cities, our work builds on the review of the following: (i) building blocks of Smart City System (Sect. 1.2); (ii) economic role of cities (Sect. 1.3); (iii) conventional urban economy; (iv) 'supply-side' approaches to local economic development; (v) 'demand-side' approaches local economic development; (vi) theory of national competitive advantage; (vii) principles of competitiveness in new urban economies (Sect. 1.4); (viii) emerging definitions and features of smart cities and smart economy (Sect. 1.5); and (ix) our reflections on these, along with our past and ongoing work on smart cities and sustainable urban development. Before going into the conceptual framework, let us first look at the nature of smart economy.

1.6.1 Nature of Smart Economy

Smart economy is characterized by the use of ICTs in all economic activities. The ten goals as well as characteristics of smart economy in smart city are:

(1) Smart economy aims for and shows high ability to transform the Smart City with the efficient utilization of ICTs in every aspect of its economic activities. Therefore, smart city with smart economy has a clear long-term economic vision, which is agreeable to civil society, public and private sectors, and other relevant stakeholders.
(2) Smart economy builds on and cultivates a knowledge-based economy through the active sharing of tacit and explicit knowledge for economic benefit of all people.
(3) Innovative spirit that finds newer approach to economic activities. Innovation is stimulated through competition, collaboration, and clustering of economic units and activities.
(4) Entrepreneurship is generated out of individual effort (independent of family wealth and inheritance) and is nurtured through positive business climate, capacity building, institutional strengthening, and openness to unforeseen opportunities.
(5) Smart city economy acts as a force that creates international economic embeddedness in order to benefit from the process of economic globalization.
(6) Smart economy has the ability to create economic imaging, branding, and trademark.
(7) Smart economy features high productivity of land, labour, and capital.
(8) Flexibility of labour market that includes acceptance of labour from outside city, states, and nations that are devoid of conflicts.
(9) A good quality of life for all is essential for the growth of smart economy. This implies effective provision and management of urban infrastructure,

Table 1.7 User mode of access to Internet in India, (%) by year

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
Work	34	38	40	29	32	14	10F	8F	6F
Home	30	26	23	37	32	24	19F	16F	14F
Cybercafe						19	13F	9F	7F
Mobiles	36	36	37	34	27	43	58F	67F	73F
Total	100	100	100	100	100	100	100	100	100

Source India Brand Equity Foundation [115]; also see Deutsche Bank Markets Research [116]
Note F—forecast

services, and amenities, and efficient management of urban environment, natural resources, and urban liveability.

(10) Appreciation, conservation, and promotion of local culture and heritage is central to smart economy, which celebrates it, manages it efficiently, facilitates the creative evolution in local art, culture, and heritage, and links it to the development and promotion of sustainable tourism.

A prerequisite for smart economy in smart cities is universal access to high-speed Internet. Smart city inhabitants tend to use Internet for all walks of life whether it is shopping, recreation, education, or participatory democratic governance. For instance, user mode access to Internet in India during 2007–2015 is given above (Table 1.7). The user mode in India has been changing over time from desktop Internet to mobile smartphone Internet, and also from work places to home. This will change the current window-shopping practice to Web browsing practice to select the particular brand of goods and services and purchase it strictly based on lower price at home delivery of high-quality products. Many of them may not be available in local market. The user mode data given in Table 1.7 are for entire India, but smart cities may show higher percentage of mobile users and home users than overall national average. This has great significance in E-Commerce (Sect. 1.6.2.2).

1.6.2 Conceptualization of Smart Economy in Smart Cities

We have made an attempt to conceptualize smart economy in smart cities in this international project at four urban spatio-economic levels: (i) smart economy of agglomeration and innovation, (ii) smart economy in commerce, (iii) smart economy in transportation and logistics, and (iv) smart economy in services.

1.6.2.1 Smart Economies of Agglomeration and Innovation

Due to economic factors, through historical reasons, or due to purposeful design and planning, economic units tend to agglomerate. This may take place in central

city areas—as in the case of specialized traders of Shahjahanabad in Delhi, on city's outskirts in industrial parks, or SEZs. Traditionally, agglomeration has often taken place of similar economic units, whether they are micro-, small, and medium enterprises, and agro-products industry (food processing of dairy or horticultural products). This has resulted in positive externalities of transportation, labour market access, and supply and distribution chains. Under the smart economy in smart cities, agglomeration is promoted to stimulate innovation in product design through competition, which may develop market for new products, expand supply chains for the latter, and in turn, develop (higher) local competitive advantage. The economies of agglomeration and innovation in cities have been well documented in case of ICTs, such as Silicon Valley [76] and Bangalore ICT clusters [117]. However, there is much to learn when it comes to smart economy sectors of micro-, small, and medium enterprises, agro-industry (dairy and horticulture), smart food sheds, and the like. smart economy sectors suitable for agglomeration and innovation may include:

(1) *Concept of Smart Food Sheds and Smart Economy in Urban Agriculture, Animal Husbandry and Horticulture*: Smart Food Shed is an old concept wherein urban open green spaces are utilized for garden food production for fresh food supply in smart cities. Such fresh food production uses ICT-enabled Smart Agriculture, such as GIS-enabled soil details and periodic testing of every square metre of land connected to fertilizer requirement and minimization of water use for highest productivity possible using computer models.

(2) *Smart Economy in Industries*: Smart economy in industries uses communication infrastructure in all aspects of industrial design and production. Industrial units focusing on and manufacturing specific products agglomerate to build and make use of collaborative advantage. They make use of networks and industry clusters, build strategic alliances and PPPs, and promote trust and empowerment. Open governance and smart systems support smart economy in industries. Further, smart transportation of raw materials for production and speedy transportation of finished products is achieved using smart and intelligent goods mobility.

1.6.2.2 Smart Economy in Commerce

Smart cities will likely feature a high penetration of e-commerce activities. E-commerce include three categories of economic activities: (i) online shopping or business to consumer e-commerce, where private consumers purchase products that they receive through postal mail or courier; (ii) transactions between companies or business to business e-commerce, such as that between manufacturers and wholesalers or between wholesalers and retailers; and (iii) transactions between individual sellers and individual consumers, for instance those supported by eBay [118].

In today's economy, an increasing number of commercial transactions take place through the use of Internet. E-commerce statistics for a few selected economies as

Table 1.8 E-commerce statistics in selected economies, 2013

	India	USA	China	Australia	Brazil	Sri Lanka	Pakistan
Internet users (millions)	137	245	538	20	79	3.2	29
Penetration (%)	11	78	40	89	40	15	15
Online buyers (million)	25	156	270	11	27	2	NA
Online buyers as % of internet users	18	64	50	55	34	63	NA
Consumer e-commerce	13	224	210	30	19	2	4

Source Internet World Statistics

Table 1.9 Internet users who made a purchase via mobile phone in Asia–Pacific region, Q4 2015

Country/region	Internet users who made a purchase via mobile phone (%)
Republic of Korea	43
China	34
Hong Kong, China	33
Thailand	31
Malaysia	31
Singapore	30
Vietnam	23
Indonesia	20
Australia	19
Philippines	18
India	17
Japan	13

Source Statista [120]

of 2013 are given in Table 1.8. In India, the retail e-commerce sales have grown over sixfold, from US $2.31 billion in 2012 to US $14 billion in 2015 [119]. In Asian–Pacific countries for which data are available, in the fourth quarter of 2015, the share of Internet users that made a purchase via mobile phone ranged between a high of 43 % in Republic of Korea and a low of 13 % in Japan [120]; see Table 1.9. There are various issues connected with e-commerce and its infrastructure development in India [121], including those related to constraints of Internet. McKinsey [122] found the following obstacles related to low levels of Internet user adoption and engagement in India: (i) limited availability of Internet infrastructure, (ii) high cost of access and usage, (iii) lack of awareness and low digital literacy, and (iv) narrow range of applications and services.

Despite many problems in e-commerce in India, in the year 2014, Flipkart attracted US $1 billion and Amazon India infused US $2 billion in their business with no new government policy in place to encourage such investment in e-commerce. This US

$3 billion is used to further develop the infrastructure, such as large warehouses, big data processing, innovative delivery system and efficient logistics. There can be even e-commerce sellers located internationally who provide goods and services to buyers in India and vice versa, if red tape is removed. The buyer can browse all brands which may not be locally available in secondary (tier-2) cities and order it. It has also been shown that there is considerable growth of women buyers in India ordering garments, cosmetics, and other branded accessories. Handholding by government in terms of favourable policy regime is not required for smart enterprises in a smart city, but what they do not require is red tape and corruption perpetuated by politicians, administrators, and their organized middlemen for rent-seeking.

1.6.2.3 Smart Economy and Energy

Smart economy of energy builds on smart energy grids, energy management, and automated systems, and the development of a digitalized, renewable 'Energy Internet'. *Geographical Information System for Smart Cities* [123] has discussed the following technological solutions that can be utilized for building smart economy of energy. *Smart energy grids* include sensors and instrumentation to improve distribution network efficiency and, in conjunction with smart metering, help match energy demand and supply. *Building energy management systems* where residents can automate the energy-consuming systems in buildings, and building sensors and controls allow for better use of buildings or prediction of faults. *Smart energy metering* where automated meter reading enables utility companies and occupants to access information digitally. *Outdoor lighting smart controls*, such as dimming and other controls, support greater energy efficiency. Other technologies that support smart economy of energy include power quality monitoring and energy quality monitoring.

The development of a digitalized, renewable 'Energy Internet' holds a key to the development of smart economy of energy. 'The great economic revolutions in history occur when new energy regimes emerge and new communication revolutions emerge to organize them', argues Rifkin [124]. This is already happening in Europe where the technology of communication Internet is being used to transform its electricity transmission grid into 'Energy Internet'. Further, the development of a digitalized, renewable 'Energy Internet' will be comprised of five foundational pillars, according to Rifkin [125]: (i) Refurbishing and retrofitting of buildings and other infrastructures to make them more energy efficient as well as the installation of renewable energy technologies to harness solar, wind, and other energy. (ii) Setting of ambitious targets to replace fossil fuels and nuclear power with renewable energy sources. (iii) Embedding of storage technologies, including hydrogen fuel cells, batteries, water pumping, 'at local generation sites and across the electricity grid to manage both the flow of intermittent green electricity and the stabilization of peak and base loads'. (iv) Installation of advanced meters and other digital technologies in every building 'to transform the electricity grid from servo-mechanical to digital connectivity in order to manage multiple sources of

energy flowing to the grid from local generators'. (v) Equipping of very parking space 'with a charging station to allow electric and fuel cell vehicles to secure power from the Energy Internet, as well as sell power back to the electricity grid'. Further, Rifkin contends that:

> The phase-in and the integration of the above five pillars transforms the electricity grid from a centralized to a distributed electricity system, and from fossil fuel and nuclear generation to renewable energy. In the new system, every business, neighborhood and homeowner becomes the producer of electricity, sharing his or her surplus with others on a smart Energy Internet that is beginning to stretch across national and continental landmasses [125].

Smart cities lend themselves as the ideal places where 'Energy Internet' can be developed along with the development of smart economy of energy.

1.6.2.4 Smart Economy in Transportation and Logistics

Smart economy in transportation and logistics arises out of designing smart city-specific Smart Mobility for the movement of people, and industrial and commercial goods. The development of digitalized, automated 'Transportation and Logistics Internet' [21] becomes important in the context of smart economy in smart cities. Such designed and managed Smart Mobility logistical network, within smart cities and beyond, has the ability to expand service areas of goods and services, which can give rise to more income and, therefore, more employment for smart entrepreneurs. For example, perishable cooked food items of high international demand—like Malabar food from south India, can be transported to dining rooms in Dubai or Singapore directly through smart mobility and smart logistics in a Smart City System using ICTs. Thus, the logistics industry for smart mobility has high potential to grow under smart economy in smart cities.

Geographical Information System for Smart Cities has discussed in detail how smart people movement and smart goods movement can be executed [123] in the following ways: (i) *Smart transport cards* link multiple forms of transport and make it more convenient for travellers to use, and for transport authorities to understand mobility patterns; (ii) *Car clubs* help users to hire or share vehicles easily and will prevent purchase of new cars; (iii) *Cycle hire/share programmes* help users to hire bicycles for mobility and can thus prevent avoidable car trips and related CO_2 emissions; (iv) *Electric buses and trains* that are more efficient and ideally run on renewable power; (v) *Electric vehicles* that can become mobile energy storage units and help to balance peak demand; (vi) *Real-time transport information* that supports and facilitates mobile applications for journey planning; (vii) *Real-time transport displays* provide visibility to users and encourage uptake of public transportation; and (viii) *Real-time information for logistics* supports telematics and communications with drivers to optimize transportation routes.

1.6.2.5 From Sharing Economy in Smart Cities to 'Sharing Cities'

Sharing economy opens up a new dimension for local economic development in cities and city regions. As for smart cities, the generation and evolution of sharing economy is contingent upon digital connectivity. On the one hand, the pace of expansion of digital connectivity in a city will determine how fast it can create conditions for the generation and evolution of sharing economies. On the other hand, 'by creating a favourable environment for the rise and spread of sharing economy businesses, a city may better and faster achieve the objectives and features that characterize it as being smart' [25]. In the Information Age, this underlines that for cities to become smart cities, and in turn to support sharing economies, they ought to invest in Internet and other digital infrastructure, expand connectivity (which may require lowering the cost of access and usage), improve awareness of and expand digital literacy (especially in developing countries and for low-income groups), and provide support to expand the range of applications and services.

Based on the developments in recent years, four models of sharing economy can be understood as the following:

1. '*Individuals offering services through their own assets*: individuals increase the use of their assets by providing short-term services to other individuals, as is the case when offering a room on AirBnB, or a ride on BlaBlaCar.
2. *Private companies offering "micro" services*: in this case, private firms offer the possibility to use (rent) for short periods some of the assets that are owned by the company. Examples are the different car-sharing services, such as Car2Go.
3. *Peer-to-peer marketplaces*: platforms that give companies or individuals the opportunity to sell goods to other companies or individuals. This model can have different variations, for example, in the case of Ebay, we mainly find items produced by a fourth party, while, in the case of Etsy, the supply side is also the producer.
4. *Peer-to-peer labour services*: through these platforms, potential workers can offer their workforce for a specific task, as is the case for Taskrabbit, but the same could probably be said even for Uber drivers' [25, emphasis original].

The above survey of the various models of sharing economy indicates two areas that need attention. First, the sharing economy models are primarily based in developed countries, although some—for instance, Uber taxi—are expanding their business in emerging economies, such as China, India, and South Africa. This underlines the vast scope for the generation and expansion of sharing economy in smart cities of developing world. Second, cities in developing countries, especially those that aspire—and are on the way—to become smart cities, provide ample opportunities for the generation of localized sharing economy.

Having elaborated these ideas, it must be acknowledged that not all is well with sharing economies. Certain models of sharing economy lend themselves to 'runaway capitalism' at the cost of impoverishing (low-income) workers [126]. Instead of supporting 'a global race to the bottom to attract footloose capital', leaders of

smart cities 'need to support and emphasize communal models of sharing that build solidarity and spread trust. Sharing systems designed around equity and justice will naturally shift cultural values and norms towards trust and collaboration' [127; also see 128].

1.6.2.6   Smart Economy in Services

There are number of examples of Smart Economy in Services. The broadband Internet services and video conferencing facility available in smart cities can generate smart economy in services, such as medical service. A smart city, with a state-of-the-art medical facility having superior capacity, can diagnose remotely a disease through telemedicine and save lives. It can decentralize diagnosis and initial treatment in distant cities and human settlements through ICTs and telemedicine. With regard to education services, smart cities can provide tele-education within city regions and beyond; in turn, this can also lead to reduction of transportation trips made within and from outside the city as well as to prevention of CO_2 emissions from such trips. Other services that can involve smart economy include solid waste recycling and management, smart parking, business incubation and trade facilitation centres, and skill development centres.

1.6.3   Smart Economy and Smart City Structure

The most important question that is generated by smart city economy is how to plan and design at multilevel, urban structure and land use composition appropriate for smart city economy. Is there a need for change in existing approach? Unfortunately, there is not much of thinking generated so far on this topic internationally. The urban structure has many levels, the metropolitan urban agglomeration, the city, the zonal plan, and the urban design level. It is obvious that existing structure is not desirable since the ways in which economic activities are conducted have changed, as indicated in the previous para. The best way is to study this phenomenon in an existing smart city and find out how these changes can be accommodated.

1.6.3.1   Smart City Economy and ICT

To start with, let us investigate this relationship. Smart economy is characterized by the use of ICT in all economic activities. A smart city can be distinguished from other cities on one dominant and unique factor, namely presence and growth of ICTs in six systems of smart cities that we discussed earlier. They are measurable in terms of smart city ICT indicators, which are listed below.

(1)   The number of ICT specialists used in theses six systems.
(2)   The number of all electronic devices such as sensors connected to Internet in these six smart city-building blocks.
(3)   The number of personal computers connected to the Internet.
(4)   The number of Internet users.
(5)   The share of number of enterprises with Internet connection in all enterprises active.
(6)   Investment in hardware.
(7)   Investment and expenses for information technology products and services.
(8)   Investments and expenditures of communication for products and services.
(9)   Share of enterprises that have their own website in total company assets.
(10) Share of enterprises that buy–sell business online in total assets.
(11) Share of teleworking/telecommuting employees in total employees.

All six building blocks that constitute a Smart City System shall be using ICTs in a significant manner or showing higher percentage growth. All sectors of smart city economy contribute, and the presence of ICTs therein is an indication that the city is getting transformed to smart city economy. It is therefore important to understand the use of ICTs in the various sectors of smart city economy. For an initial list of ICT indicators for various sectors, see Appendix 1.

1.6.3.2   Hypothetical Examples of Smart Economy

In the absence of empirical studies on changing urban structure and land use of smart cities, we may look at some hypothetical examples to suggest what changes can be expected in the city structure and land use where there is smart economy operating.

To appreciate such changes, the existing urban structure needs to be understood first. Planners divide cities into several districts. Based on specialized endowment of activities in the district, there may be differing characteristics. He/she then restructures individual zones to districts and sub-districts. Higher-level facilities and services with occasional use pattern are provided in the district centres. In the sub-district or neighbourhood level, planners provide essential services and facilities for local daily needs. There can also be highest-level centres, sometime more than one in a city higher than district centres. Then required land uses are provided and zoned. The provision of these related land uses is made on the basis of income and expenditure pattern of the population in the district and sub-district, and the amount of money that can flow into these activities in these centres. This analysis gives sufficient basis for computing land use distribution based on sustainable floor area turnover per month. Spatial standards prepared by government helps in land use computation. Some governments accept mixed land use, but some others do not but marginally agree to mixed land use of certain kind. These centres sustain, lag, or perish depending upon availability of access and essential provision of required services. However, these urban structures get destroyed or replaced as soon as

major infrastructure investment such as a metro rail system comes into being. Then the area surrounding metro-stations becomes appropriate district or neighbourhood centres. Smart mobility in these centres increases the land value and generates high urban pressure to locate all mix of appropriate land use and generate needs for higher density appropriate to higher land value. If metro-station passes through a district centre, it augments its development, but if it is not, then it adversely affects its future development, so also with neighbourhood centres.

This also changes when smart economy starts operating in the city. We consider all activities, which generate wealth and employment as smart economy, and it can be based on as many land use types as possible. For the hypothetical example, we take two examples. First is that of retail trade in a neighbourhood centre, and second relates to e-commerce. There are three preconditions for smart city economy. They are integrated six building blocks of Smart City System (discussed in Sect. 1.2), ten smart economy goals (Sect. 1.6.1), and high usage of ICTs in any economic activity (Sect. 1.6.3.1).

Example 1: Neighbourhood Retail Store
The retail store in this example supplies grocery to households in the neighbourhood. The owner feels that she wants to expand her economic operation beyond this neighbourhood. Now she has a website where anyone in this town can order groceries using a special template in Excel sheet she has made in the website, and deposit money using secure payment gateway. Once money is received in her bank, she delivers what is ordered by using her bicycle. She still wants to increase her business and joins as seller in E-Commerce portals such as Amazon India, E-Bay, and Flipkart. She also tries to market some traditionally cooked items, heritage value goods, and local handicrafts through this portfolio. She often receives orders from abroad or foreign tourists for such items, and she is able to sell it abroad through eBay. Here the retail trader has shown her innovative spirit, entrepreneurship, and is creating a local image with heritage goods. She achieves high productivity by having her portal open 24 h and 7 days a week and also received international attention from foreign customers.

In this case, what has happened is that our neighbourhood retailer has transformed a local economic activity with limited service area to an international commercial activity. Smart mobility helps her to move her activity within and outside city with little loss of time. Smart governance does not regulate (i.e. harass with red tape just for rent-seeking since all her transactions are made through the website) her much to sell her merchandize abroad. The service area designated by planners for her activities has changed, and the space requirement for her activities has also changed. She reduces her work by allowing her products to be stored in Amazon warehouses that are very large and well managed, located in strategic cities in India based on logistical network that reduces delivery time, and Amazon supplies all logistics to supply her goods within and outside India for an additional reasonable fee. She also makes use of similar infrastructure of local warehouse by sharing with someone else that has his/her own storage space in the city. She longs to move to a shop near to metro-station so that her mobility increases and her

delivery time of retail goods minimizes. Neighbourhood concept in local retail seems to have vanished long ago at the advent of smart cities and smart economy, which will increasingly be the case also for the structuring of cities by planners. Face-to-face use of neighbourhood social space is replaced by virtual goal-oriented communities in ICT space. Her requirement for shop area is reducing as she innovates using other warehouses controlled by computers, and so also her rent and capital requirement for retail trade establishing the value of smart people. Her profit margin increases as she attempts to be more innovative and realizes her strength lies in local branding and heritage value addition to her business.

Example 2: E-Commerce in India

Nowadays, the main goal for e-commerce in India is to reduce the time of delivery after electronic payment is made, which ranges from one day (or few hours) to seven working days. Sellers send their stock to E-Commerce providers, such as Amazon warehouses, which provide support for packing and delivery using couriers, which is monitored by sellers and buyers. With more capital infusion in their business, Amazon India is now in the process of acquiring land and developing a system of large capacity automated warehouses in more accessible locations across India to stock seller's products and that is delivered to buyers eventually within 24 h or even less, say 4–8 h. They are also increasing the list of cities where same-day (within few hours) delivery order is possible, thereby replicating the role of neighbourhood shopkeepers by providing home delivery neighbourhood service nationally. They are attempting to shrink nation to neighbourhood. Amazon and Google are collaborating with drone manufacturers to use it as another way of delivering sellers' items in E-Commerce directly to households. Amazon is also using local *Kirana*-shop (grocery store) with excess capacity to use it for e-commerce delivery points to pick up goods sold. While such services are easy to execute in mega-cities, it is difficult in secondary (tier-2) cities. It is the secondary cities that show rapid rise in buyers' population for Amazon and eBay. Amazon and others are now using various approaches for speedy delivery of goods. They include high-technology solution of airdrop using unmanned drones in USA to using local *Kirana*-shops in India to stock and deliver goods home locally. The main goal of e-commerce in India is to deliver goods in few hours after ordering in the same day across India. It is important to find out how much percentage of household expenditure is used for E-Commerce in a smart city, and what are the requirements of E-Commerce infrastructure, for example large warehouses and their likely location as changes affect the land use computations of planners.

Locational decision and logistics of smart city population may change the land use requirement of a smart city. There may be need for less retail space in the neighbourhood, but more nearmost accessible areas, such as around metro-stations. Local *Kirana*-shops can be part of e-commerce without even attached to Amazon, eBay, or Flipkart. They can have a website, and advertise and sell their products. Smart mobility in smart city helps them to send their products to anyone wherever they are located. This phenomenon changes the traditional concept of retail trade service area and turnover per square metres computation of commercial area. All

commercial uses when zoned are mixed-uses with varying proportion of recreational component for all age groups. More research is required on such mixes and urban design appropriate to such mixes in smart cities.

It is important to identify at smart city level what changes of land use are required thereby to change the land use plan. It is also important to increase population density in areas around high-mobility nodes and hubs in a city, such as mono- or metro rail stations through urban design for urban compaction, and evolve high-density and high-quality urban living. The benchmark population density suggested in Smart City Mission of India is 175 persons per hectare. This will be in contrast to older-generation planners who recreated low-density village life in urban settings, which was against the principle of land economics and land use succession. Some Indian cities have low urban population density, which needs to be increased further for economic use of infrastructure and providing high mobility to all. Public realm assumes greater importance in smart cities with more disposable household income for recreation of all age groups. It is important to reinvent into public realm and use high-quality urban design to be of use to smart city population. Mixed land use is accepted in India now, as in many other countries. It is important to play with various levels of mix land uses in high-mobility hubs and nodes of smart cities. There is scope for urban redevelopment and renewal in these nodes keeping the characteristics of heritage.

1.6.4   Smart City and Institutional Processes

Smart City Economic Development has taken place in different countries under differing institutional frameworks. It is important to have comparative study of such institutional set-up and enrich and reform the existing institutional frameworks (for example, MPC in India) that plan, develop, and manage smart cities. Triple Helix Model is evolving in many smart cities. Is it possible to transform existing institutional set-up with Triple Helix Model?

The collective and symbiotic leadership of three actors in Triple Helix Model is of prime importance for metropolitan regional development. The 74th constitutional amendment legislation of India had given constitutional status for Metropolitan Planning Committee (MPC) for metropolitan cities or agglomerations of one million plus population. Without Triple Helix Model built into it, many state governments have difficulty in understanding its true worth (for the composition and functions of MPC, see Appendix 2).

After many years of enacting the 74th Constitutional Amendment, only West Bengal and Maharashtra States have constituted the MPCs in Kolkata and Mumbai, respectively. Two other states—Andhra Pradesh and Gujarat—have enacted enabling legislation to constitute MPCs. Bengaluru in Karnataka State could enact MPC only in 2013. Other states having other metropolitan cities are yet to take any action in this regard. Kerala introduced MPC in its Planning Ordinance in 2013, but no cities have MPC as of today.

Generally as in Kolkata, the Chief Minister of West Bengal State is the Chairperson of the MPC. Prime Minister and/or Chief Minister are also involved in appointing Vice Chancellors of University, Directors of higher educational establishment and Public Research Institution and laboratories. Generally in metropolitan cities (population over 1 million), there should be higher education institutional cluster and industrial cluster. The first task is to institute the MPC, which should give leadership in implementing Triple Helix Model for accelerated economic development of the smart city or Smart Urban agglomeration. The MPC should have members drawn from the highest level of academia, industries and government, not necessarily from local institutions. In addition to Mayors and President of 'Panchayats' (rural local governments) and Municipalities, Academia and Industrialist shall be members of the MPC. There should be an implementing Agency for MPC. It should manage the data of the Metropolitan GIS Centre. Implementing Agencies should have Planning Wing with well-trained and experienced professionals, Engineering Wing capable of large-scale construction, and Finance wing capable of mobilizing large-scale funding for metropolitan development from India or abroad. Director or Vice Chancellor of University or Public Research Institution in an urban agglomeration can be a proven Industrialist to bridge the relationship between industry and university and make the triple helix evolve. Government can implement regional development policies and give special incentives to accelerate triple helix functioning for fast economic development. Industries shall be encouraged to undertake undergraduate technical education with the collaboration of universities. There is a recent attempt of Mercedes Benz Industries (Germany) to start School of Mechatronics in Trivandrum. Oracle Corporation is also setting up a training centre in a Village software start-up in Kerala to train college students around.

These are evidence of emerging Triple Helix Model working in Kerala. Government should also start training institutes similar to Kerala Institute of Local Administration or Institute in Management in Government. They can be enablers of Triple Helix Model at the state level in Kerala. The first step of smart city planning is to make city self-aware by encouraging students and research workers to collect ecological, economic, and cultural data to be fed into smart city GIS for making city self-aware continuously. Incentives and funds may be provided to universities, polytechnic, or schools to collect and update information and by the use of models if it is required by the MPC. The information generated by smart city GIS shall be used by all constituents of Triple Helix Model to frame their policies, plans, and strategies. Finally, it is the MPC that should prepare Policy and Strategy for smart city.

1.7   Smart Cities, Smart Economy, and Social Inclusion

Can smart cities and smart economy be socially inclusive? How to strategize social inclusion in smart city development, or how to make smart cities socially inclusive? What economic activities can be promoted for social inclusion in smart economy? These are some of the key questions that arise with regard to the role of people and

their (civil society) organizations in smart economy in smart cities. We will discuss these three important questions in the following subsections.

1.7.1 Smart People Are Central to Smart Cities

Can smart cities and smart economy be socially inclusive? Smart People are central to smart cities, as noted earlier (Sect. 1.2). They are the most prominent building block in the Smart City System. Without the active participation and involvement of smart people, a smart city will not be able to function. However, there are two factors that will determine if smart cities and smart economy will be socially inclusive: (i) Internet access, and (ii) affordability of (smart) digital devices.

Internet Access. The global access to Internet has been rising gradually (Fig. 1.13). In 2013, 2.69 billion people, or 38 % of world's population, had Internet access. According to an estimate, the global figure of Internet users will surpass three billion in 2015 and reach 42.4 % coverage [129; also see 130]. India already (2014) has 215.6 million Internet users, and this number is expected to grow to 346.3 million in 2018. It is important to note that Internet access is generally higher in cities than in rural areas though this is changing fast in developing
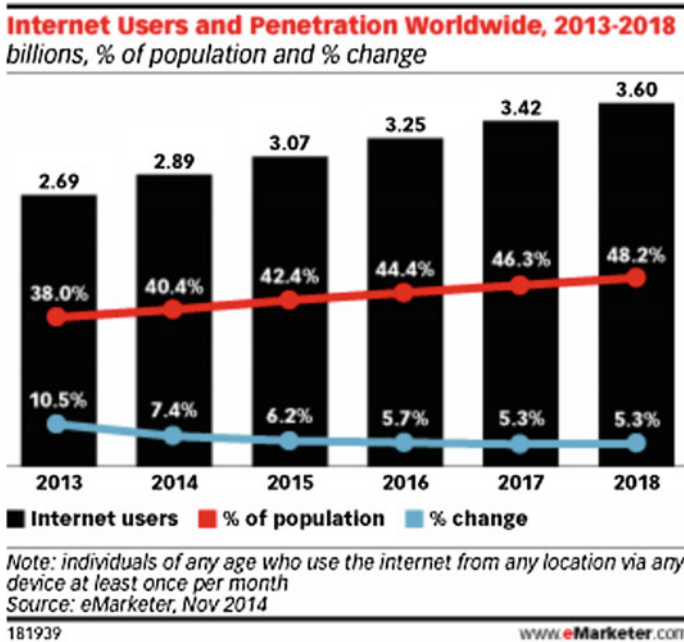
Fig. 1.13 Internet users and penetration worldwide, 2013–2018. *Source* [129]

countries. For instance, China plans to expand full broadband access to its rural and urban areas by 2020 [131].

Affordability of (Smart) Digital Devices. If user mode of access data is taken into account as proxy indicator, it shows that the proportion of people accessing Internet with mobile phones has been increasing in India (Table 1.7). The affordability of smart digital devices has also been increasing. However, one cannot deny the fact that a large number of people may not have access to (smart) digital devices and Internet for many years to come. In such cases, governments have to move forward and provide Internet access through the public availability of Internet hubs. This has been/is being successfully done in Kerala State of India, which is the only state in India (or perhaps the world) where 100 % e-literacy is achieved through training by an institution called Akshaya. Run mainly by private entrepreneurs, Akshaya provides Internet access to people at a walking distance. The spread of Akshaya is a testimony of its economic viability, and all e-governance functions of the Government of Kerala can be executed at a nominal fee [44, 132]. Therefore, Internet access and affordability of (smart) digital devices are critical for facilitating and promoting two-way interaction between the local government and people.

1.7.2   Strategies for Social Inclusion in Smart City Development

How to strategize social inclusion in smart city development, or how to make smart cities socially inclusive? There are three strategies that can facilitate social inclusion in smart city development, which are discussed as follows.

1.7.2.1   Strategic Vision for Smart City Development

For the collective preparation of a *Strategic Vision for Smart City Development*, governments can directly involve citizens through 'strategic planning' exercise and request their inputs through a dedicated two-way interactive website. To people who have personalized Internet access, they can directly provide their inputs. To people who do not have personalized Internet access, governments can provide open access through public sector Internet cafes/hubs that can be installed in local governments offices or other public buildings. Moreover, governments can complement Internet-based consultation with seminars and open meetings in public spaces in the city, especially for those with limited Internet access. Governments can also organize webinars, particularly to involve those who are not locally based and/or may be travelling at the time of such strategic consultations.

1.7.2.2 People's Participation in Smart City Planning

People's participation in urban planning is a well-researched subject. However, people's participation in Smart City Planning has gone beyond the statutory consultation required for preparing urban master plans. We feel that this will require paying attention to three specific aspects.

People-Driven Physical Development of Smart City. First, as cities become increasingly smart, governments will have to invite and receive people's concrete feedback on the ways in which the conventional city is changing. A case in point is the changes in land use that may occur with the growth of e-commerce, as discussed earlier (Sect. 1.6.3.2). This may hold true about changing travel patterns, evolving modal split in transportation, location of economic activities next to mono- or metro rail stations, reductions in household water usage in view of resource constraints, or improved recycling through efficient solid waste management.

ICT-facilitated Planning Consultations. Second, people's involvement in smart city Planning will increasingly become easier and simpler with the ever-expanding Internet access and affordability of (smart) digital devices. In addition to open consultative meetings and seminars, webinars and online consultations will become commonplace. This will add to transparency in Smart City Planning and better record keeping of consultations.

Increased Frequency in Planning Consultations and Decision-Making. Third, as one would expect, the increasing usage of ICTs and enhancing interface between governments and citizens will lead to an increasing frequency of people's participation in Smart City Planning and related decision-making. For instance, if interactive websites are properly designed, it would become possible to apply for and obtain planning permission online, as designed in the urban design studio exercise conducted at the National Institute of Technology, Calicut (cross-reference this with the Chapter on Calicut study once all chapters are numbered).

1.7.3 People-Driven Economic Development of Smart City

What economic activities can be promoted for social inclusion in smart economy? Given the central role Smart People will play in a Smart City System, perhaps this question should be rephrased as: What sort of people-driven economic development activities would contribute to smart economy? Although the idea of smart city holds the promise of an expanding role of people in smart economy, we would like to discuss two areas of people's proactive involvement and inputs can significantly expand economic activities. First is the development of economic clusters where micro-, small-, and medium-sized enterprises can come together, develop business blueprints and knowledge-based economy plans, and seek government support. Such initiatives can be based on conventional professional guilds and/or economic enterprises located in one or more contiguous neighbourhoods. The people-led design and implementation of such initiatives will build and/or strengthen *local*

collaborative advantage, and thus will add to competitiveness of smart economy. Second, people can take lead or work together with local governments to design and develop urban economic activities linked to culture and heritage conservation, preservation, and celebration (latter in the form of art and cultural festivals). Such economic activities would contribute to expansion of smart economy, develop city branding, provide employment, and preserve local culture and heritage. The design and development of such economic activities people can integrate the use of ICTs and smart digital devices and build on the purposefully designed websites.

1.8 Supporting Transition to Smart Economy in Smart Cities

Supporting the transition from conventional urban economy to smart economy in smart cities will require extraordinary changes in the urban management, governance, and decision-making. Such changes will become critical because they will be required as a result of the expanding interaction between governments, private sector, civil society organizations, and citizens. Therefore, it is important to discuss the various approaches to and stages of urban governance with regard to the transition of conventional urban economy to smart economy in smart cities.

1.8.1 *Government-Led Conventional Urban Economy*

The development of conventional urban economy relied on public sector-led planning, design, investment, implementation, and monitoring of development process. Primarily national governments, and in some cases their local-level offices, played a key role in economic and spatial (including master) planning; development of growth poles, new satellite towns, economic enterprise zones, industrial parks, business parks and technopoles; and infrastructure planning and development. Such an approach was considered important in the immediate aftermath of many African and Asian countries becoming independent from colonial powers. In many cases, the new and independent governments of the developing countries had inherited state-of-the-art know-how and technologies for managing cities and towns. The development models that were proposed during 1950s and 1960s emphasized significant roles of national governments. This began to change during 1970s and 1980s when it was realized that central governments were unable to deliver development outcomes and poverty was rising. Consequently, the demand for decentralization and local-level accountability became increasingly evident. Many countries enacted legislation during 1980s and 1990s to decentralize authority to sub-national and local governments [3]. Decentralization of authority and devolution of financial powers to local governments was to revolutionize the ways in

which towns, cities, and metropolitan areas were to be governed, with increased role to be provided for locally elected representatives as well as local communities. Decentralization did lead to democratization of local polity as elections were instituted at local level. However, the newly elected political leaders at the local level did not view community leaders in good light. As a result, in many cases a confrontational relationship developed between the representatives elected to local governments and the local leaders who were elected to and represented community-based organizations, for example Civic Exnoras in Chennai [133], and resident welfare associations in many cities of India. To address such issues, an effort was made in Delhi through a government and resident welfare association partnership programme called *Bhagidari* (literally, 'partnership') [134]. Despite decentralization drives in many countries, local development activities have remained under the overarching influence of national and sub-national governments, for instance in India where limited financial and taxation powers were given to local governments under the 74th Constitutional Amendment Act of 1992.

1.8.2   Public and Private Sector Cooperation

In early 1990s, international development organizations started to argue about improving efficiency in 'governance'. As governments were often found lacking in technical and financial capacity, cooperation between the public and private sectors was seen as a key to improving (urban) infrastructure and services. 'PPPs are a mechanism for government to procure and implement public infrastructure and/or services using the resources and expertise of the private sector. Where governments are facing ageing or lack of infrastructure and require more efficient services, a partnership with the private sector can help foster new solutions and bring finance" [135]. Advocates of PPPs argue that these partnerships utilize the skills and resources of both the public and private sectors and share risks and responsibilities. While the public sector focuses on policy, planning, and regulation by delegating day-to-day functions, the city benefits from the technical expertise of the private sector. Arguments against PPPs include increase in utility tariffs—for instance for water supply and wastewater management, displacement of public sector employees [82], and corruption [3].

Where the public and private sector cooperation seems to work better is in the development of SEZs, industrial estates, and science parks. Governments provide developed land with infrastructure and services, and the private sector makes investment in form of economic enterprises. SEZs have worked to trigger (and sustain) export-oriented growth when they properly equipped with infrastructure and have geographical connectivity. However, many SEZs and science parks have not aimed to focus on innovation and development local economic competitiveness. Instead, they have become an agglomeration of manufacturing units focused mainly on exports (Sect. 1.4). Apart from SEZs, industrial estates, and science parks, governments' main strategy to support local economic development relies on

building of infrastructure, and the individual economic enterprises are expected to take advantage of it.

1.8.3 Participatory Governance for Smart Economy in Smart Cities

Due to the ongoing development of ICTs and their ever-increasing use, human settlements of all sizes—whether they are towns, cities, metropolitan areas, or mega-cities, will evolve into smart cities. With the power of ICTs and smart digital devices in their hands as well as growing online financial transactions, people have already begun to expect much more from their governments, infrastructure and service providers, and commercial vendors. Contributors to 'E-governance for Smart Cities' [44] have discussed, supported by empirical case studies, how e-governance is contributing to the development of smart cities. The spread of electronic banking has facilitated online bill payments, including those to utility and service providers.

One of the next big stages, if not the very next big stage, will be the expansion of people's role in the development of smart economy in smart cities. This has already begun in the case of expanding e-commerce, for example in India, which is changing the way in which people shop on a daily basis (Sect. 1.6). Next, in terms of generators of demand for developed land, people are already contributing, though indirectly, to governance and decision-making, for example with regard to land use planning and development decisions around metro-stations. In the coming years, if not decades, this may evolve further where groups of economic enterprises may seek redevelopment of brown fields as land use succession takes place. Inner city old industrial areas may become clusters of clean ICT industries, thereby promoting local economic competitiveness for the development of smart economy in smart cities. An approach to revitalize inner city areas was supported by Porter [136] who argued that:

> A sustainable economic base can be created in the inner city, but only as it has been created elsewhere: through private, for-profit initiatives and investment based on economic self-interest and genuine competitive advantage—not through artificial inducements, charity, or government mandates.

Meeting the challenge of providing greater role to people in the development of smart economy will require: (i) putting together of people's ideas into workable proposals for local economic development (Sects. 1.7.2 and 1.7.3), (ii) openness of different levels of government and planning authorities to such proposals made by citizens and citizen groups (which may be registered as associations or companies), and (iii) ICT-facilitated interaction between governments and citizens to ensure ART in urban governance decision-making.

1.9 Sustainable Models of Smart Cities and Towards Smart Cities Standards

1.9.1 Sustainable Development of Communities—Indicators for City Services and Quality of Life (ISO 37120)

1.9.1.1 ISO 37120 and Its Benefits

In May 2014, the International Organization for Standardization (ISO) launched ISO 37120 on "*Sustainable development in communities—Indicators for city services and quality of life*" as part of an integrated suite of standards currently being formulated for sustainable community development. ISO 37120 'defines and establishes methodologies for a set of indicators to steer and measure the performance of city services and quality of life' [137]. This International Standard does not provide a value judgement, or numeric thresholds on what a particular city should choose as appropriate targets for the indicators. Rather it gives internationally standardized indicators, which are consistent, standardized, and comparable over time or cities. Indicators are qualitative, quantitative, or descriptive measures.

In this age of rapid urbanization, city indicators can be used as critical tools for city managers, politicians, researchers, business leaders, planners, designers, and other professionals to help ensure policies are put into practice that promote liveable, tolerant, inclusive, sustainable, resilient, economically attractive, and prosperous cities globally. Cities need indicators to measure their performance for improving quality of life and sustainability globally. Moreover, planning for future needs of the city must take into account current use and efficiency of resources in order to plan for tomorrow. Existing indicators are often not standardized, consistent, or comparable over time or across cities, thereby establishing importance of ISO 37120. Performance measurement of city services and quality of life over time can, in turn, help to strengthen smart governance and smart living. These indicators can also be utilized to measure city services and quality of life for sustainable development of smart cities with respect to impact of ICT deployment.

The launch of ISO 37120 is important because it is the first ISO standard that can be utilized to measure the performance of, plan for, and support decision-making for smart cities. The ISO 37120 standardized indictors are provided for 18 themes related to city services and quality of life: (i) economy, (ii) education, (iii) energy, (iv) environment, (v) finance, (vi) fire and emergency response, (vii) governance, (viii) health, (ix) recreation, (x) safety, (xi) shelter, (xii) solid waste, (xiii) telecommunication and innovation, (xiv) transportation, (xv) urban planning, (xvi) wastewater, (xvii) water and sanitation, and (xviii) reporting and record maintenance [138].

Benefits of Standardized Indicators. The International Standard ISO 37120 lists out 10 benefits of standardized city indicators for service delivery and quality of life [139].

(1)   More effective governance and delivery of services
(2)   International benchmarks and targets
(3)   Local benchmarking and planning
(4)   Informed decision-making for policy makers and city managers
(5)   Learning across cities
(6)   Leverage for funding and recognition in international entities
(7)   Leverage for funding by cities with senior levels of government
(8)   Framework for sustainability planning
(9)   Transparency and open data for investment attractiveness
(10) Data are moving fast [through Internet leading to] big data and the infor-
      mation explosion. ISO can help to give cities a reliable foundation of
      globally standardized data that will assist cities in building core knowledge
      for city decision-making, and enable comparative insight and global
      benchmarking.

1.9.1.2   ISO 37120 and Smart Economy in Smart Cities

The International Standard ISO 37120 with regard to urban 'Economy' is given in
its Sect. 1.5 that is directly related to smart economy in smart cities. There are two
types of standardized indicators: (i) core indicators are those 'that are required to
demonstrate performance in the delivery of city services and quality of life'.
(ii) Supporting indicators are those 'that are recommended to demonstrate perfor-
mance in the delivery of city services and quality of life' [138].
   Core Indicators:

(1)   *City's unemployment rate (core indicator)*: Unemployment rate always has
      been a key performance indicator as it is the single most important measure of
      a city's economic health and vitality. ISO 37120 calculates unemployment rate
      in a traditional manner and defines the unemployed as those seeking work in
      the past month, and excludes the discouraged, hidden, and long-term unem-
      ployed from the calculation. Employment exchange data may help here.
(2)   *Assessed value of commercial and industrial properties as a percentage of
      total assessed value of all properties (core indicator)*: This indicator can help
      cities detect and quantify an eroding economic base. It is a very good indicator
      of dynamics of industrial and commercial development of a city. ISO 37120
      focuses on commercial and industrial property values only.
(3)   *Percentage of city population living in poverty (core indicator):* ISO 37120
      defines persons in poverty as 'those unable to adequately provide water, food,
      shelter and basic needs for themselves over a 12-month period'. Children are
      particularly affected by poverty, which can lead to poor health, impaired
      educational attainment, homelessness, and chronic unemployment.

Supporting Indicators:

(4) *Percentage of persons in full-time employment (supporting indicator)*: This indicator is similar to the unemployment rate and reflects the economic health of a city as well as the impact of local economic policy. ISO 37120 focuses this indicator on city residents of legal working age who work 35 h or more per week.

(5) *Youth unemployment rate (supporting indicator)*: As important as the overall unemployment rate is, the youth unemployment rate can be an even better indicator of a city's economic and social stability. Young men and women in many countries around the world face increasing uncertainty about their economic future, which can translate into significant social unrest and upheaval. ISO 37120 defines unemployed youth as those persons above the legal age and under 24 years of age who are actively seeking employment.

(6) *Number of business per 100,000 populations (supporting indicator)*: This indicator measures the level of a city's economic activity and performance and can reflect a city's overall business climate and attitudes towards growth and entrepreneurship.

(7) *Number of new patents per 100,000 population per year (supporting indicator)*: Innovation is an essential element of a city's or region's continued economic prosperity. However, there are issues of using these indicators primarily because patents for multinational corporations are generally filed in that corporation's home city, and universities file it in the capital city, and so on. Maybe the number of patents used in the city *for* 100,000 populations per year is a good surrogate and not that is registered *in* a city.

These indicators can be used to track and monitor progress on city performance, in this case with regard to smart economy in smart cities.

1.9.2 Towards Measuring Progress of Smart Cities

India's Smart Cities Programme [60, 64] has generated copious discussion on what is the current state of cities in the country, and what will be the benchmarks and indicators to measure progress towards the development of 100 smart cities. One strand of this discussion relates to the potential pathways to reach a state of 'smart city' or to develop 'smart cities'. A related theme is how progress towards reaching the state of or developing a smart city can be measured. In this regard, it is pertinent to look at the 'Smart Cities Maturity Model' developed by the Sustainable Business Leadership Forum (SBLF) [140].

1.9.2.1 Maturity Model for Smart Cities

SBLF argues that the current paradigm of 'successful cities' targets on providing 'access' to infrastructure and services. This leaves 'a very limited focus and scope to drive resource optimization over the "whole system" of a city, particularly through the integrated use of physical infrastructure and ICT' [140, p. 7] in the following four areas:

- 'Changing behaviour of citizens when interacting with the physical environment
- Closing the loop on resource and energy flows within different parts of a city, as also its exchanges with other cities, peri-urban areas, and rural supply bases
- Creating negligible response times to variability events (biohazards, climate change, security, disasters, crime)
- Measuring, tracking, and embedding efficiencies in resource and energy consumption'.

What is then needed is a 'common lens on success' on the above four areas for which SBLF has developed a 'Smart Cities Maturity Model', as shown in Fig. 1.14. Through a 4-stage maturity model, the SCMM aims to establish the metrics that can be applied to a 'future city' to gauge preparedness on the above-mentioned four areas, viz. access, efficiency, behaviour, and systems focus. In the first stage of Smart Cities Maturity Model, 'urban resilience' takes form of access to basic urban services. The second stage involves efficient resource and energy use, which is actively measured and embedded in a future smart city. Third stage is reached when people interact with physical assets in various ways that unlock new pathway for achieving sustainability. The fourth stage of 'high urban resilience' is attained with 'systems focus' wherein close-loop and sustainable resource and energy exchanges are strengthened in a future smart city.

Maturity Model	1	2	3	4
	Basic Urban Services			High Urban Resilience
KPIs relate to…	Access	Efficiency	Behaviour	Systems Focus
What success looks like…	Urban infrastructure and technologies are available and urban services are being delivered	Efficient resource & energy use is actively measured and embedded in a future city	People interact with physical assets in ways which unlocks new pathways for sustainability	Close-loop & sustainable resource & energy exchanges are being strengthened within a city

Fig. 1.14 Smart Cities Maturity Model. *Source* [140, p. 7]. *Note KPI* key performance indicators

Table 1.10 Measuring smart city resilience in India

Maturity Model	1		2		3		4	
	LOW URBAN RESILENCE						HIGH URBAN RESILENCE	
	Access		Efficiency		Behaviour		Systems Focus	
	ISO	India	ISO	India	ISO	India	ISO	India
Transport	✓✓	✓✓	●	●	✓	●	●	●
Spatial Planning	✓✓	✓✓	●	●	●	●	●	●
Water Supply	✓✓	✓✓	✓	✓	●	●	●	●
Sewerage & Sanitation	✓✓	✓✓	●	●	NA	NA	●	●
Solid Waste	✓✓	✓✓	●	●	●	●	●	●
Storm Water Drainage	NA	NA	●	✓	NA	NA	NA	NA
Energy & Electricity	✓✓	✓✓	✓✓	✓	●	●	●	●
Telecom & WiFi	✓✓	✓✓	●	●	●	●	●	●
Economy, Finance, Education & Health (Grouped)	✓✓	✓	●	●	✓	✓	NA	NA
Environment	✓	●	●	●	●	●	●	●

Source [140, p. 9]

1.9.2.2 Measuring Smart City Resilience in India

In order to measure the current state of smart city resilience in India, SBLF applied the Smart Cities Maturity Model to the metrics under ISO 37120 on *Sustainable development in communities—Indicators for city services and quality of life* [137] and Government of India's *Smart City Concept Note Benchmarks* [55]. The result of this exercise is presented in Table 1.10.

The findings presented in Table 1.10 portray a realistic picture of the state of 'urban resilience' in India based on the application of the Smart City Maturity Model. SBLF notes four key findings as follows:

(1) 'Indian and International norms are on-par and in agreement on: (a) baseline performance expected for urban services in smart cities; and (b) the need to build and embed a focus on resource efficiency as we start to use smart city infrastructure.

(2) There is absence of KPIs [key performance indicators] to promote resource sustainability and urban resilience by creating a change in resource flows within the city or through the way citizens interact with the physical environments.

(3) The conversation on Efficiency is limited to energy and water only—there is a huge missed opportunity to recover materials and energy from sewerage, solid waste, and wastewater from urban ecosystems.

(4) There is a lack of a "systems" approach both within the National and the International standards framework to fostering urban resilience' [140, p. 9].

This exercise conducted by SBLF on Smart City Maturity Model with regard to measuring the current state of 'urban resilience' underlines that a lot of work needs to be done with regard to developing smart economy in smart cities of India.

Appendix 1

ICT Indicators for Economic Sectors

ICT use in government: Generally, Governance System is resistant to change unless great visionary politician rules the democratic institutions with absolute majority. This is very much exhibited by the fact there are many Administrative Reform Commissions, but only a fraction of recommendations are implemented in many countries. Progress of ICT use in government can be studied by the following indicators.

(1) Number of ICT specialists employed in government works.
(2) The number of electronic devices used in government.
(3) The number of personal computers connected to the Internet in government offices.
(4) The number of Internet users in government.
(5) The percentage of institutions with Internet connectivity in all institutions.
(6) The share of investments and expenditures for ICT products and services in total investment and expenditure.
(7) Investments and expenditures for ICT products.

Observation of the economic and financial indicators illustrates the increases/decreases in quantitative and qualitative indicators of the smart city economic development. It is important to watch how ICTs are used for the sale and purchase products online products and changing turnover due to online sales. Growth is indicated in India by Flipkart infusing US $1 billion and Amazon India infusing US $2 billion in e-commerce business in India in later half of 2014.

Educational Sector also contributes to smart city economy. Education sector includes both educational institutions in the public and private. The calculation of indicators of urban economy in educational sector will take into account of all three levels, namely primary, secondary, and tertiary. Further, there shall be provision for continuing education for smart city citizen. The indicators that measure the progress of smart city economy in education sector are the following.

(1) The number of PCs per 100 students.
(2) The number of PCs connected to the Internet per 100 pupils and students.
(3) The education institutions connected to the Internet in total number of educational institutions.
(4) The number of students using Internet.

ICT in Public Health Sector: The use of ICT in public health sector can result in growth of smart city economy. The number of persons employed per hospital bed is generally on a higher side than large and medium industries and certain capital-intensive small industries, and therefore, health sector contributes to smart city economy in a great deal. By implementing the health sector of new electronic communications services will achieve an increase in efficiency, with lower costs. Health sector growth of smart city economy can be measured in the following indicators.

(1) The number of ICT equipment used.
(2) The number of personal computers connected to the Internet.
(3) The number of medical institutions sharing Internet connection in all institutions.
(4) The share of investments and medical expenses for ICT products and services in total investment and expenditure.
(5) Investments and expenditures for ICT products used in health sector.

ICT in Household Sector: Analysis is also needed for the household sector and influences the degree of development of settlements. The indicators are:

(1) Share of households with fixed telephone and mobile.
(2) Share of households owning personal computers connected to the Internet in total households.
(3) Share of total household expenditure on communications.

ICT in SME Sector: Another important employment generator in smart city economy is SME sector. It is important to watch how ICT products are used there.

(1) Share of enterprises that have personal computers.
(2) Share of employees using personal computers.
(3) Share of enterprises with Internet access.
(4) Share of the number of employees using the Internet.
(5) Share of enterprises with website.
(6) Share of enterprises that sell via the Internet.
(7) Share of enterprises purchasing on the Internet.

Tourism and heritage (both cultural and natural resources) are another component of smart city economy which contributes to income growth. The related indicators are as follows:

(1) Share of cultural institutions holding personal computers.
(2) Share of employees using personal computers.
(3) Share of cultural institutions with Internet access.
(4) Share of employees using the Internet.
(5) Percentage of institutions of cultures with website.
(6) Share of cultural institutions that sell over the Internet.

Tourism sector generates large revenues, which make this sector a pillar of economic development in smart cities, and hence the implementation of new ICTs.

(1) The percentage of tourism that have personal computers.
(2) Share of employees using personal computers.
(3) Share of employees using the Internet.
(4) The percentage of tourism industrial units with website.
(5) The percentage of tourism that provides services via the Internet.

Similar ICT indicators can be developed for key economic sectors of smart cities.

Source: Authors

Appendix 2

Composition and Functions of Metropolitan Planning Committee (MPC) in India

Article 243ZE. Committee for Metropolitan Planning.

(1) There shall be constituted in every metropolitan area a MPC to prepare a draft development plan for the Metropolitan area as a whole.
(2) The Legislature of a State may, by law, make with respect to

  (a) The composition of the MPCs;
  (b) The manner in which the seats in such Committees shall be filled:

Provided that not less than two-thirds of the members of such Committee shall be elected by, and from among, the elected members of the Municipalities and Chairpersons of the Panchayats in the, Metropolitan area in proportion to the ratio between the population of the Municipalities and of the Panchayats in that area;

(a) The representation, in such Committees of the Government of India and the Government of the State and of such organization and institutions as may be deemed necessary for carrying out the functions assigned to such Committees;
(b) The functions relating to planning and coordination for the Metropolitan area, which may be assigned to such Committees;
(c) The manner in which the Chairpersons of such Committees shall be chosen.

(3) Every MPC shall, in preparing the draft development plan,

  (a) Have regarded to:

    (i) The plans prepared by the Municipalities and the Panchayats in the Metropolitan area;

     (ii) Matters of common interest between the Municipalities and the Panchayats, including coordinated spatial planning of the area, sharing of water and other physical and natural resources, the integrated development of infrastructure, and environmental conservation;

    (iii) The overall objectives and priorities set by the Government of India and the Government of the State;

    (iv) The extent and nature of investments likely to be made in the Metropolitan area by agencies of the Government of India and of the Government of the State and other available resources whether financial or otherwise;

   (b) Consult such institutions and organization as the Governor may, by order, specify.

(4) The Chairperson of every MPC shall forward the development plan, as recommended by such Committee, to the Government of the State.

Functions of MPCs are as follows:

As per 74th Constitution Amendment Act legislature of the State may, by Law, make provisions regarding functions relating to planning and coordination for the metropolitan area that may be assigned to MPC. Accordingly, it is suggested that the following functions may be assigned to MPCs:

  (i) Preparation of Draft Development Plan for Metropolitan Area.

  (ii) Coordination of plans prepared by the Municipalities and Panchayats in the metro area including coordinated spatial planning of the area.

 (iii) Coordination and sorting out of common issues involving Panchayats and Municipalities in the metro area including sharing of water and other physical and natural resources.

  (iv) Allocation of resources made available by the state and central government to local-level institutions.

  (v) Phasing and prioritization of development works or works involving number of Panchayats or urban area.

  (vi) Advice and assistance to local bodies in preparation of development plans.

 (vii) Serving as a link to disseminate development objectives, policies, and priorities of Central and State Governments among various local bodies by formulating operational guidelines so that the same may be considered while preparing plans of the respective local bodies.

(viii) Resolution of conflicts and to avoid areas of overlap between different agencies operating in the metropolitan area.

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Part II
Canada-Ottwa

Chapter 2
Ottawa: Rise of a Smart Community

**Barry Gander, Bruce Lazenby, Charles Duffett, Greg Richards,
Mark Hoddenbagh, Mark Kristmanson, Ritch Dusome,
Sarah Linkletter and Sorin Cohn**

Abstract The need to communicate forced Canada to invent the tools of the modern Communications Age, which are now being used worldwide. Ottawa in particular became a hotbed of communications technology development, as it was

B. Gander (✉)
i-CANADA, 1919 Pereau Road, Canning, NS B0P 1H0, Canada
e-mail: barrygander@yahoo.com

B. Lazenby
Invest Ottawa, 80 Aberdeen St, Ottawa, ON K1S 5R5, Canada
e-mail: blazenby@investottawa.ca

C. Duffett
City of Ottawa, 110 Laurier Ave W, Ottawa, ON K1P 1J1, Canada
e-mail: charles.duffett@ottawa.ca

G. Richards
Telfer School of Management, IBM Centre for Business Analytics and Performance,
University of Ottawa, 55 Laurier Ave E, Ottawa, ON K1N 6N5, Canada
e-mail: richards@telfer.uOttawa.ca

M. Hoddenbagh
Partnership and Applied Research, Algonquin College, 1385 Woodroffe Ave,
Ottawa, ON K2G 1V8, Canada
e-mail: mark.hoddenbagh@algonquincollege.com

M. Kristmanson
National Capital Commission, 202-40 Elgin Street, Ottawa, ON K1P 1C7, Canada
e-mail: mark.kristmanson@ncc-ccn.ca

R. Dusome
Centre of Excellence in Next Generation Networks, 555 Legget Drive,
Tower a, Suite 600, Ottawa, ON K2K 2X3, Canada
e-mail: ritch.dusome@cengn.ca

S. Linkletter
EPSI, 6 Sainte-Marie, Gatineau, QC J8Y 2A3, Canada
e-mail: SLinkletter@epsi-inc.com

S. Cohn
Conference Board of Canada, 255 Smyth Rd, Ottawa, ON K1H 8M7, Canada
e-mail: scohn@rogers.com

home to government Research and Development Laboratories. It also had a heritage of innovation from local inventors who pioneered many of the electronic aids used in households today. Innovation, therefore, was given a springboard for growth in Ottawa's culture. Innovation is the driver of the Smart Economy today, responsible for three-quarters of all economic growth in the USA since World War II. It is triggered by associations of ideas are intuitive; it arises from hunches and that vague hard-to-describe sense that there is an interesting solution to a problem that has not yet been addressed. The number of innovations in a centre is directly tied to the number of linkages in a centre: the higher the linkages between people, the greater the momentum of the innovation. To be effective as an economic force, a second ingredient is needed: the ability to find the commercial value of the innovation. This value-adding characteristic has thus far been difficult to assess due to the tentative nature of innovations in their early stages. In Ottawa, a new assessment tool is being used that can detect the overall intensity of the "Smart City" environment, based on hundreds of factors. Another new tool drills down to the organizational level and assesses the efficiency of the organization's ability to commercialize innovation. These tools can be used by any city wishing to obtain a Smart Economy.

Keywords Smart Economy · Smart City · Innovation · Ottawa · Canada · Technology development · Economic growth · Innovation tools · Smart City assessment · Smart Economy assessment · Smart City awards · Smart City standards · Innovation development

> "*Our knowledge sector contributes billions of dollars to our economy; innovation and collaboration are at the heart of our growth*".
>
>   *Jim Watson, Mayor, City of Ottawa* [1]

2.1 Forward

Ottawa is the capital city of the country that *created* the Communications Age.

Necessity drove Canadians to invent the ingredients of the Communications Age: the telephone itself was invented in Canada, and the world's first long-distance telephone call was made in Canada. Canadians heard the first broadcast of voice on a radio transmission [2]; launched the first domestic communications satellite (Anik); saw the first direct-to-home satellite transmission (a Canadian hockey game); made the first international connection to the Internet; and invented the first digital telephone exchange—one that ushered in today's Digital Era in the Communications

Age. Other Canadian innovations that are fundamental to the digital age include the touch screen for computers and the Internet search engine.

This focus on Communications is not surprising for Canada, because the country owes its *existence* to Communications.

Canada was formed when separate provinces decided to unite rather than face the prospect of being absorbed by a powerful neighbour. The solution hinged on the provision of a railway to connect the country from coast to coast…a promise made on Confederation Day in 1867 and completed in 1885. In <20 years, it spanned a distance of 4000 km. Foreshadowing the future, a *telegraph line accompanied the rail track*, highlighting the importance the emergent country already placed on electronic communications.

A high proportion of the basic tools of today's Communications Era that emerged from Canadian innovations originated in the capital city of Ottawa. As it took its pioneering steps, Ottawa became, in a sense, the "***Measure* of Innovation**"—the standard of success against which other centres can be compared. Ottawa is also the place where **innovation itself** has first been measured in a realistic and useful set of indicators for growth.

This chapter will explore:

1. How Ottawa's unique position gave it an advantage in creating the linkages that made it a Smart City innovation powerhouse; and
2. How Ottawa's new tools to assess innovation and Smart Communities prepare the city for future success.

"Innovation" here is understood to have different but complementary meanings for business and society. *Business innovation* enhances corporate value by attracting customers with better/cheaper products and services and by surprising the competition with more effective and efficient internal and external processes and capabilities. *Community innovation* blends business and social values to differentiate the city and enhance prosperity and well-being.

A "Smart Community" is defined as a collaborative, entrepreneurial area of higher social harmony, employment, effective education, satisfactory recreation, and better safety and health care from the effective use of information infrastructure and resources. It is much more than infrastructure and technology: it is the mobilization of social and business resources behind a common vision of a community's future.

Smart City status is important to Ottawa because it has to maintain its competitiveness in the face of global forces that are driving the development of competing Smart Communities at a fevered pace:

1. New major centres of creativity, wealth, and social importance are coming into prominence every year across the globe;
2. People are crowding into cities and communities at a pace never experienced before; and
3. The immense pressure this migration puts on city infrastructure and civic interaction requires a new level of problem-solving.

The fundamental reason for the exponential growth of Canadian—and global—Smart Cities is that they can mobilize the great density of urban people to organize an adequate social response to the challenge of growth. The larger the city, the more people are likely to come into contact with each other. Ease of access to ideas and opportunities drives the productivity of the city. Today, fast communications have the potential of making every location a "super-city".

In Canada, urbanization rates match the global trend. The surge in city living over suburban living is no longer an "emerging trend" but "the new normal" as millennials and a growing number of their parents transform downtown cores across much of Canada at dizzying speed, according to a new report [3]. For example, that urbanization trend—the shift to living and playing close to work—continues to blur the lines between commercial and residential development in downtown cores, fuelling the creation of new office towers and even spurring a resurgence in rental-apartment construction for the first time in decades.

With 79 % of its population living in urban centres, Canada ranks 40th on the list of most urbanized countries in the world. It is predicted that by 2025, Canada will have 82 % of its population in urban centres [4].

This growth in urbanization is expected to continue in Canada for two reasons:

– The older Canadian economic model of reliance on rurally based resource industries such as lumber, oil, and agriculture is giving way to an economy based on knowledge industries, which tend to favour urban concentrations; and
– The Canadian cities of 100,000+ population are growing fastest of all, because of immigration from other countries where the new arrivals cluster in the larger centres, plus migration from the Canadian countryside.

In fact, these factors are driving Canada's largest urban centres (Toronto, Montreal, Vancouver, and Ottawa) to grow at a faster rate than other centres [5].

Canada's relatively small share of the global population (0.5 %) despite its rank of second largest country in the world means that to sustain its position in the world economy, the country has to make full use of all the "power tools" that innovation can provide. Each centre has to be a Smart City; each town has to be a Smart Community; and each rural area needs to be a Smart Region.

This is the value of Ottawa: it is the spear-point for Canadian Smart Community development, and indeed, because of Canada's pre-eminent place in the Smart City movement, for other communities around the world.

2.2 Linkages, Innovation, and Ottawa

Some 20 years ago, the Canadian Advanced Technology Alliance (CATA) did a survey of 12 cities across Canada, to determine what factors led to their prosperity [6]. The single most commanding factor was the **closeness of the bonds between**

the companies within the city and with the city's institutions. The closer the linkage between these groups, the faster was the rate of innovation.

Linkages in fact drive innovation in such a fundamental way that the act of innovating is an act of linking, both at the product level and at the community level.

The Smart Economy is an economy of linkages.

2.2.1 Innovation-Generation Capability Depends on Linkages

We are surrounded by innovations today, like a fish is surrounded by water, and—like the fish—it is often hard for us to realize the totality of our immersion. From clothes to communications, we are coddled by the results of a thousand years of innovations. Our environment now consists of the accumulated and linked labour of millions of inventive people, working decade after decade. Understanding the cumulative power of innovation allows a better analysis of how it can be encouraged to shape into an *intentional future*—the Smart City future.

"Innovation" in this sense is the realization (i.e. the implementation and the successful exploitation/commercialization) of a good idea to add value in monetary and/or social ways. It differs from pure "research" in that research is the discovery of previously unknown knowledge. Research costs "money"; innovation makes "money".

According to expert Stephen Johnson [7], innovation is intuitive; it arises from hunches and that vague hard-to-describe sense that there is an interesting solution to a problem that has not yet been addressed. According to Johnson, these hunches are slow-developing and cumulative. Good ideas are not conjured out of thin air; they are built out of a collection of existing parts, the composition of which expands (and, occasionally, contracts) over time. Some of those parts are conceptual: ways of problem-solving or recasting what constitutes a problem in the first place. Some of them are, literally, mechanical parts.

Good ideas are triggered by inspiration from concepts that are adjacent to them. The greater the field of available adjacent hunches, the faster the rate of innovation. This is what Johnson calls "the adjacent possible", a kind of shadow future, hovering on the edges of the present state of things, a map of all the ways in which the present can reinvent itself. The boundaries of the adjacent possible grow as the innovation cluster grows. Linkages expand opportunities for, and success of, innovation exponentially.

Innovation follows linkages—this is a proposition that can be demonstrated historically, with the precursor of the Internet, the Post Office. In nineteenth-century America, there was a correlation between the presence of a post office and the subsequent rise in the number of patents issued in a particular county. That relationship remained even after accounting for population and numerous other variables. Moreover, because the burst of patents followed the arrival of a post office,

rather than vice versa, the authors of a recent study [8] say that the relationship is causal: where the post office increased linkages, innovation bloomed.

This extends to the fine-grain level of single organizations. An increase in linkages within a company leads to faster innovation. In companies that limit innovation to a select few leaders, says a recent study, there is "a tenfold increase in innovation when all employees are both expected and given the permission to find ways to innovate and improve their organizations every day" [9].

Even within companies, innovation happens through links, concurrently, between various domains. Firm-level innovation is best seen as a set of overlapped processes in various stages of development [10] (Fig. 2.1).

This is why linkages are so important: innovative environments are better at helping their inhabitants explore the adjacent possible, because they allow greater and more diverse numbers of ideas to novel ways of recombining those parts.

Smart Cities are environments that do more than allow people to "think outside the box"—they allow minds to move through multiple linked boxes.

Often, the concepts created by these linkages produce products that themselves deliver *only* linkages.

The Twitter platform, for example, derives from a deliberate strategy that Dorsey, Williams, and Stone embraced from the outset: they built an emergent platform first, and then they built Twitter.com as a platform for linkages. Other platforms that provide linkages offer stellar examples of the important role that linkages have in the Innovation Economy:

- The world's largest taxi company owns no taxis; it links customers to drivers (Uber)
- The largest accommodation provider owns no real estate; it links customers to accommodation (Airbnb)
- The largest phone companies own no infrastructure; they provide online linkages (Skype, WeChat)

Fig. 2.1 Overlapped views of innovation domains. *Source* BD *Cohn*sulting presentation

- The most valuable retailer has no inventory; it is a middleman with linkages (Alibaba)
- The most popular media owner creates no content; it is solely concerned with linkages (Facebook).

The ability to establish effective linkages is the key to success for a Smart Community. A Smart Community—be it a small city, a metropolis, or a connected region—takes advantage of an exponential rise in power. As linkages grow, everything that involves creativity and innovation—patents, R&D budgets, "super-creative" professions, inventors—follows a law of compounding value, such that an area that had ten times the linkages of its neighbour was not just ten times more innovative; it was 17 times more innovative. An area with 50 times the number of linkages than another area is 130 times more innovative.

Different sectors within Canada, such as health care and education, exhibit linkages that have been made possible by technologies such as the Internet of Things (IoT), the Cloud, and Big Data. In today's health care environment, for example, open technologies allow health information to cross departmental boundaries and allow data manipulation and information management tasks, plus the provision of an extensive range of information services. As the health care sector continues to mature in its utilization of computer-based technologies for health records, the focus on data analysis and interpretation to improve decision-making, to advance greater efficiencies, and to drive improved system performance will continue to grow. Similarly in education, through immersive learning, students are able to experience virtual environments from historical settings to underwater laboratories.

Through the deployment of these technologies, Canada is moving up the value chain from a natural resources economy to one based on the value-add of innovative products. Collectively, the companies that make up the high-tech slice of the Toronto Stock Exchange are now valued at more than $250-billion, a number greater than the aggregate value of the mining sector [11].

2.3 The Spread of Innovation Linkages Through Ottawa

Ottawa has been able to use this compounding power of linkages to supercharge the innovation underlying its Smart Economy. The results today demonstrate the interaction of a Smart Community's linkages and innovation:

- Ottawa has the highest number of patents per capita of any Canadian city;
- Ottawa has 65 federal government laboratories to help companies test products and create ideas;
- Ottawa leads all cities in Canada in knowledge occupations;

- Its five colleges and universities help generate the highest concentration of scientists, engineers, and patents in Canada, and the second highest in North America;
- It has international linkages as a home to 130 embassies and consulates from other nations; and
- It's 2000 knowledge-based companies in Life Sciences, Cleantech, Defence and Aerospace, Digital Media, Film and Television, Communications Technologies, and Software.

Tracing the growth of Ottawa's success shows again how innovation builds from historical linkages.

In the early years of Ottawa's growth, a practical challenge was to stay alive during the cold winter months. Ottawa and the area around it became a centre for the production of wood-burning stoves. A local innovator, Tomas Ahearn, had a contract to build the first electric streetcars in Ottawa. He designed efficient electric heaters to keep the cars warm. Linking that concept with the local expertise in stoves, Ahearn created the world's first electric stove. Ottawa, in fact, was the first place in the world where electrically cooked food was served, in August of 1891 (Fig. 2.2).

The linkages continued. By the late 1940s, the first of the computing companies emerged, with the start-up of computing devices. Its technology, linked to technology from the National Research Council, sparked the emergence of Leigh Instruments, financed by a local businessman in the stove manufacturing business. Leigh Instruments in turn spun out Lumonics, whose laser systems were created with linkages to Ottawa's Defence Research Board.

This created a pattern in Ottawa, where companies located in two "magnetic" areas of Ottawa: the central core, home to two universities and several federal research laboratories, and the West End (Kanata) area, original home of the stove manufacturing businesses and where the giant Nortel company (originally Northern Telecom) came to be located.
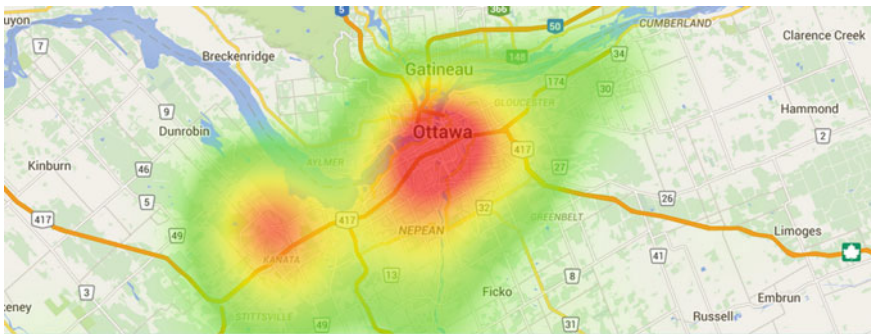
Fig. 2.2 A "heat map" of knowledge-based industries in the Ottawa area. *Source* Invest Ottawa

   The original decision by Northern Electric in the late 1950s to establish a research facility in the region was made after a judicial decision in the USA cut off its ready access to patents from the Western Electric Co. Its purchase of a substantial tract of land on the outskirts of Ottawa as the future home of Bell Northern Research (BNR), largely because of the concentration of federal government laboratories in the nation's capital, created a steady stream of industrial engineers, researchers, and managers moving into the region. Many of the leading entrepreneurs in the Ottawa telecommunications and photonics cluster began their careers as researchers for BNR or its failed subsidiary, Microsystems International Ltd (MIL). Both technical and entrepreneurial talents left Nortel over the years to form new firms in the region. The demise of MIL was significant for the cluster in two respects—it attracted a large number of highly skilled IT scientists and engineers to the Ottawa area in the 1970s and its closure released a significant number of skilled workers into the regional economy, many of whom went on to found, or work for, new firms. More than 20 local start-ups emerged from the collapse of MIL, including some of the cluster's leading firms, such as Mitel and Mosaid. A similar emergence of new companies occurred after Nortel was dissolved; the new companies formed exponential numbers of linkages that would help speed the growth of innovation.

   A consistent feature is the centrality of skilled labour as the single most important local asset in attracting and holding firms in the region. The most important early source of talent in Ottawa was BNR (Bell Northern Research). The establishment of BNR in Ottawa in the late 1950s drew thousands of industrial engineers, researchers, and managers into the region. This influx provided the critical mass of talent needed to exploit later developments in telecommunications and photonics.

   The joint origins of these communications-focused companies led to high levels of internal networking, both formal networks and informal and interpersonal contacts. These linkages still exist between firms in related industries, such as photonics and telecom in Ottawa. Some firms in individual clusters rely upon a local supply base for certain inputs, but the vast majority draw components and knowledge inputs from a diverse array of geographical sources. The most important linkages, however, are to markets, particularly international markets, as many of the firms were geared to supply continental and international markets from their inception.

2.4   Ottawa's Rich Sources of Innovation Linkages

Today, Ottawa has a thriving culture of innovative companies and organizations, continuing to provide linkages for successful products. A few of the more prominent include

Federal Government Agencies

As Canada's capital, Ottawa is the headquarters for most of the country's foremost research institutions. These are hubs for linkages for social as well as technological and business innovation.

Agriculture and Agri-Food Canada Ottawa Research and Development Centre

The Ottawa Research and Development Centre of Agriculture and Agri-Food Canada leads Eastern Canada (Manitoba to Prince Edward Island) in crop development, targeting corn, soy, spring wheat, winter wheat, oats, and barley. The Centre also has a national mandate for assessing and utilizing biodiversity and environmental resources for Canadian agriculture. It operates the Central Experimental Farm, established in 1896, which comprises 427 ha (1055 acres) of open space in downtown Ottawa. Its experts research new plant varieties, soil management, animal breeding, and food processing [24].

Canadian Institutes of Health Research

The Canadian Institutes of Health Research (CIHR) is the Government of Canada's health research investment agency. Located in Ottawa, CIHR's mandate is to "excel, according to internationally accepted standards of scientific excellence, in the creation of new knowledge and its translation into improved health for Canadians, more effective health services and products and a strengthened Canadian health care system". Its funding covers cancer research, ageing, genetics, child and youth health, immunology and public health, among others. It also builds research capacity in underdeveloped areas and training the next generation of health researchers, and focuses on knowledge translation that facilitates the application of the results of research and their transformation into new policies, practices, procedures, products, and services. It is one of the agencies providing $156-million annually to Ottawa's ten hospitals [25].

CanmetENERGY

CanmetENERGY is Canada's leading research and technology organization in the field of clean energy. It has a team of 450 scientists, engineers, and technicians that make it a leader in clean energy technologies. It focuses on fuel-efficient vehicles, cleaner fossil fuels, energy-efficient buildings, bioenergy, Canada's oil sands production, renewable energy such as solar and water power, and industrial processes [26].

Communications Research Council

The Communications Research Council (CRC) is Canada's federal centre of excellence for wireless telecommunications R&D, be a leading contributor to solutions for wireless demand in a modern economy. The CRC prepares Canada for the opportunities available in the 1000 times increase in mobile data traffic by 2020, by performing wireless telecommunications R&D that advances the efficient exploitation of the radio spectrum, and serves as the government's leading source of scientific knowledge and long-term technical advice for spectrum management, regulation, and policy purposes. It takes part in strategic R&D collaborations that

leverage CRC's activities, resulting in knowledge and technology transfer, to the benefit of the 280,000 Canadians who work in the mobile sector, Canadian industry, the economy and citizens [27].

Defence Research Development Centre, Ottawa Research Centre
The Ottawa Research Centre develops technologies in support of Space Systems and Technology, Cyber Operations, Communication and Signals Warfare, Radar Sensing Exploitation, Radiological Nuclear Defence, and Navigation Warfare. Ottawa is also home to the Department of National Defence (DND), whose purpose is to provide the Canadian Armed Forces (CAF), other government departments, and public safety and national security communities with the knowledge and technology needed to defend and protect Canada [28].

Innovation, Science and Economic Development Canada
The Ottawa-based federal Ministry of Innovation, Science and Economic Development Canada works with Canadians in all areas of the economy and in all parts of the country to improve conditions for investment, enhance Canada's innovation performance, increase Canada's share of global trade, and build a fair, efficient, and competitive marketplace [29].

International Development Research Centre
The International Development Research Centre is a Canadian federal Crown corporation that invests in knowledge, innovation, and solutions to improve lives and livelihoods in the developing world. It initiates, encourages, supports, and conducts research into the problems of the developing regions of the world and into the means for applying and adapting scientific, technical, and other knowledge to the economic and social advancement of those regions. In doing so, it supports networking and knowledge sharing between scientific, academic, and development communities in Canada and developing countries [30].

National Research Council
The National Research Council (NRC) is comprised of three integrated R&D divisions, each guided by advisory bodies composed of industry leaders. Under these three umbrella R&D divisions, there are 12 integrated and consolidated portfolios focused on key industry sectors, or areas of R&D. These portfolios represent areas of strategic importance and economic value for Canada. Within each portfolio, there are a variety of programs focused on addressing specific business-identified priorities and challenges through a unique offering of technical and advisory services, research facilities, licensing opportunities, and programs and partnership opportunities.

NRC offers Canadian businesses access to unique research infrastructure as well as the experts to optimize its use. This includes aerospace engineering and manufacturing, astronomy, high-throughput DNA sequencing, photonics, biotechnology, and nanotechnology—to name just a few. Access to these facilities allows innovative businesses to pursue blue sky R&D opportunities here in Canada, while lowering the risks associated with R&D and accelerating product development [31].

Social Sciences and Humanities Research Council
The Social Sciences and Humanities Research Council (SSHRC) works on social innovation to find new ways to overcome pressing social challenges and deliver community services and strengthen communities as a whole through research. It coordinates from its Ottawa office the work of 24,000 full-time professors, 21,000 doctoral students and 46,000 Masters students, and oversees the granting of some $345-million in scholarships. It focuses on Aboriginal, digital, environmental, disability, and business research. For business, it invests more than $100 million in management, business, and finance, covering some 1500 research projects. In the digital field, SSHRC moves beyond pure technology and builds valuable insights about people who will, ultimately, fuel Canada's success [32].

City of Ottawa
The City of Ottawa supports an **Innovation Centre**, as a one-stop shop and "mashup" of technical, business and market capabilities, resources and expertise that helps technology entrepreneurs and companies launch, grow, and thrive. It provides promising entrepreneurs and technology firms with the technical, business, and market capabilities they require to thrive. It serves as a springboard for these ventures, helping them to reduce risk, accelerate growth, and spur commercial success and economic development in our community.

In addition to core business advisory services, the City of Ottawa provides mentorship for innovation through the **Innovation Pilot Program**. This new program is designed for local, national, and international start-ups to pilot new technologies, products, or services with the City of Ottawa. The program focuses on technologies, products, or services that will provide a benefit to programs and services offered by the City to residents. These new projects are to be unique and innovative, and have yet to be widely commercialized.

Invest Ottawa
Invest Ottawa delivers collaborative economic development programs and initiatives that increase entrepreneurial momentum, wealth and jobs in the City of Ottawa and its surrounding region while marketing Ottawa's diversified economy and high quality of life. Invest Ottawa offers business webinars and workshops, mentorship and business advice, start-up and incubation services, and international expansion services. It also delivers an "Innovation Clinic" to help companies find out where they need to focus to meet their business objectives for innovation [33].

Crown Corporations
National Capital Commission
The National Capital Commission (NCC) is the federal Crown agency dedicated to ensuring that Canada's capital is a dynamic and inspiring source of pride for all Canadians, and a legacy for generations to come. Building on more than a century of experience, the NCC provides unique value in the capital region by fulfilling three specific roles: long-term planner of federal lands, principal steward of nationally significant public places, and creative partner committed to excellence in development and conservation.

The NCC encourages creativity and innovation in everything it does. This means building strong relationships with people and organizations throughout the region and across the country, and fostering strategic partnerships, alliances, and collaboration with a diverse range of stakeholders—from local municipalities, Aboriginal communities, and government departments to national and international organizations.

Initiatives to foster innovation linkages include the **Capital Urbanism Laboratory**: An innovative gathering place where leaders, experts, professionals, interest groups, and the general public can come together to share knowledge and learn about the elements that go into the short- and long-term planning and stewardship of a national capital. Discussion topics include emerging trends and best practices for supporting and promoting excellence in urbanism, protecting natural and built heritage, enhancing environmental conservation and sustainability [34].

The Natural Sciences and Engineering Research Council of Canada

The Natural Sciences and Engineering Research Council of Canada (NSERC) aims to make Canada a country of discoverers and innovators for the benefit of all Canadians. The agency supports university students in their advanced studies, promotes and supports discovery research, and fosters innovation by encouraging Canadian companies to participate and invest in postsecondary research projects. NSERC researchers are on the vanguard of science, building on Canada's long tradition of scientific excellence. Over the last 10 years, NSERC has invested more than $7 billion in basic research, projects involving partnerships between postsecondary institutions and industry, and the training of Canada's next generation of scientists and engineers [35].

Universities and Colleges

Algonquin College

Algonquin College offers students hands-on experience, integrated with classroom activity. Providing "degrees that matter", Algonquin graduates are equipped to start work immediately, through training that is tightly tied to the business environment. The goal of the college is to be a global leader in digitally connected applied education and training [36].

Carleton University

Carleton University is a dynamic research and teaching institution dedicated to achieving the highest standards of scholarship. It strives for innovation in research, teaching, and learning. Carleton's graduates have an entrepreneurial spirit, are prepared for careers in the rapidly changing job market, are driven by a desire to change the world, and number 125,000 [37].

University of Ottawa

The University of Ottawa (uOttawa) is the largest bilingual (English–French) university in the world. Its advances in social sciences, health, science, and the humanities make uOttawa a unique place to learn, grow, and excel. In addition to being a major economic force in Ottawa, its 5000 employees provide more than 450

programs in 10 faculties and achieve a 97 % employment rate for graduates. Advanced courses like the IBM Centre for Business Analytics and Performance (CBAP) support research and curriculum development in the domains of Business Analytics (BA), Business Intelligence (BI), and Performance Management (PM) [38].

Université du Québec en Outaouais

The Université du Québec en Outaouais connects academics and students to Quebec's educational network with its $300 million in research financing, and draws in leaders from Eastern Canada and beyond. A large part of UQO programs are rooted in the specific needs of the labour market and society; such is the case of programs in education, health sciences, administrative sciences, computer sciences, social work, and psychoeducation. Having made a breakthrough into the world of applied sciences with the computer engineering program, UQO now offers a new program in natural sciences. The university also offers a series of masters- and doctoral-level programs [39].

Private Sector
Alcatel-Nokia

Nokia Networks purchased control of Alcatel in 2015, uniting two telecommunications giants into a network solutions provider with a significant global customer base. The Alcatel research team in Ottawa is dedicated to making global communications more innovative, sustainable, and accessible for people, businesses, and governments worldwide. Its mission is to invent and deliver trusted networks to help customers unleash their value [40].

Apple

Apple—the world's largest company by market value—is setting up a research facility in Canada. Reports indicate that Apple has leased 22,000 ft.^{2} of office space in Kanata, the west-end suburb of Ottawa known as a tech hub. It may focus on the development of the iCar, Apple's driverless car [41].

Avaya

Avaya is a leading provider of solutions that enable customer and team engagement across multiple channels and devices for better customer experience, increased productivity, and enhanced financial performance. Its world-class contact centre and unified communications technologies and services are available in a wide variety of flexible on-premises and cloud deployment options that seamlessly integrate with non-Avaya applications. The Avaya Engagement Environment enables third parties to create and customize business applications for competitive advantage. The Avaya fabric-based networking solutions help simplify and accelerate the deployment of business critical applications and services [42].

Centre of Excellence for Next-Generation Networks

Canada's Centre of Excellence in Next-Generation Networks (CENGN) bridges the gap between research and commercialization. It is a consortium of industry, academic, and research leaders dedicated to accelerating the commercialization of

next-generation communications solutions. CENGN's internationally recognized testing centre employs interoperability between multiple software and hardware products, providing a unique environment to commercialize advanced products, applications, and services.

CENGN brings together major players in the global telecommunications sector to provide a unique multi-vendor platform populated with state-of-the-art network equipment, which allows companies and researchers to access a "real-world" environment. CENGN provides these companies with significant market advantage by accelerating product research and reducing product development time and costs [43].

Ciena

Ciena makes the network infrastructure programmable, so it can easily adapt to the changing needs of users. When that programmability is combined with network-level applications, network operators can rapidly deliver new services and support new applications. Ciena's years of creating solutions for the world's largest and most reliable telecommunication networks have led to more than 1550 US patents and patents pending, as well as more than 500 additional foreign-issued patents and applications. Ciena has 5000 employees worldwide [44].

Conference Board of Canada

The Ottawa-based Conference Board of Canada is the foremost independent, not-for-profit research organization in Canada. It delivers insights on economics, public policy, and organizational performance. Its 200 employees research and analyse economic trends, as well as organizational performance and public policy issues. An exemplary catalyst for linkages, its conferences and institutes connect public and private leaders, and through its affiliation with the Conference Board of New York, it provides ties to 2000 companies in 60 countries [45].

Ericsson

Ericsson is a driving force behind the Networked Society—a world leader in communications technology and services. It has long-term relationships with every major telecom operator in the world allow people, business, and society to fulfil their potential and create a more sustainable future. With approximately 115,000 professionals and customers in 180 countries, it combines global scale with technology and services leadership. Its networks connect more than 2.5 billion subscribers. Ericsson's Ottawa location performs research on advanced network technology; together with Avaya, Ciena, and Genband, Ericsson bought Nortel's research divisions in 2009 [46].

GENBAND

GENBAND is a global leader in real-time communications software solutions for service providers, enterprises, independent software vendors, systems integrators, and developers in over 80 countries. Kandy, its award-winning, disruptive real-time communications software development platform, is built from the company's global telecommunications network and security technologies. The platform

enables these companies to easily embed a full suite of voice, video, chat, screen-sharing, and collaboration capabilities into their existing business, Web, and mobile applications. GENBAND's market-leading solutions, which are deployable in the network, on premise or through the cloud, help its customers connect people to each other and address the growing demands of today's consumers and businesses for real-time communications wherever they happen to be [47].

Venus Cybersecurity Corporation (VENUS)

VENUS is a not-for-profit organization designed to make Canada a leader in cybersecurity. VENUS provides its membership with the people, space, and infrastructure to work on complex, leading-edge cybersecurity problems affecting individuals, businesses, and governments throughout the world. The interdisciplinary approach, served by a business ecosystem created specifically to address cybersecurity issues, provides its membership with a rate of return that is expected to be ten times greater than if they worked independently [48].

Additional Private Companies

Ottawa is the headquarters to more than 1500 associations and not-for-profit organizations. More than 1700 companies are engaged in the innovation-intensive knowledge sector in the city. The companies include these companies and these innovation linkage hubs:

The **Defence** sector is an innovation hub for 10,000 workers and includes General Dynamics, Lougheed Martin, MDS, INGRobotic Navigation and Maritime Way Scientific.

Among the 120 innovative companies in the **Cleantech** sector are Clearford, Energate, and Ensyn.

Digital Media is a hive of interactivity in Ottawa, with Star Wars Rebels, Gigataur, XYZyborg8, Magmic, and Fuel; all companies come together in the Ottawa International Animation Festival.

Creative minds in the **Film and Television** industry add $50 million in revenue to the city each year, shooting 700 film days.

Ninety per cent of Canada's **Communications Technologies** are created by researchers in Ottawa, using the CENGN centre, in companies that deserve special mention: Alcatel-Lucent with its research arm in Ottawa, Cisco, and its Ottawa R&D division expanding to some 2000 experts, Ericsson with its strength in WiFI services, Huawei and its $67-million Research Centre, 60-year Ottawa veteran Mitel serving 60 million global users, TV spectrum expert 6Harmonics, BTI Systems and their innovative networks serving 40 countries, and pioneering network company Newbridge Networks, purchased by Alcatel for $7-billion.

Life Science innovators work in more than 100 companies in Ottawa, including Abbott Point of Care, MedDev, Gamma-Dynacare Medical Laboratories, and Nordion.

The **Software** sector is an Ottawa innovation strength, with more than 20,000 experts working for some 600 companies, including names like QNX (acquired by Blackberry for $200 million in 2010) Cognos (acquired by IBM for $4.9 billion),

Halogen (which raised $50 million through an IPO in 2013), Kinaxis (with a $100-million IPO in 2014), and Shopify (valued at $1 billion with a 2014 IPO of $100 million).

All of these companies—and the research laboratories that catalyse them—have their fires of innovation fuelled by unique international linkages. 130 embassies in Ottawa help entrepreneurs get direct access to a unique conjunction of four major economic blocks that Canada alone simultaneously connects to: the USA, China, the EU, and the Commonwealth.

These linkage centres are critical to Ottawa's construction of a Smart Economy based on Innovation.

Invest Ottawa, for example, is a one-stop agency that drives entrepreneurial growth.

CENGN propagates excellence in next-generation networks. The partnerships and project goals are varied: one project involves the orchestration of data connectivity and unites Telus and Cenex to synchronize a network to ensure optimal data routing, another project unites Jupiter Networks and Inocybe in showcasing a complete Smart City programmable infrastructure and network.

2.5 Effective Innovation and Ottawa's Innovative Metrics

2.5.1 Measuring Innovation

Ottawa is obviously interested in sustaining its innovation drive and Smart Economy. Understanding the basics of how it works requires measurement, for it something cannot be measured it cannot be managed. Ottawa has therefore been very interested in pioneering the measurement of innovation value.

> "*When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind*".
>
> *Lord Kelvin* [12]

Organizations—companies and communities—evolve through similar stages of birth, growth, maturity, and decline; yet, they can last much much longer than individual people thanks to (i) renewal capabilities—ideas and/or people; and (ii) continuous innovation to adapt to changing environments and to fight threats. Innovation enables growth, avoidance of decline and, ultimately sustainable success (competitive-wise if business, relevance-wise if public/social entity) [13].

Throughout history, innovation has been the engine driving humanity towards economic and social progress. This has been done through the creation of new or better products and services; through the development of new ways to address

production, social problems, health issues, etc.; and through the creation of new economic and/or civic entities, industries, and entire markets. An organization's success (be that a company or a community) is predicated on having a vision to rally the people in the organization, the will to succeed in spite of all obstacles and competitive difficulties, together with the knowledge and means for achieving the necessary tasks [14] (Fig. 2.3).

The ultimate goal of innovation is to create value for the organization and to maintain or enhance its position—a competitive position in the market if it were a business, or a relevant position in the socio-economic–political environment if it were a community or a government organization. Innovation is a by-product of the interplay of discovery "push" and user need "pull". While "research" can be construed as the transformation of money into knowledge, "innovation" implies the transformation of knowledge into value and ultimately economic and social benefits. The attitude towards innovation, the types of innovation pursued, and the levels of risk accepted depend upon the situation of the organization in its environment (market). In the end, the biggest risk to an organization—be that a business, a community, or a government department—is that it does not innovate and evolve consistently enough to stay competitive/relevant and survive.

The fundamental issue affecting an organization's performance—be that a community or a business—is its management, and most specifically its innovation management, i.e. its capabilities to envision a good future and to drive effectively and efficiently towards achieving it. Success starts with leadership that nurtures a culture of entrepreneurship and pursues innovation ***comprehensively, competitively,***
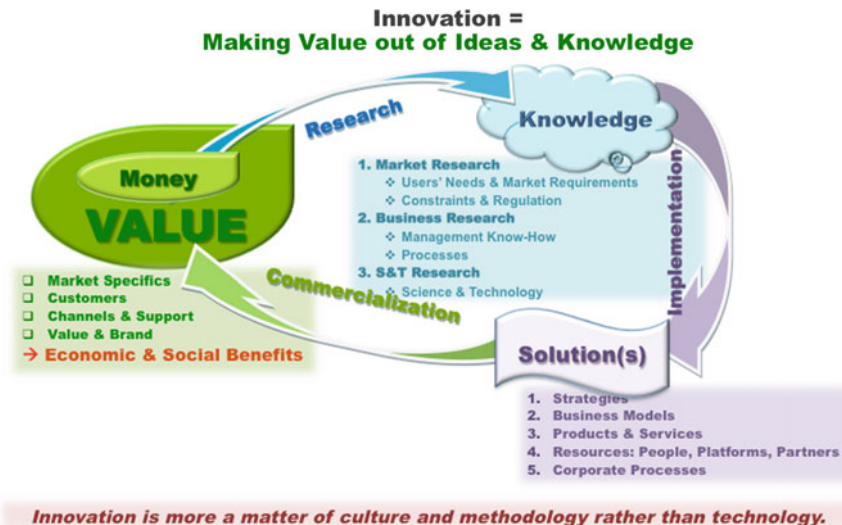
Fig. 2.3 Innovation means obtaining value from ideas. *Source* BD *Cohn*sulting presentation

and ***methodically*** with the right ***metrics*** to ensure tangible and timely value where it counts: in the market if a business, in the eyes of its citizens if a community.

One cannot understand and manage something without measuring it properly by determining the most important indicators and associating ways of evaluating them, i.e. the metrics. Having the right metrics is essential because metrics drive behaviour and determine how people are meeting their tasks and adapt in the face of change. For example, valuing research by the amount of money poured into it is akin to valuing a painting by the number of strokes the painter used to do it. Would we measure the value of fishermen by how many times they dip their rods (or nets) into water or by the quality and quantity of fish they get to take to market and feed their families?

Likewise, innovation without methodology is just luck. Effective innovation requires that people:

- Do the ***right things*** by establishing what the vision is, by knowing and preparing oneself, and by determining the priority things that need to be done first;
- ***Do*** the things ***right***, which requires that one gets the necessary <u>and</u> sufficient means for having them done, that one organizes and executes methodically with the proper metrics, and that one evaluates and adjust as necessary;
- Learn and continue because competition and world changes never end and, therefore, innovation cannot end either (Fig. 2.4).

The c-FIT innovation management methodology [15] captures the eight critical stages for achieving success:

- **WHY**: learn about what innovation is about and agree to pursue it comprehensively, competitively, and methodically

Fig. 2.4 Key components of the competitive forward innovation technique. *Source* BD *Cohn*sulting presentation

- **WHO**: know about yourself (your organization), its leadership, its vision, its goals, what works and what does not at present
- **WHERE**: determine how well is your organization positioned in its environment (market) and what are its most important competitive attributes and needs
- **WHICH**: select the specific activities that are of highest priority, fund them, and resource them with the right people, platforms, tools, and partners
- **HOW**: plan and organize the selected portfolio of innovation activities' as proper projects with associated plans, budgets, milestones, and metrics in addition to having a balanced portfolio of corporate-level metrics (the score board)
- **Go-&-Do**: execute, measure, and manage the projects in the innovation portfolio
- **WHAT**: as timely as possible evaluate and adjust the corporate innovation portfolio; learn, improve, and continue
- **WE**: at all times, nurture a culture of innovation and enhance the structure and capabilities of the organization.

That is exactly what was undertaken in Ottawa—both with respect to the social aspects and metrics of Ottawa as a thriving community and with respect to the business innovation aspects of the core industries in the Ottawa region.

The Ottawa innovation studies are the first time that metrics have been used to measure the alignment of innovation culture with business goals and the market impact of their innovation investments. These surveys are innovations by themselves.

2.5.2 Metrics on Smart Community Linkages

As a framework for its metric on **social innovation** or Smart Community status, Ottawa used the *i*-Community Open Architecture (*i*-COA) model, developed by Bill Hutchison for *i*-CANADA, as the background for the development of the Intelligent Community Assessment by Stakeholders Tool (*i*-CAST) by Sorin Cohn, President BD Cohnsulting Inc [16]. This *i*-COA framework of smart or intelligent community capabilities looks at community culture, public and private development, institutions and their services to the community, the existing collaboration ecosystem, and the outcomes (Fig. 2.5).

The *i*-COA model is composed of five domains: place, infrastructure, collaboration ecosystems, solutions, and life, each of them subdivided into several dimensions:

1. The Place domain is the most stable one, being largely dependent on the existing environment within which the community has evolved throughout its history. It also contains the elements of governance overseeing its activities and takes advantage of its environment. This is the foundation.
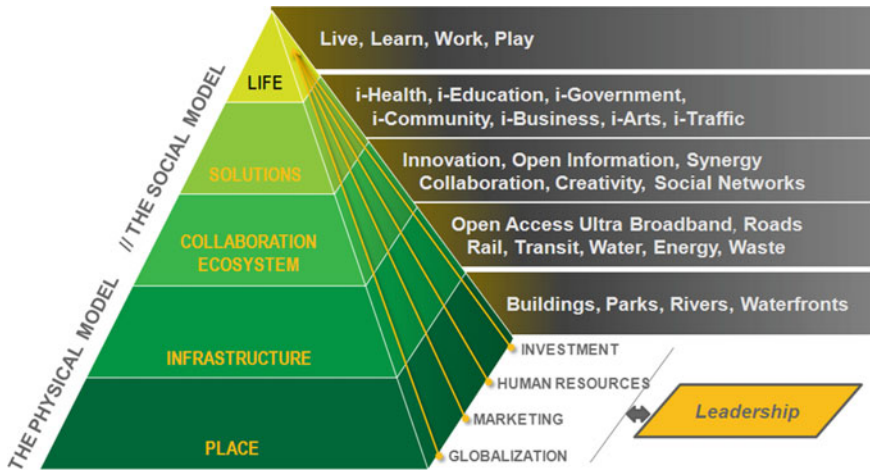
Fig. 2.5 Components of a Smart Community. *Source i*-CANADA presentation

2. The Infrastructure domain covers the usual services necessary to make the community live and work: roads and railways, energy services, water services, and very important nowadays the communication services—both fixed and mobile. Most of these are based on legacy developments and change in relatively long times.
3. The Collaboration domain addresses the levels of community involvement, how well its various elements work together, the entrepreneurial and innovation spirit of the community, its knowledge workforce and the ways by which the community markets itself internally and externally.
4. The Solutions domain covers the online eservices the community provides for its access to government, for its programs, for business development as well as for education, health, and also for recreation and culture.
5. At the pinnacle of the pyramid is the Life domain, which captures the quality of living and working and playing in the community in conjunction with the safety and social cohesion of the community.

The model shows that as the levels rise, the importance of the role played by linkages increases. In the realms of collaboration and solutions, for example, the value of the community is measured by how well it is interlinked.

The complete *i*-CAST analysis [17] is layered in five domains consisting of 26 critical differentiating areas covering over 100 dimensions of competitiveness that could be characterized by large numbers of indicators depending on the resolution required. To capture a balance view of the community status, the analysis can differentiate results the distinct perspectives of:

- The municipal staff,
- The business community,
- The residents in the community and, very important,

- The YOUTH in the community, for whom, and often by whom, the community is being built.

The results of the *i*-CAST study can be comprehended at a glance when they are portrayed as a "dashboard" in the form of a radial map, where an optimum outcome would be on the outer circle, and real-world results are part-way points on the measurements of the 26 critical areas of differentiation (Fig. 2.6):

From this map, it is easy to see how well *community involvement*, the spirit of *innovation*, and *entrepreneurship* are developed in any city. It is also easy to see where the shortcomings are that would lead to the improvement of an unsatisfactory result.

From the results of the *i*-CAST evaluation of Ottawa, it was found that Ottawa has the strongest Smart Community ranking in Canada. *The linkages that are the hallmark of an innovative or Smart Community were strikingly evident* in each attribute of Smart Community development:

- **Entrepreneurship**: 90 % said that entrepreneurs were celebrated and supported in Ottawa, and 68 % gave satisfactory marks to the success of the community businesses, government, and not-for-profit institutions in creating dynamic partnerships to foster innovation within the community;
- **Talent**: Two-thirds thought Ottawa had good community programs for enhancing digital (data) skills and increasing the knowledge-work constituency of the workforce, while 80 % said that more than half of Ottawa's workforce had a college or university degree;
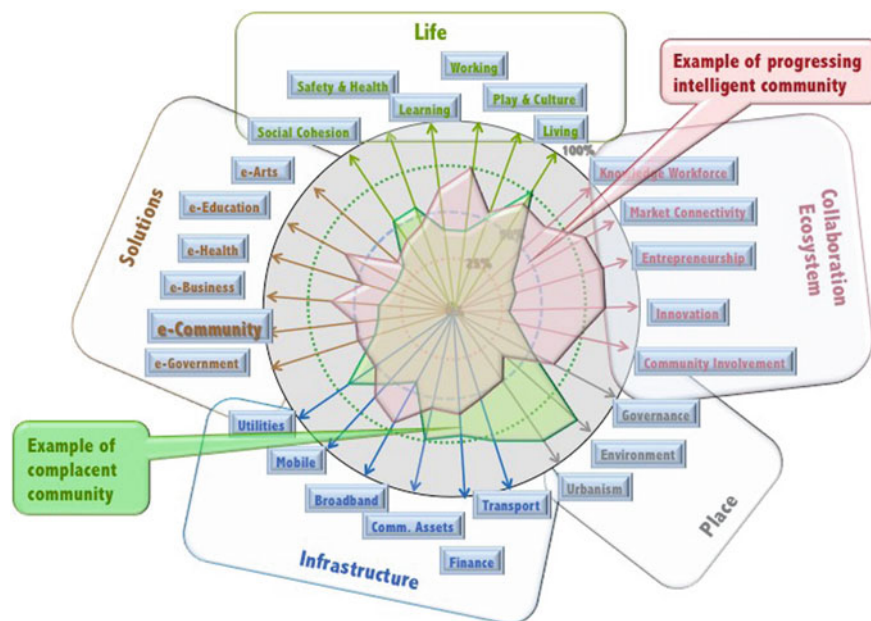
Fig. 2.6 Community assessment survey. *Source* Invest Ottawa presentation

- **Infrastructure**: 85 % think that the urban/rural infrastructure of streets, bridges, and buildings is sound; two-thirds gave good marks to the strength of financial effectiveness, transportation, and education; and 95 % have pride in the community and its environment;
- **Cooperation**: Three-quarters praised the intensity and effectiveness of collaboration between private businesses and civic institutions in their efforts towards a more vibrant, intelligent, and innovative community; and
- **Knowledge Economy**: More than half rated Ottawa as having a high knowledge economy rating.
- **Digital Equality**: 85 % of the community gave high ratings to the effectiveness of government programs for enhancing digital participation by underprivileged groups. More than 90 % praised programs the dealt specifically with women, children and youth, ethnic minorities and immigrants, and the unemployed.

These translated into very high marks on the community scorecard (Fig. 2.7).

Ottawa Intelligent Community Score Card:

Domain	Grades	Area	Grades	Score
LIFE	A-	Living	A-	8%
		Playing	B+	75%
		Working	B	65%
		Learning	B+	75%
		Safety & Health	A	81%
		Social Cohesion	A-	78%
E-Solutions	B-	E-Government	B-	59%
		E-Community	B	64%
		E-Business	C+	51%
		E-Health	B-	59%
		E-Education	C	48%
		E-Recreation	B	65%
Collaboration Ecosystem	B-	Community Involvement	C+	52%
		Innovation	B	61%
		Entrepreneurship	B	68%
		Marketing	C	46%
		Workforce	B	61%
Infrastructure	B	Transport	B	65%
		Financials	B+	75%
		Community Assets	A-	80%
		Broadband	B	61%
		Mobile	B	70%
		Utilities	B	60%
Place	B+	Governance	B	70%
		Environment	A-	77%
		Urbanism	B+	74%

Fig. 2.7 Ottawa's rating as an intelligent community. *Source* Invest Ottawa presentation

2.5.3 Study of the Business Value of Innovation in Ottawa

Invest Ottawa decided it was important to complement the *i*-CAST evaluation of Ottawa as a Smart Community with an evaluation of Ottawa's business community using the Competitive corporate Innovation Management (c-IM) diagnostic tool also developed by BD Cohnsulting Inc [18]. The c-IM tool acts as an "Innovation Compass" helping companies enhance their competitive position through effective management of firm-level innovation by capturing "who" the company is, what its business objectives are, how it has managed its innovation investments, what are its business models, and how well it competes against primary competitors in their targeted markets (Fig. 2.8).

The *c-IM* diagnostic tool is based on the Value-add Comprehensive Innovation Management (*v-CIM*) framework, which can also be portrayed by a five-layer pyramid capturing the critical domains by which a company differentiates itself in the market. Business innovation is complex and multidimensional, and the interaction between innovation and the firm's organization depends on a multitude of factors some of which may be external to the firm itself. The *v-CIM* framework together with the metrics-based *competitive Innovation Management Techniques* (*c-FIT*) and associated tools enable companies to tune their innovation activities to market realities, align their management teams, select the necessary innovation targets, and manage methodically their efforts to accelerate company growth, avoid decline, and enhance position in the market.

Studies done by the Conference Board of Canada have demonstrated that investing in innovation is not sufficient to ensure success. Investments must be properly managed, and companies that invest without managing properly their
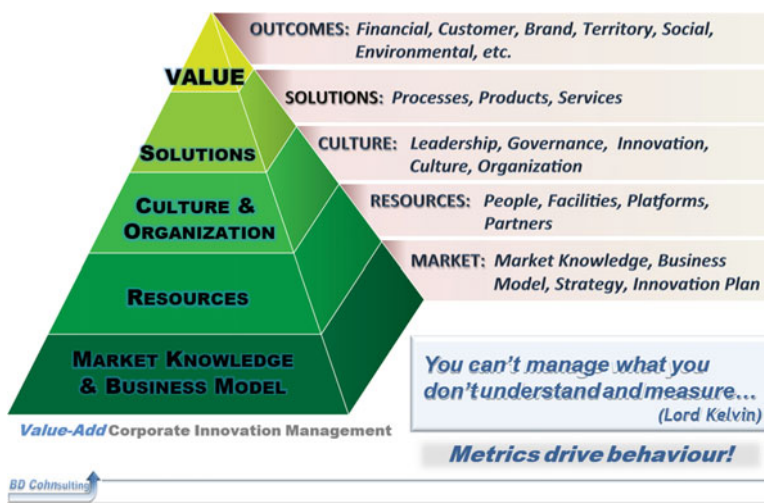
Fig. 2.8 Innovation management framework. *Source* BD *Cohn*sulting presentation

innovations perform significantly worse than those who do. The Canada-wide study found that fully one-in-four companies were investing heavily in innovation; yet, their innovation performance was negative—worse than if they had not been innovating at all. One-in-five companies had modest investment but—with high levels of innovation management—had innovation performance that added to the bottom line.

The *c-IM* innovation compass is using an online questionnaire that undertakes a targeted competitive analysis and probes the executive understanding of the company's business models, innovation strategies, management practices, and the cultural alignment with business goals. Answering the probing questions requires no preparation and takes about 35 min of an executive time. The result is a multi-dimensional targeted competitive dashboard that reflects the executive mindset, the team alignment, and its management capabilities. The *c-IM* tool can be used as:

- **CEO Leadership Tool**, which zeroes on critical corporate issues, points to competitive imperatives, and determines areas for competitive improvement
- **Investor's Due-Diligence Tool**, which determines likelihood of investment success and corporate improvement needs by discovering deep-seated management views, by pinpointing to competitive weaknesses, and by assessing corporate innovation management capabilities
- **Executive Team Management Tool**, which points to executive misalignment issues, maps roadwork ahead, and unifies the team behind common goals.
- **Regional/Sectorial Industry Tool**, which provides insightful industry performance analyses necessary to determine directions for evolution as well as wiser support programs and investments.

2.5.4   Innovation Assessment in a Dashboard

The Ottawa 2015 business community c-IM innovation assessment was undertaken under the leadership of the Innovation Group at Invest Ottawa and the Economic Development Department of the City of Ottawa in the summer–autumn of 2015. More than 200 executives participated, 50 % of which were driving their companies to become leaders in their industry segments while 15 % of the executives were more interested in building their companies for outright sales as early as profitably possible. About 35 % of the companies participating in the study were in the start-up stage, while 32 % had attained the growth stage in their lifecycle. A good percentage (27.5 %) of companies considered themselves to be at the maturity stage while about 5 % admitted to be challenged in the decline stage.

In terms of age and size, about 44 % of companies were over 10 years old while 15 % were older than 30 years. Almost 20 % were very young at less than 2 years old, while 37 % were between 2 and 10 years. About 6 % f companies had annual revenues in excess of $200 M, while 21 % had revenues between $5 M and $200 M. A rather large percentage (31 %) had revenues below $200 k.

Ottawa being the federal capital of Canada, it was not surprising to find that about 30 % of companies in our study were in the Professional Services market, while almost 30 % were in the Information and Communications (ICT h/w and s/w) industry, with about 20 % of companies in the broad category of Service Providers that includes utilities, cable and telephone companies, etc. About 9 % were companies in the Cultural and Education markets, 6 % in the Life Sciences and Cleantech segments, and only 2 % in the manufacturing sector.

We do not consider R&D investments to be a good measure of the intensity of innovation in most companies because R&D is only one aspect of business innovation in addition to strategy development, innovation in corporate resources (training, etc.), innovation in corporate processes (including sales and marketing), etc. As time is money, we consider the average corporate time dedicated to all innovation activities to be a better measure of innovation intensity in a company. In Ottawa, about 55 % of companies claimed to make very high investments in innovation (>15 % of their corporate time), while 11 % claimed high investments (between 10 % and 15 % of corporate time) and a further 11 % had moderate investments (between 7 % and a 10 % of their corporate time).

In terms of their financial performance, despite their usual rosy glasses, about 22 % of executives stated having had a neutral CAGR growth over the past 3 years and 7 % acknowledged to a decline in their revenues. Almost 40 % of executives stated positive growth and a significant number (31 %) claimed strong positive growth (Fig. 2.9).
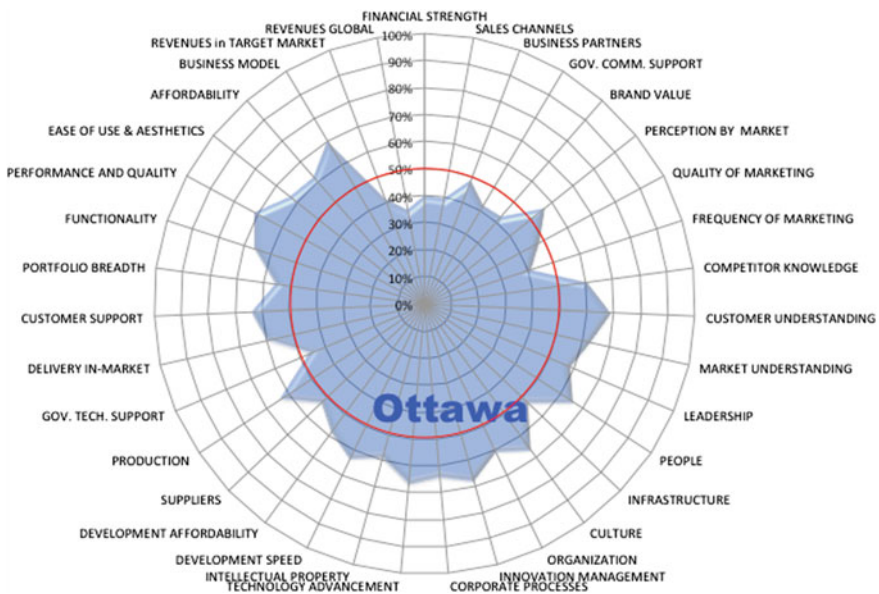
Fig. 2.9 Assessment of Ottawa executives for innovation strengths in their firms. *Source* BD *Cohn*sulting presentation

The c-IM Competitive Dashboard shown above presents the average competitive self-assessment against the primary competitors in the primary markets of the businesses participating in the study. The dashboard captures how Ottawa executives consider they are doing vis-à-vis their primary competitors across 35 competitive areas in five domains: Business Position at the top, Market Knowledge at the upper right, Resources and Organization at the lower right, Technology and Production at the lower left and Solutions Portfolio at the upper left. Performance is much worse than the competition towards the centre of the circle, and much better on the outside, with the red circle denoting competitive equivalence.

Ottawa businesses are quite competitive and doing better than the competition in terms of their product/service solution portfolios—affordability, functionality, performance, etc., as well as in terms of their market understanding, their leadership and resources, as well as their technology advancement, development agility, and affordability. On the other hand, Ottawa executives consider their companies to be somewhat less competitive in terms of commercial capabilities: revenues, channels to market and business partners. This can be partly correlated with the fact that, by their own admission, Ottawa companies are less aggressive in their marketing efforts. Surprisingly, despite their co-location with the major Federal Government support agencies, Ottawa executives appreciate that their companies benefit from less government support than their competitors.

Overall, the Ottawa c-IM Dashboard appears to be better than the one for the rest of Canadian companies, thus testifying to the fact that Ottawa is the innovation capital of Canada. Still, as mentioned above, there is scope for significant competitive improvement: better quality of marketing and more frequent marketing activities in the first place, and better sales channels to accelerate their revenues and boost their financial strength. Naturally, the other competitive imperative is to learn to take better advantage of the various government programs supporting technical and commercial innovation.

The c-IM Innovation Compass also provides an assessment of the innovation management practices in companies. On average, Ottawa businesses showed better practices (average grades in the C+ to B+ range) than those of companies in the rest of Canada, which had, on average, grades in the C to B range. As well, Ottawa businesses exhibited a somewhat better alignment of corporate culture with business goals and innovation strategies.

The most important aspect of our study is that it provided Ottawa business executives the c-IM Innovation Compass that reflected to them their reality-based competitive imperatives and the need for them to pursue innovation more comprehensively, competitively, and methodically with the right metrics to ensure performance in the market. In response to these developments, Invest Ottawa has decided to implement starting with the spring of 2016 an **Innovation Clinic**, where companies can acquire their own c-IM Innovation Compasses on the basis of which they can focus their innovation investments according to their strategic competitive imperatives.

By improving the fine grain of innovation at the commercial entity scale, Ottawa is addressing the fundamental unit of the Smart Economy. Together with changes made possible by measuring the City-scale challenges, the entire Smart Economy ecosystem is transformed.

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Chapter 3
Ottawa: Rewards for a Smart City in a Global Innovation Economy

Barry Gander, Bruce Lazenby, Charles Duffett, Greg Richards, Mark Hoddenbagh, Mark Kristmanson, Ritch Dusome, Sarah Linkletter and Sorin Cohn

Abstract Ottawa has risen to lead global organizations like the G7, because its intense Innovation Economy has provided it with advantages in almost every area of economic and social life. Because of the need to excel in a knowledge-based

B. Gander (✉)
I-CANADA, 1919 Pereau Road, Canning, NS B0P 1H0, Canada
e-mail: barrygander@yahoo.com

B. Lazenby
Invest Ottawa, 80 Aberdeen St, Ottawa, ON K1S 5R5, Canada
e-mail: blazenby@investottawa.ca

C. Duffett
City of Ottawa, 110 Laurier Ave W, Ottawa, ON K1P 1J1, Canada
e-mail: charles.duffett@ottawa.ca

G. Richards
Telfer School of Management, IBM Centre for Business Analytics and Performance,
University of Ottawa, 55 Laurier Ave E, Ottawa, ON K1N 6N5, Canada
e-mail: richards@telfer.uOttawa.ca

M. Hoddenbagh
Partnership and Applied Research, Algonquin College, 1385 Woodroffe Ave, Ottawa, ON
K2G 1V8, Canada
e-mail: mark.hoddenbagh@algonquincollege.com

M. Kristmanson
National Capital Commission, 202-40 Elgin Street, Ottawa, ON K1P 1C7, Canada
e-mail: mark.kristmanson@ncc-ccn.ca

R. Dusome
Centre of Excellence in Next Generation Networks, 555 Legget Drive, Tower a, Suite 600,
Ottawa, ON K2K 2X3, Canada
e-mail: ritch.dusome@cengn.ca

S. Linkletter
EPSI, 6 Sainte-Marie, Gatineau, QC J8Y 2A3, Canada
e-mail: SLinkletter@epsi-inc.com

S. Cohn
Conference Board of Canada, 255 Smyth Rd, Ottawa, ON K1H 8M7, Canada
e-mail: scohn@rogers.com

world, Ottawa has developed educational systems in its universities, colleges, laboratories, and research institutions that have made it—literally—the most educated city in the world. Smart Community author Richard Florida ranks Ottawa as Canada's number one city based on the three Ts of economic development: Technology, Talent, and Tolerance. Ottawa leads all cities in Canada in knowledge occupations—that is, occupations characterized by their use of high technology, computing, knowledge intensive processes, and creative activity. More than one in four workers are employed in the knowledge field, and 61 % of the workforce have a post-secondary degree. Factors that are forcing the rise of the smart community movement continue to shape the direction of Ottawa's growth. This has created an environment where some 2000 highly innovative companies give birth to "offspring," and have spurred the highest value of Initial Public Offerings (IPOs) of any city in Canada. Cities following Ottawa's pattern can expect the same high levels of achievement.

> *"New technology is always dazzling, but we don't want technology simply because it is dazzling – we want it, create it and support it because it improves people's lives."*
>
> – *The Right Honourable Justin Trudeau, Prime Minister of Canada* [1]

3.1 Forward

Focusing on becoming a Smart Community, with a priority in knowledge-based work, has allowed Canada to lead organizations like the G7, where it enjoys the best quality of life, lowest taxes, lowest R&D costs, and fastest economic growth.

From its start, Ottawa was not just a national political capital, but a capital for information innovation (see below). This continuing search for meaningful innovation has helped Ottawa become ranked as Canada's best large city to live in, based on factors such as incomes, unemployment rate, housing, lifestyle, and culture [2] (Fig. 3.1).

Ottawa's evolution into a smart city has become especially vital in the context of the global revolution in urban development. This revolution, and the rewards for Ottawa from being a Smart Community, is the subject of the following sections.
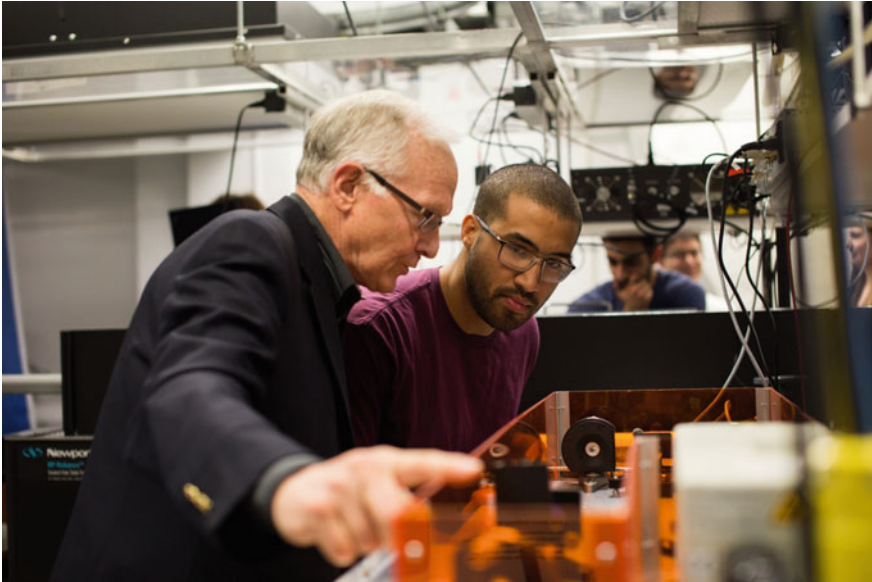
Fig. 3.1 Ottawa is the world's most educated city: Two physicists at the National Research Council typify the city's ranking as the "most educated workforce in Canada"—and Canada itself the world's most educated nation. It is the only country where more than half the population have post-graduate and graduate education [3]. *Source* OECD 2013

3.2   Context: The Surge in Smart Cities

3.2.1   The Move to Communities

In 2014, more than half of the world (54 %) became urban. Globally, one million people are moving into cities every week. In India alone, *every minute*, 30 country dwellers move permanently to a city.

In this first "urban century," when cities comprise more than half of humanity and produce some 80 % of global wealth, humanity is in fact undergoing a revolution: By 2050, the human population will have reached 9 billion people with 75 % of the world's inhabitants living in communities.

The urban issues that arise from dealing with this move into cities affect every aspect of life.

The top 750 cities will create two-thirds of the world's GDP by 2030. People occupying just 2 % of the world's land will consume about three-quarters of its resources (Fig. 3.2).

Yet today, despite the comparative advantage of cities, urban areas are more unequal for their inhabitants than rural areas, and hundreds of millions of the world's urban poor live in substandard conditions. In some cities, unplanned or inadequately managed urban expansion leads to rapid sprawl, pollution, and

Fig. 3.2 Population growth in India. *Source* i-CANADA presentation

environmental degradation, together with unsustainable production and consumption patterns.

3.2.2 The Rise of Smart Communities

Organizing these communities into "Intelligent Communities" is essential to align social, business, and technological visions and help comprehensively rethinking policies, processes, and products, and relationships between stakeholders and partners.

Communities have jumped into this leading role because they have a critical mass of citizens working toward common goals and the economies of scale, and the protection and the support provided by the communal ecosystems, with their business excellence, social cohesion, and quality of learning, working, playing, and living.

This rush into cities is driving a voracious demand for "smart city" approaches to solving the challenges of urban life. These challenges—if not met with new approaches and solutions—threaten to strangle city life. The surge of new arrivals is choking traffic, slowing waste removal, generating pollution, and smothering the social responses of government, education, and business.

Smart cities offer ways to break through these challenges. Smart cities optimize resources through better information on the resource use cycle. This information enables better management on the part of the utility. It also enables consumers to make more informed use of resources and lower their consumption. This in turn reduces utility operating costs and extends the operating life of existing infrastructure. Smart technologies also provide opportunities for new services to citizens. Ultimately, the engagement of citizens with municipal government brings their energy to the fore, enlisted in the cause of a better life for all.

Within the next decade, there is expected to be a fourfold increase in the number of smart cities worldwide. They will proliferate as local governments, civic groups, and the private sector struggle to cope with the swelling issues confronting urban centers [4].

There will be at least 88 smart cities all over the world by 2025, up from 21 in 2013. Their distribution is expected to be as follows:

– Asia-Pacific will account for 32 smart cities of the total;
– Europe will have 31; and
– The Americas will contribute 25.

This would seem at first glance to be a roughly equal distribution of smart cities, except for the fact that the Asia-Pacific region accounts for 61 % (4.2-billion people) of the world's population. A more balanced account emerges when India's 100-city program begins to take effect, more than doubling the count for the number of smart cities in Asia-Pacific.

A global disproportion would still exist, however. There would be approximately one smart city for every 20-million inhabitants in Asia-Pacific, one smart city for every 2-million inhabitants in Europe, and one for every 3.8-million in the Americas.

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The market for smart city products are services is forecast to exceed $1.5 trillion by 2020. If this market opportunity could be visualized as a national GDP statistic, it would count as the 12th largest nation on earth (Fig. 3.3).

The world capacity for "smart" services is huge: 84 % of the world is literate (vs. 56 % in 1950), and one-third of the world has Internet. "Information pressure"—the need to solve problems using data—continues to rise and will skyrocket with the increasingly fast development of the "Internet of Things"—the drive to put monitors and meters on devices and plug them into the network.

3.2.3 Urban Challenges Driving the Rise of Smart Communities

The urban issues that arise from the rush into communities affect and compound every aspect of city life and drive a voracious demand for "smart city" approaches to solving the challenges. These challenges—if not met with new approaches and

Fig. 3.3 Size of smart cities market against national GDP. *Source* i-CANADA presentation

Smart Market Would Be 12th Largest GDP

U.S.	$16.6
China	$9.1
Japan	$4.9
Germany	$3.7
France	$2.8
U.K.	$2.6
Brazil	$2.2
Italy	$2.1
Russia	$2.0
India	$1.9
Canada	$1.8
SMART CITIES	$1.5
Australia	$1.5
Spain	$1.3

solutions—threaten to strangle city life. The surge of new urban populations is choking traffic, slowing waste removal, generating pollution, and smothering the social responses of government, education, and business.

Smart cities open up options for leaders—more flexibility in ways to deal with urbanization challenges. Smart cities optimize resources through better information on the resource use cycle. This information enables better **management** on the part of the utility. It also enables consumers to make more informed use of resources and lower their consumption. This in turn reduces utility operating costs and extends the operating life of existing infrastructure. Smart technologies also provide opportunities for new services to citizens. Ultimately, the engagement of citizens with municipal government brings their energy to the fore, enlisted in the cause of a better life for all.

Smart city approaches offer the only way to break through. Smart cities optimize resources through better information on the resource use cycle. This information enables better management on the part of the utility. It also enables consumers to make more informed use of resources and lower their consumption. This in turn reduces utility operating costs and extends the operating life of existing infrastructure. Smart technologies also provide opportunities for new services to citizens. Ultimately, the engagement of citizens with municipal government brings their energy to the fore, enlisted in the cause of a better life for all.

In achieving **energy-efficiency** targets, for example, London is retrofitting both residential and commercial buildings to lessen carbon dioxide emissions. The city is also adopting charging infrastructure to support the introduction of 100,000 electric vehicles.

The energy challenge for cities, however, is huge. Cities represent three-quarters of energy consumption and 80 % of CO_2 emissions worldwide [1] and represent the largest of any environmental policy challenge. The only way to cope with this is

to invent new ways to manage cities and make them more effective. The "smart" convergence between digital technology and the world of energy will pave the way for a new ecosystem of services which will enable both a better quality of life and reduced energy consumption.

Within cities, **buildings** are the most energy-intensive systems; they consume up to 42 % of all energy worldwide. By 2025, buildings will likely be the largest consumers of energy—and the largest emitters of greenhouse gases—on the planet. Even worse, about 30 % of a building's total operating cost goes for energy. So, as the cost of energy goes up, the need to reduce both consumption and overall building expenses takes on new urgency. Innovations that marry the digital and energy disciplines are widespread, including technology that controls the energy consumption of buildings and interoperable communicating devices—such as temperature and air quality sensors, as well as smart meters and intensity-controlled LED lighting.

For areas of the world where **water** is scarce, smart cities can allocate this precious resource, using sensors to manage water use or provide critical information on water-storage levels. In Santander, Spain, soil-humidity sensors detect when land requires irrigating for more sustainable water use. In the Yarra Valley in Melbourne, Australia, an innovative collaboration brought together local and regional water authorities, businesses, and scientists to use analytics to improve the management of its water system, reducing the cost of managing water by 15 %. When water officials in Thiruvananthapuram, India, see spikes or any other changes in usage, the system alerts engineers so that problems can be rectified immediately. Because sensors were installed throughout the water treatment process, water-authority teams can measure turbidity, salinity, conductivity, pH, and chlorine levels in the moment. And these sensors combine with mobile technology so that workers can receive alerts through their mobile phones, smart devices, or laptops. Teams can respond in near-real-time to get a problem fixed.

Public safety issues increase exponentially as population rises. Smart city solutions for law enforcement and emergency management incorporate best of breed technologies that help cities collect, integrate, analyze, visualize, and distribute critical information among multiple agencies, police officers, and first responders. Data visualization, real-time collaboration, and deep analytic capabilities can help cities prepare for emergencies, predict and prevent crimes, coordinate emergency response efforts, and streamline case management. Cities can realize immediate benefits while supporting a longer-term public safety transformation from a reactive approach to a proactive, predictive approach that creates a safer, more desirable environment for citizens.

Budget cuts have strained schools and **education** systems, yet the need for quality education remains strong within cities. The demand for knowledge workers with specialized skills is growing every year. Many jobs require lifelong training and a continuous updating of skills. To meet demand with increasingly limited resources, cities must improve efficiency and address redundancies, such as educational institutions, that have silos of management processes. Yo foster student success and build the skills for employment throughout a citizen's lifetime.

Analytics and advanced modeling tools can help provide learning profiles for each student. Cloud technologies can be adopted to share best practices and collaborate on new ideas. Computers can be used for remote teaching and for bringing global best-practice experts into any classroom anywhere.

In many developing cities, **transport** infrastructure—whether it be roads, metro systems, or trains—is not growing fast enough and cannot keep up with the ever-increasing demand for urban mobility. Indeed, constructing urban transport infrastructure is both expensive and challenging. First, many cities do not yet have the capacity to mobilize the large amount of funds needed to finance infrastructure projects. Second, planning and implementing urban transport infrastructure projects is tough, especially in dense urban areas where land acquisition and resettlement issues can be extremely complex. Traditionally, cities have attempted to solve transportation challenges by expanding the infrastructure—building more roads, tunnels, and bridges—but uncertain financial conditions and land constraints make that approach impossible. Smart transportation systems use big data analytics to optimize traffic flows and minimize congestion. They coordinate resources to ensure safety and improve operations. In the near future, autonomous self-driving vehicles may be the transport method of many citizens; these vehicles can be controlled directly by big data systems that provide a drop-off service that eliminates the need for parking.

The transportation infrastructure is perhaps the most urgent application for smart communities. Most communities face the challenge of leading an unprecedented expansion of the transit system, adding new services throughout the region, and continually seeking ways to improve the customer experience. But like other Public Sector organizations, transportation authorities are providing these services against a background of harsh realities for community planners: aging infrastructure, declining budgets, and increasing populations. It has been estimated that Canada alone faces a $165-billion deficit [1] in underfunding of public projects; organizations in Canada and elsewhere must use novel and innovative means to balance public expectations against available resources.

Drawing these applications together as a magnet for the move to smart communities is the field called the **Internet of Things** (IoT) or the Internet of Everything (IoE). The IoT is a network of networks of uniquely identifiable endpoints (or "things") that communicate without human interaction using Internet Protocol connectivity. The IoT ecosystem contains a complex mix of technologies including modules/devices, connectivity, IoT purpose-built platforms, storage, servers, security, analytics software, IT services, and security. Autonomous connectivity is a key attribute, and thus, the IoT does not usually include devices such as smartphones, tablets, or PCs. Smart communities have the unique ability to look beyond human users of the networks and to consider the new values arising from that Web of physical items and enterprise assets as they are connected to both the Internet and to each other. In the IoT, these things will sense more data, become context-aware, and provide more experiential information to help people and machines make more relevant and valuable decisions. Examples of "things" in IoE

include smart sensors built into structures such as bridges, and disposable sensors that will be placed on everyday items such as milk cartons.

According to research firm IDC, the worldwide Internet of Things market will grow from $655.8 billion in 2014 to $1.7 trillion in 2020 with a compound annual growth rate (CAGR) of 16.9 % [1]. This growth is happening because the thresholds have been lowered as devices become cheaper, more practical, and more powerful. In a recent study from Cisco, it was calculated that the Internet of Everything, applied in more than 20 core "use cases" in five areas of business (asset utilization, employee productivity, supply chain and logistics, customer experience, and innovation), has "the potential to deliver $14.4 trillion of value (net profits) for private-sector companies globally between now and 2022. This 'Value at Stake' is based on the ability to secure lower costs and higher revenues from IoE strategies and applications. The use cases cover areas such as smart grid, smart buildings, connected health care and patient monitoring, smart factories, connected private education, connected (commercial) ground vehicles, connected marketing and advertising, and connected gaming and entertainment" [1].

In a follow-up study, Cisco estimated that in 2013 alone, IoE will drive $613 billion of value for private-sector companies in 12 of the world's largest economies. The key is creative use of new technologies that are emerging in the Internet of Everything economy, over and above the growth of current data sources. The value is unlocked when data are combined with changes to the "people" dimension (skills, attitudes, culture, work style, and work practices) and to business processes (especially the more pervasive use of collaboration).

Networks themselves—backbones of the smart community—need smart city approaches. The flow of knowledge has caused the use of the worldwide network to roughly double every two years. This traffic, and the rise in bandwidth-eating video traffic, often pushes communities into adopting fiber optic and ancillary infrastructure capable of gigabit-level data speeds. Traditionally, telecommunications service providers would construct that network, but today, many utility companies are providing the service no behalf of the community. The network is superimposed on the energy grid right-of-way, taking advantage of the experience of the utility in metering infrastructure. Chattanooga TN, for example, has launched a 10-Gbps broadband network through its electrical utility. In addition to providing low-cost network service for the residents, the upscale smart city network has:

– Triggered a Return on Investment (ROI) in terms of new businesses and social benefits of $865.3 million
– Added 2800 people to the employment rolls;
– Sparked an influx of new Venture Capital funding of $50 million—up from zero in 2009;
– Become America's first true "Smart Energy Grid," saving $50 million a year
– Brought new businesses to Chattanooga, including Volkswagen, and Amazon and high-bandwidth firms in sectors such as medical analysis and 3D printing.

This type of smart community ROI is not restricted to large centers. In further chapters, the benefits of a "neighborhood-sized" gigabit network are explored, which had similar returns for a $1.2-million network investment. St. Louis experienced an ROI that included almost 2000 new jobs, $132 million in new wages and benefits, and $172 million in additional economic benefit.

Smart cities also can provide other benefits. They can generate new employment opportunities through the creation of projects, prevent citizens from moving away by improving quality of life within their jurisdictions, and reduce costs. In the case of cost reduction, cities are discovering the benefits of light-emitting diodes (LED) in street lighting, an area that can take as much as 40 % of a city's energy budget.

3.3   The "Smart City Economy" *Is* the "Innovation Economy"

A smart city sustains itself through mastery of the Innovation Economy, which is now the engine of most of the economic growth around the world.

Innovation concerns the improvement of existing or new products or services in a manner that adds value. The value can be created through new technologies, business models, services, forms of entrepreneurship, or improvements in Public Sector governance. Innovation drives both long-term economic growth for countries and supports global improvements in quality of life and standards of living:

– Three-quarters of all economic growth in the USA since World War II can be linked to technological innovation [5];
– In his 2011 State of the Union address, US President Barack Obama said: "In America, innovation doesn't just change our lives; it is how we make our living."
– In the UK, two-thirds of private-sector productivity growth from 2000 to 2007 resulted from innovation;
– A recent report published by the World Economic Forum states that in fewer than 30 years, possession of intellectual property will be the only competitive advantage for nations and businesses; and
– 90 % of the variation in the growth of income per worker across nations can be attributed to innovation [6].

Having an Innovation Economy gives these benefits:

– The ability to turn ideas into useful new products, services, and ways of doing things as the wellspring of prosperity for any developed country
– The companies that invest most in innovation tend to grow faster than ones that do not; and the countries that invest most in innovation do as well

– The planning needed to do best today in innovation gives nations the ability to articulate a clear vision of where they think their future wealth and jobs will come from
– Countries with innovation strategies sustain a mood of optimism and possibility through crisis like the malaise of the past years, and given business a sense of the future gains that make investment today worthwhile.

Innovation is especially important to Canada's export-oriented economy.

Some 30 % of Canada's GDP is earned through exports; by contrast, only 12 % of America's GDP comes from exports.

The Innovation Economy favors intellectual work over physical labor and mental power over tangible production. In 1975, intangible assets made up one-sixth of the value of S&P 500 companies; by 2015, they made up five-sixths of the value. On an inflation-adjusted basis, intangible asset values grew by 8.5 % a year, compounded, over 40 years, while tangible asset values shrank.

3.4 The Rewards for Ottawa of Being a Smart Community

Today, Ottawa is recognized as a "Top 21" smart city, by the Intelligent Community Forum (ICF) in New York. In fact, Ottawa is a keystone in the bridge of smart communities across Canada.

As the national capital with a population of 1.2 million, it enjoys investment from four levels of government: municipal, regional, provincial, and federal. Most importantly, for the smart city story, it is the center for government research laboratories and academic programs. These knowledge factories have spawned the growth of hundreds of enterprises based on research and technology. Ottawa's innovation engine is fueled by:

3.4.1 Smart Economy Baseline

- Ottawa is the home of 1700 knowledge-based companies;
- Ottawa's software companies have raised more money in IPO's over the last two years than the rest of Canadian cities combined;
- Sectors include Life Sciences, Cleantech, Defence and Aerospace, Digital Media, Film and Television, Communications Technologies, and Software;
- Ottawa is an established, internationally recognized center of excellence in wireless telecommunications technologies encompassing telecommunications, semiconductor, optical technologies, and wireless systems, as well as converging opportunities with photonics, optics, and life sciences. There are over 400 companies in the sector employing over 35,000 people. The world's largest

wireless telecommunications network equipment companies such as Alcatel-Lucent, Ciena, Cisco, Ericsson, and Huawei are developing their next generation products in Ottawa.

- Ottawa is Canada's national hub for Aerospace and Defence. As a G7 capital city and headquarters for most federal government departments, including the Department of National Defence, Public Safety Canada, the Royal Canadian Mounted Police, the Communications Security Establishment Canada, and the Canadian Security Intelligence Service, Ottawa is home to over 300 companies, employing in excess of 17,000 people.
- Ottawa's 150+ interactive digital media companies have produced content ranging from original IPs in mobile software and games to interactive content like museum exhibits and online worlds. Some of the local companies include bitHeads, Exocortex, Fuel Industries Inc., Lixar I.T. Inc, Magmic, Shopify, and Snowed in Studios.
- There are more than 140 life sciences companies in the city, employing over 8500 people. Ottawa is also home to 20 public research institutes and 20 associations focused on the sector. On the health side, there are 10 hospitals undertaking in excess of $156 million of research annually (Fig. 3.4).
- Ottawa has 65 federal government laboratories to help companies test products and create ideas;
- In the past year alone, Ottawa has seen announcements for a $15-million investment in medical devices innovation, a $24-million partnership to support

Fig. 3.4 Ottawa's Shaw Centre is rated as one of the two top convention facilities in the world [7], attracting knowledge leaders from science, technology, and arts. *Source* Invest Ottawa

software entrepreneurship, a $46-million investment in a Centre of Excellence for Next Generation Networks, a comprehensive collaboration meeting of innovators and entrepreneurs, and collaborative partnerships between post-secondary academic institutions; [8].

- Ottawa has the highest number of patents per capita of any Canadian city (2005–2012)
- Ottawa accounts for 90 % of Canada's industrial telecommunications R&D; and
- Companies with a presence in Ottawa own 74 % of the global optical telecom market.

3.4.2 Smart Workforce

- Smart Community author Richard Florida ranks Ottawa as Canada's number one city based on the three Ts of economic development: Technology, Talent, and Tolerance;
- Ottawa leads all cities in Canada in knowledge occupations—that is, occupations characterized by their use of high technology, computing, knowledge intensive processes, and creative activity. More than 1 in 4 workers are employed in the knowledge field [9], and 61 % of the workforce have a post-secondary degree;
- Its five colleges and universities enroll 120,000 students—20 % of whom are in the sciences;
- Together, the city's colleges and universities undertake $342.7 million of sponsored research annually;
- This drives Ottawa's reputation as having the most educated workforce in Canada—two-thirds have post-secondary education. Canada itself is listed as being the most educated country in the world;
- Educated people take care to ensure a sustainable future: Ottawa tied for 3rd in the world in the ranking of best eco-cities (Mercer); and
- It has the highest concentration of scientists, engineers, and patents in Canada, and the second highest in North America (Fig. 3.5).

3.4.3 Smart Connections

- It is larger in area than the next five Canadian cities combined;
- It has one of the world's best Foreign Direct Investment strategies;
- It was ranked #1 of 61 global cities in the Martin Prosperity Institute's "Creative Class."

Fig. 3.5 Ottawa companies such as QNX technologies are world pioneers in putting mobile communications into vehicles; there are 240 communications technology companies in Ottawa whose 20,000 employees drive 90 % of Canada's industrial telecommunications R&D. *Source* QNX

- Its best-in-Canada airport puts 200-million people in reach in a two-hour flight;
- Ottawa is the only city in the world with direct trade agreements with the three largest economies: the USA, the EU, and China;
- It is home to 130 embassies and consulates from other nations and has a multicultural tradition so strong that it has been rated as Canada's "Best City for New Immigrants" [10], with one in four residents being an immigrant;
- It is rated as third best city in North America for quality of living and 16th in the world;
- Recreation options include golf, skiing, skating, boating (including a World Heritage canal), white water rafting, biking, camping—and relaxed recovery in the largest spa in North America;
- It has been rated as the most sustainable city in Canada and third best in North America; and
- It is the least expensive large Canadian city to live in, allowing companies to hire four times the number of knowledge workers than they would in (e.g.,) San Francisco (Fig. 3.6).

Fig. 3.6 The world's largest tulip festival, in Ottawa, celebrates cultural diversity. Ottawa is Ontario's best large city for festivals. *Source* Festivals and events Ontario

3.5 The Innovation Goal

Yet with all this power, Ottawa knows that it must continue the journey to becoming a Smart Community, because it seeks to achieve high spatial efficiency: a high density of high-value economic activity. Ottawa is aiming to be a hub of innovative entrepreneurs working in the knowledge-based services sector. The community is putting in place plans to rise even higher in the ICF factors of Broadband Connectivity, Knowledge Workforce, Innovation, Digital Inclusion, and Community Marketing (in which the public is brought onside with Intelligent Community goals).

Ottawa's expectation as a catalyst in this Smart Community process is ***leadership in Innovation***.

Ottawa seeks leadership in innovation because the goal of innovation is to *create value*. Throughout history, innovation has been the engine of progress and economic growth by achieving value through the creation of new products, and services, as well as new ways of addressing the creation of new economic and social entities, industries, and entire markets. Innovation is the interplay of discovery "push" and user need "pull" leading to new value. Firms and cities innovate to create value and maintain or enhance their competitive position in their environments. Numerous elements are required to develop an ecology of innovation including supportive organizational structures, space, risk tolerance, incentive systems, knowledge exchange opportunities, and skilled labor. Firms or communities that can use innovation to lead in their markets have the luxury of long-term

Fig. 3.7 The new Centre of Excellence in Next Generation Networks (CENGN) consolidates Ottawa's ownership of communications innovation

strategic thinking, thanks to the benefits of their financial situation and the rewards of pursuing high-reward innovation (Fig. 3.7).

For Ottawa, innovation is defined as "a process through which economic and social value is extracted from knowledge through the generation, development, and implementation of ideas to produce new or improved strategies, capabilities, products, services, or processes" [11].

Simply put, the different between research and innovation is that research is the transformation of money into knowledge, while innovation is the transformation of knowledge into money.

This innovation process is what Ottawa's smart city program is creating.

3.5.1 How Ottawa Sees a Smart Community

The long-established Intelligent Community Forum defines the principal characteristics of an Intelligent Community as: Broadband Connectivity, Innovation, Knowledge Workforce, Digital Inclusion, and Marketing and Advocacy.

According to India's trade association NASSCOM, a smart city is "…the current megatrend where an Indian city's sectoral service delivery leverages technology to enrich its resident's standards of living, provides positive investment climate for businesses, and equips governments to maximize resource utilization and provide transparency."

i-CANADA adds the factor of leadership and expands on the "Life" component. This definition includes aspects of technology, innovation, human capital, and knowledge translation that have been shown to be important drivers of economic growth.

The common element in this and other definitions is that a smart city offers more considered and sustainable living conditions for residents. The infrastructure of such a city uses interconnecting IT systems to foster better management of energy resources, water, transport and traffic, safety, and security—delivering improved service delivery and quality of life and reduced environmental footprint.

These many definitions of "smart city" today invariably contain many common elements. A true smart city today, however, has one fundamental characteristic that differentiates it from past understandings: *All the elements within the community are interconnected and interactive*.

Instead of (e.g.,) a Smart Traffic department or a Smart Energy division, a smart city is a *system of systems*. The Smart Traffic information interacts with data from the Smart Energy grid to optimize energy use by electric vehicles, and they both interact with Smart Buildings to locate available parking locations, while the Smart Utilities function prioritizes the need to replace burnt-out street lights in areas being affected by heaviest traffic volume (Fig. 3.8).

Within this interactive system of systems, the elements can be viewed dynamically as a continually evolving hierarchy of processes.

Fig. 3.8 A smart city's services interact and share information. *Source* Hutchison Management International
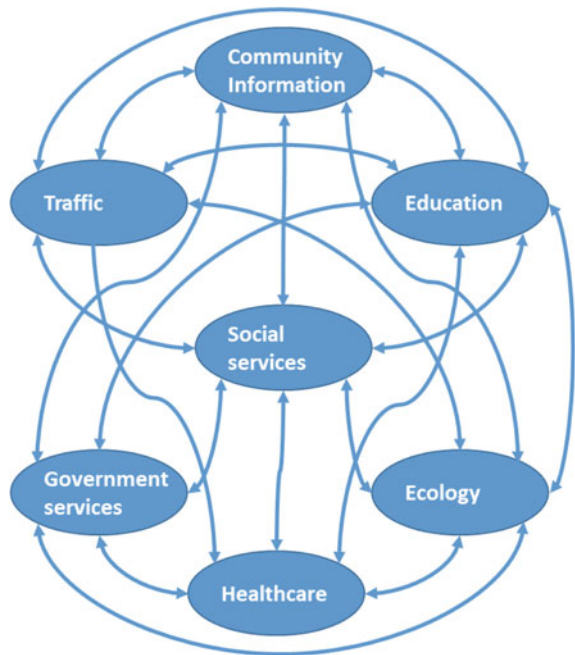
To determine how to become a smart city, or the competitive advantage that a particular smart city can offer, requires the analysis of this hierarchy, including information technology, community orientation, governance structures, business innovation, human capital, and community knowledge infrastructure. To manage their competitive progress, community leaders need to understand their community's competitive position on a map that (i) reveals the community's factors of strength; (ii) pinpoints the weak aspects for remedial action; and (iii) determines the path for progress. As a culture of innovation and the active enrolment of key community members are determinant factors for success, it is necessary to measure and manage not only the hard data about a community's infrastructure, its business components, and its investments. It is also necessary to measure the spirit of the community and its capabilities of energizing itself in the right directions of evolution.

For that, one needs appropriate tools and maps capable of providing at a glance the understanding of the community status across all key domains of competitiveness and the areas where more work needs to be done for meaningful progress.

In one respect, Ottawa is geographically fortunate, in that it has a huge land area that ameliorates the issue of congestion. Yet even in Ottawa, Smart Traffic is a focus project, with a new Light Rail Transit system being constructed (Figs. 3.9 and 3.10).
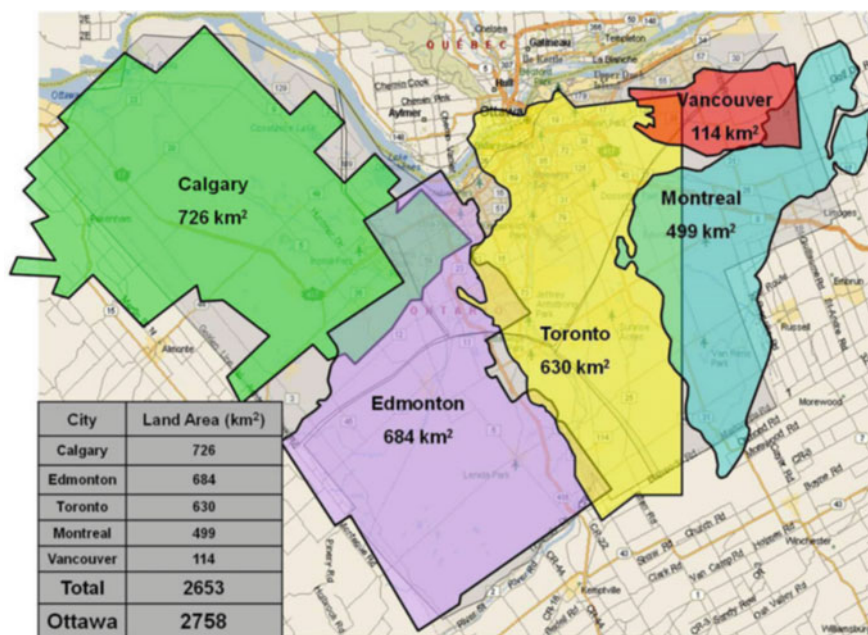
Fig. 3.9 Ottawa is larger in area than the next five Canadian cities put together. *Source* Invest Ottawa

Fig. 3.10 The confederation line light rail transit system underway in Ottawa is a 12.5-km, $2-billion project that includes a tunnel through the downtown core of the city

3.6   What Ottawa Offers to Share with Others

The survey and follow-through activity provides a model for all communities—urban and rural, large, and small—to have an effective framework for assessing their competitive status and monitoring their progress toward higher quality of living, learning, working, and playing in the competitive global world of today. The methodology is linearly straightforward, and the tools are easy to apply. They provide an at-a-glance visual map capable of pinpointing the strengths and weaknesses of the community as perceived by the important constituents of the community itself. Thus, they enable the community leadership to proceed "in-the-know" with well targeted development plans to bring tangible results most efficiently.

The tools have proven to be of value in enrolling various constituencies of the community in a democratic process of assessment and planning. In addition, the tools described in this paper have brought a higher level of transparency and accountability to community development efforts.

Finally, the tools enable higher levels of government—at the regional, provincial, or federal levels—to acquire and benchmark the necessary community assessments across their entire jurisdiction, thus allowing well-motivated decisions on the areas requiring support and the development of programs that can bring effective solutions to the entire region, province, or country. Equally beneficial, with this process, Ottawa can bring together community leaders—developers, service providers, equipment manufacturers, consultants together with government, academic, financial and health care institutions—in concerted efforts to develop from the ground up an "innovation nation" community by intelligent community.

Ottawa intends to take its place as one of the world's most accomplished Smart Cites, befitting its status as the capital of the "Country that invented the Communications Age"—and to use that knowledge to help other cities around the world achieve their own dreams.

Fig. 3.11 Highlights of Canadian strengths. *Source* Invest Ottawa

In 2017, Canada celebrates its 150 birthday as a nation. In the spirit of 150 years of Confederation, Ottawa would be pleased to offer to share its heritage of technology and social innovation with the world community (Fig. 3.11).

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Chapter 4
Ottawa: Leaders' Views on Innovation and the Smart Community

Barry Gander, Bruce Lazenby, Charles Duffett, Greg Richards, Mark Hoddenbagh, Mark Kristmanson, Ritch Dusome, Sarah Linkletter and Sorin Cohn

Abstract Eight CEOs of leading Ottawa companies were surveyed for their views on the ingredients that are most helpful in creating a commercially strong innovative company. All the leaders defined innovation in commercial terms: the addition of value to new or existing ideas, to redefine, improve, and create new opportunities. The key factors involved in success were identified as allocation of investment and resources, time, acceptance of calculated risk and failure, a clear and concise vision that is communicated, and the "right" people to create value. In addition to education and skill, these people needed initiative, judgment, creativity, curiosity, and the ability to apply and build upon knowledge and experiences. Ottawa's leaders were unanimous in stating that innovation is not only affordable, but that it is impossible to move forward without being innovative.

B. Gander (✉)
i-CANADA, 1919 Pereau Road, Canning, NS B0P 1H0, Canada
e-mail: barrygander@yahoo.com

B. Lazenby
Invest Ottawa, 80 Aberdeen St, Ottawa, ON K1S 5R5, Canada
e-mail: blazenby@investottawa.ca

C. Duffett
City of Ottawa, 110 Laurier Ave W, Ottawa, ON K1P 1J1, Canada
e-mail: charles.duffett@ottawa.ca

G. Richards
IBM Centre for Business Analytics and Performance, University of Ottawa,
55 Laurier Ave E, Ottawa, ON K1N 6N5, Canada
e-mail: richards@telfer.uOttawa.ca

4.1 Forward

A Smart Community is fuelled by the Innovation Economy, and Ottawa is a good example. It evolves and thrives in competitive national and international markets due to leaders who understand the value of innovation and how it is generated. The leaders identified here offer exemplary insights into how the process of innovation works to help organizations—and their city—achieve growth targets, and set a path for the future. Here Ottawa's leaders show how they are developing, integrating, and communicating innovative and competitive strategies and offer insights within their respective domains.

> *"Innovation is fresh ideas that create value, ideally monetary value at the end of the day; in many ways, it is the commercialization of creativity."*
>
> *—Bruce Lazenby, President, Invest Ottawa* [1]

As recognized by Ottawa's leaders, innovation is seen as the addition of value to new or existing ideas, to redefine, improve, and create new opportunities. Innovation comes from linking concepts across domains and creating a new lens for pre-existing ideas.

> *"It is rare to have a brand new idea that no one has thought of. Innovation is viewing an opportunity through a different lens and redefining that opportunity."*
>
> *—Jeff Westeinde, Windmill Development* [1]

M. Hoddenbagh
Partnership and Applied Research, Algonquin College, 1385 Woodroffe Ave,
Ottawa, ON K2G 1V8, Canada
e-mail: mark.hoddenbagh@algonquincollege.com

M. Kristmanson
National Capital Commission, 202-40 Elgin Street, Ottawa, ON K1P 1C7, Canada
e-mail: mark.kristmanson@ncc-ccn.ca

R. Dusome
Centre of Excellence in Next Generation Networks, 555 Legget Drive, Tower A,
Suite 600, Ottawa, ON K2K 2X3, Canada
e-mail: ritch.dusome@cengn.ca

S. Linkletter
EPSI, 6 Sainte-Marie, Gatineau, QC J8Y 2A3, Canada
e-mail: SLinkletter@epsi-inc.com

S. Cohn
Conference Board of Canada, 255 Smyth Rd, Ottawa, ON K1H 8M7, Canada
e-mail: scohn@rogers.com

Fig. 4.1 Critical factors for smart communities. *Source* Invest Ottawa Report, February 2016

Critical Factors

■ Allocation and investment of resources

■ Time

■ Acceptance of calculated risk and failure

■ A clear and consise vision that is communicated

■ The "right" people
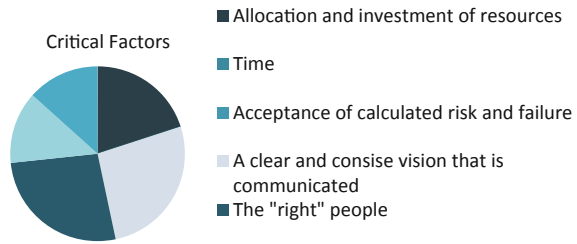
The new process or service that adds value can be monetary or social. In both cases, as the need for competitive strategies continues to be paramount across organizations and leaders, this need for innovation will become increasingly common, as companies reach for levers to ensure they remain relevant and fast-growing.

Critical Factors: Across domains, Ottawa's leaders agreed on several critical factors associated with innovation, and the commonalities are in Fig. 4.1.

4.2   The "Right" People

Ottawa's leaders agree that educated and skilled team members assist in the foundation of an innovative environment and valuable business outcomes. Other essential characteristics include initiative, judgment, creativity, curiosity, and the ability to apply and build upon knowledge and experiences. By creating a team that is able to identify challenges, problem solve, and transfer knowledge and experience from one context to another, they will be more likely to generate innovative solutions. Leading a team is equally as important; leaders that communicate organizational goals, facilitate calculated risk-taking, provide opportunities across domains and borders, and direct innovative ideas towards valuable outcomes will be more likely to engage their teams and foster an innovative work environment.

> *"An innovative culture doesn't have to been nurtured – they are already instilled in the teams we've brought together. The culture of the organization stems from the people you hire and innovation flows from their ability to learn and apply new skills in new ways."*
>
> *—David Coletto, CEO, Abbacus Data* [1]

4.3   Bottom Line

As with many organizational initiatives, change can be associated with cost. However, Ottawa's leaders were unanimous in stating that innovation is not only affordable, but that it is impossible to move forward without being innovative (Fig. 4.2).

> *"The business must innovate, and therefore must create the funds necessary to support innovation. This is about a relentless focus on the execution underpinning sustained customer satisfaction and sound financial performance."*
>
> *—David Ibbetson, Vice President and General Manager, General Dynamics Mission Systems International* [1]

> *"Innovation is occurring all over the world and is limited when ideas are constrained within borders, By sharing and building upon ideas, our dialogue and or conversations become more diverse and rich- the possibilities are endless."*
>
> *—Cheryl Jensen, President, Algonquin College* [1]

4.4   Interview with

Jeff Westeinde

Investor and Entrepreneur

Fig. 4.2 Smart Community leadership profile. *Source* Invest Ottawa Report, February 2016

How Affordable is it to be Innovative?

	Value
Unaffordable not to	2
Affordable	2
Affordable - money perspective	2
Unaffordable - time perspective	1
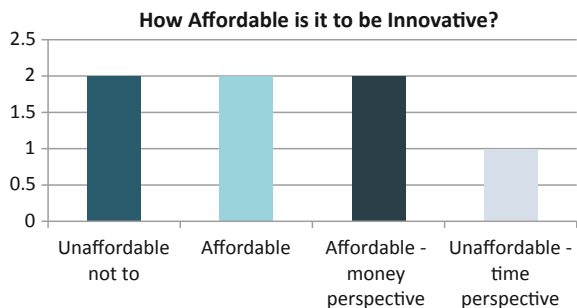
Overview

In your own words, what is innovation?
It is rare to have a brand new idea that no one has thought of. Innovation is viewing an opportunity through a different lens and redefining that opportunity.

What role does innovation play in your organization?
Property development is not ripe with innovation. You have to build innovation by constantly pushing the envelope in both social and environmental contexts.

How is innovation and its respective strategies managed within your organization?
It is managed through goal setting. You need to identify what you are trying to achieve and what change you are trying to initiate. It is also important to get the right people around the table and facilitate connections and the generation of ideas. This refinement of ideas by aspiring individuals creates innovation.

How "affordable" is it to be innovative?
Innovation is an essential element. Affordability is not an issue. If you want to distinguish your organization, then you have to be innovative.

Do you think Ottawa has the potential to become national leader in innovation? Why or why not?
We already are. We have a tremendous amount of pure research and development in government and private sectors. Due to our commercialization, captivity, and real world leaders, we have all the ingredients to be an innovate capital. The story we tell includes setting local leadership around innovative goals. To facilitate an innovative community, it is essential to rally the community. Look for the obvious community leaders and entrepreneurs in all sectors. By encouraging a clear and concise message from those leaders, we can facilitate innovation across sectors and groups.

Windmill Development Group is a visionary real estate development company dedicated to transforming conventional development practices using the triple bottom-line approach of people + planet + profits. They harness innovations that optimize the use of land, water, air, energy, and building materials towards a goal of zero ecological footprint buildings.

Why Is Innovation Important?
Innovation is essential and is at the basis of all great ideas (e.g. fire, the wheel). This evolutionary process is facilitated by the creation of an innovative environment.

In this respect, innovation is binary—you have to create the right environment in order for the evolutionary process of innovation to thrive.

Innovation Strategy: Critical Factors Needed to Aid in Success
The mandate is a key when developing an innovative strategy. You need the right technology, the incentive, and the ability to capture the market product. The ability to be innovative is a necessity; if you don't encourage creativity and innovation, then you risk putting out your organizational flame. This flame includes necessity and urgency in developing an organizational strategy that is embedded with innovative practices. Large enterprises have the tendency to "buy" innovation through acquisition, but this practice often kills the innovative culture of acquisition targets.

Innovative Workplace Culture as an Important Aspect of Business Strategy and Success
Creativity and innovation ensues from rapid failure management. In order to be innovative, you need to be accepting of error. These series of rapid failures facilitate adjustments and ultimately lead to a better outcome. This can be difficult to acknowledge when failure is not seen as a positive outcome; however, it is important to embrace a culture of failure in which individuals are encouraged to fail, adjust, and strive for innovative solutions.

Entrepreneurship and Innovation as an Important Aspect of Community Strategy, Success, and Culture
Entrepreneurship and innovation are important aspects of community strategy, success, and culture. However, not all strategies need to innovative. You can infer that if you put your business on Main Street, you will automatically attract more customers based on location and not on an innovative strategy.

Measurable (Metrics-Based) Innovation Management to Support a Culture of Innovation
Innovation is not measured in and of itself—the goal is to be most environmental and sustainable—so, you measure your organization's ability to reach that outcome. As a result, you reach the outcome through innovative means. For example, in order to be more sustainable, you need a better design to reach that goal—the steps taken to design a zero carbon system must be innovative in order to reach the goal of being sustainable. Targets must be set that demand innovation.

Nurturing a Culture of Innovation in Your Workplace
There are always choices to be made, and not all areas in business can demand the same degree of innovation. For example, accounting doesn't demand the same amount of innovation as a technical or strategic role requires. To nurture a culture of innovation, you need to set an agenda and the respective goals to be successful. If so, everyone has a role to play in developing a culture of "pushing the envelope". If people do not feel protected, then they won't be comfortable with being innovative.

Challenges Faced in Developing a Culture of Innovation in Your Organization

Failure is constant, so you need to be able to embrace it. Not many people can stand up and say, "I screwed up however I learned from my mistakes and will apply this knowledge in the future". It is important to allow for mistakes within the organization while also managing those mistakes. However, critical decisions should be appropriately managed and error should be minimized. If you are experimenting with an accounting procedure and the account is unable to deliver, then the outcome can have negative impacts. Technological advances on the other hand have more room for experimentation, and if the change is not effective, there is room to manage and adjust. As a result, it is important to pick the right time and place to encourage an innovative culture.

Easy Aspects of Integrating Innovation Strategies into Your Workplace

Creating an innovative culture is easy when you have senior executives leading by example. By having an open office policy and sharing ideas, successes, and failures, an integrated innovative strategy is easy to implement. It is also important to identify expectations and particular tones for the entire organization.

The Outcome of an Innovative Strategy

A recent outcome of an innovative strategy is the pilot of environmentally friendly buildings with mechanical variable refrigerant flow (VRF) systems. It is the first time this system has been used in an American climate. This system uses refrigerant as the cooling and heating medium and has cut energy costs by 30 %. By utilizing technology available in different industries and geographical regions and making small improvements to fit our requirements, we were able to develop an innovative system. This iterative process is innovation.

4.5   Interview with

Hans Molin

President

Overview

In your own words, what is innovation?

Innovation for me, for us, is putting one idea together with another idea in order to generate a third idea. You may have thousands of ideas yet only one may be brilliant. You need to approach these ideas with a different mindset. Identify targets and strive for quality and functionality in an innovative

thinking process. Even when developing a new technology or idea, bring in expertise to assist in innovative capacity.

Innovation Strategy: Critical factors needed to aid in success
There are two critical factors: an open door policy and looking for "doers". Having an open door policy is important because it encourages others to share knowledge and ask questions. It is also important to have "doers" in your organization; people who will identify a mistake and correct it. You want individuals who know the direction of the organization and take action to make it happen. There are many cultures in today's workforce. It is the same R&D site, however, with a lot of different people.

How "affordable" is it to be innovative?
You can't afford not to be innovative. Don't schedule time to be innovative; it should be part of everyday life. Bring in new ideas through awareness of the world around you.

Do you think Ottawa has the potential to become national leader in innovation? Why or why not?
I do, for sure. Otherwise we wouldn't be here. The competency bank in Ottawa is amazing, and many people across industries are willing to network and share ideas. We have the right educational infrastructure to nurture future leaders, and Ottawa attracts innovative people who will challenge pre-existing systems of work. Our climate also forces us to change. Between our green summers and harsh winters, people must constantly adapt to their environment in and outside of the workplace.

Syntronic assists their clients from an idea, or any point in the product life cycle, to a finished product and aftermarket services. They have the knowledge and capacity to support projects on a global scale and have a strong presence in the South American market.

Why Is Innovation Important?

Why is it important to grow? There are a lot of philosophic answers; however, it comes down to the fact that it is more fun to grow, to have innovative ideas, and to see how these ideas help companies and people. This is the way innovation should be. You may ask, why do we innovate? My reply would be, why do trees grow? It's not a matter of why trees grow; it's the essence of their nature. Trees grow. People innovate.

What Role Does Innovation Play in Your Organization?

Innovation is a survival strategy; without innovation, our organization would continue to do what we are doing now. Now, since we have been profitable since we started, that doesn't sound like a bad thing however, ten years from now while we are maintaining consistency, our competitors will have surpassed us. Innovation is an opportunity to do something different and provide organizations with a

competitive edge. With a good understanding of the competitive landscape, we are able to stay one step ahead. But if you look too far ahead, then that initial idea or concept is no longer innovative. When you see a good idea, you have to embrace it and contextualize it within the current timeframe.

How Is Innovation and Its Respective Strategies Managed Within Your Organization?

Innovative strategies are project based and customer driven. Because we are working with so many different industries, it is important to meet with the customer, identify the problem, and generate and collect ideas across industries. Just because your customer is in the IT sector, it doesn't mean you can't draw from innovative ideas or concepts from an automobile sector. The management team plays a significant role in generating and collecting ideas; management who meet with their team, foster a collective mindset, and bring together two sets of ideas into one cohesive plan will be able to put forward innovative solutions. We don't believe in an innovative strategy; by labelling and segregating innovative ideas into boxes, it limits the innovative capacity of the idea. You need to find the moment where people are open to new ideas and where people are engaged and open to others. When you find this moment, document the ideas and start singling out the best.

Innovative Workplace Culture as an Important Aspect of Business Strategy and Success

Workplace culture is necessary for organizational and individual growth. We talk a lot about continuity, long-term relationships, and mutually benefitting investments. When knowledge is shared, innovation will stem from that environment. This type of environment can be a challenge to transfer across borders, even with today's technology. We encourage the use of competency and skills and focus on R&D as we expand across borders. We are working with teams in Beijing, Sweden, and even Malaysia, and we encourage our employees to travel to different sites; this is an opportunity for us to develop the company culture and our travelling employees.

Measurable (Metrics-Based) Innovation Management

There is more measurement implemented by our customers as they evaluate our KPIs. There is not much benefit for us—it is just a way for people to measure something with little success. I'd say there is more customer satisfaction measured within our organization. At the end of the day, it is important that we have satisfied customers and innovation is definitely part of that. However, like I said, there are not really any metrics driven to measure innovation.

Nurturing a Culture of Innovation in Your Workplace

Time is always a factor that limits us. We do have kick-offs in which we bring together innovators that are known to break boundaries. These innovators lead discussions and facilitate activities for our staff; one employee even walked across hot coals. The last two years we have been growing and haven't been able to host these kinds of events. However, we do promote a change in mindset. Even something as simple as taking a different route to work can initiate new thoughts. Through this mindset, we hope that our employees move forward with an open

mind and are challenged at work. However, we can only go so far. At the end of the day, we are still responsible for employee stability and salary. We need to continue to be profitable in order to nurture this culture in the first place.

Entrepreneurship and Innovation as an Important Aspect of Community Strategy, Success, and Culture

Entrepreneurship is in our genes—so many aspects of our world are built from entrepreneurship and its respective mindset. Our core values and morality direct us towards opportunities, and it is our responsibility to grasp these new opportunities as incentives for personal and organizational development. If a light bulb breaks in your office, and you wonder, "Who will change that for me?", then you are in trouble. You should be thinking how you are going to change the light bulb yourself. This is the entrepreneurial mindset we are looking for. Entrepreneurship is not necessarily part of our day-to-day vocabulary; it is more of an underlining concept. From time to time, you hire people with different ways of doing things, people who are an expert in a narrow area, or bring a local flavour to the table. We are looking for people who are more horizontal and people with multiple skills in multiple areas. These types of people can support organizational directions in more than one way. These are the people that build and that grow.

4.6 Interview with

Bruce Lazenby

President & CEO

Overview

"*If I know about everything going on, then there isn't enough happening*".

The "Right" People

To innovate collaboratively and with speed, you need the right people. By using psychometric testing and job profiling, we are able to identify individuals who match the position as well as the organization. We also look for people who have high aptitude levels; it is easier to teach people the skills and knowledge, while aptitude is more innate.

Our Future

Employment is slowly dropping as technology increased. It seems we work harder and harder to create fewer jobs through our technological advances. An example of this is self-driving cars—think of how many people are

employed in the automobile industry and the effect self-driving cars will have on our working class that relies on transportation as a service.

Employees are increasing their independence in the work force through contract work and personal career management. There is less emphasis on company loyalty, and employees are more likely to have multiple career paths and jump from job to job.

Invest Ottawa delivers collaborative economic development programmes and initiatives that increase entrepreneurial momentum, wealth, and jobs in the City of Ottawa and its surrounding region while marketing Ottawa's diversified economy and high quality of life.

In Your Own Words, What Is Innovation?

Innovation is fresh ideas that create value, ideally monetary value at the end of the day; in many ways, it is the commercialization of creativity. Innovation should be encouraged, not harnessed—it is about being focused, thinking, and empowerment. For people to be innovative, they need to get out and try new things; they need to think and act boldly; and they need to be recognized for their efforts.

> *"As an Executive coach, I used to sit down with CEO's and ask, what are the six things that described the culture of your company? And they would respond, why six? And I would say, because that is how many you've got on your website."*

If you don't know your organizational values, then you cannot expect your employees to know it. Our values are concise and easy to remember—innovation, collaborative, and speed. We repeat these values often and I am confident that if you asked anyone in the organization what our three values are, they would be able to respond. To promote our values in the day-to-day work of the organization, we have presidency awards of one hundred dollars in which people are nominated and recognized for work that is innovative, collaborative, and related to speed. Additionally, if our decisions are not innovative, collaborative, or related to speed, then we don't do it. There needs to be a sense of urgency, of excitement—for example, we were notified about an upcoming event, Global Entrepreneur Week, in which organizations globally compete and demonstrate their passion for entrepreneurship. The event was set to start in three weeks, and it was noted that due to the time restraints, we wouldn't be able to apply. Instead, we found a way to be innovative—within the three week timeframe, we reached out to our networks and were able to host 45 events in seven days. Our innovative thinking, collaboration with the Ottawa community, and speed proved to be beneficial as we finished third.

In order to accomplish goals with restricting timeframes, you have to get people engaged quickly. People want to do exciting things; all you need to do is invite them. Alongside urgency, however, is planning. Speed has a price and can often work against collaboration. Bringing together groups to collaborate and develop a solution may take longer, but the results are usually extraordinary.

What Role Does Innovation Play in Your Organization?

Innovation is the driver of technology in Ottawa—we think about it, encourage it, identify challenges, and set an example. Innovation still has its challenges as there is an association with fear and failure. Understandably, people fear failure and this is the impediment of innovation. It is important not to reprimand people who have tried something bold and consistent with the business objectives when it does not produce the intended outcomes. Instead, spend time familiarizing your employees with strategic directions on where we want to go and how we want to do things. This is why innovation, collaboration, and speed are so important.

When employees come to you for advice on decision-making, encourage them to provide three options that are aligned with the organizational initiatives and values. When they provide you with the three options and the benefits and challenges of each, ask them what they think is the best option and do your best to agree. After several times, employees won't need to request your advice, and they will be able to identify options and evaluate these options against the organizational values and initiatives. Encouraging autonomy is part of being a leader, a mentor.

Innovation Strategy: Critical Factors Needed to Aid in Success

A critical factor in an innovation factor is making sure everyone knows what we are trying to accomplish—you need to give people the opportunity to use their best judgment to achieve organizational goals. In many ways, this is similar to the theory of compound interest. Another factor is hiring the right people, smart people; the kind of people that do not wait to be told what to do. Everyday people make decisions that take the organization on a particular path; it is the responsibility of the manager to identify what the most strategic path is. By gathering input from others and communicating the strategic path to the team, the organization is more likely to reach its objectives.

It is important to integrate annual surveying into the organization. Engagement surveys identify whether employees understand and support decision-making, are committed to the organizations goals, and can visualize the strategic direction of the organization. It is also important to take the time to meet and discuss personal life goals with your employees. In order to engage them, you need to know what they want out of their career.

For example, I had an excellent employee in marketing; he was coherent, focused, and smart. I brought him to conferences, introduced him to new opportunities, but I sensed that he was reluctant. Finally, one day I asked him. "What do you want to be doing in the next five years?", and he replied, "Exactly what I am doing now". I learned that you need to ask first so that you are able to provide opportunities and mentor them in areas of their own professional interest. This is how you truly engage people, when they see that you are looking out for their best interest. When you establish this kind of respect, it develops both ways.

4.7   Interview with

Eric Sauve

Entrepreneur

Overview

In your own words, what is innovation?
Innovation is doing something different; it can be taking something old and changing the context, or shifting from one domain to another. Innovation is time based and is a modernized process, for example taking a personal interest and developing it into a professional market. You see this in business and in nature. There is a species of bioluminescent jelly fish in the St. Laurence River, and Tesla has adapted this biological function to develop bioluminescent paint. This is innovation: building on other ideas and developing contexts with different values.

How "affordable" is it to be innovative?
Innovation is affordable from a money perspective but not very affordable from a time perspective—innovation flourishes when people have the time and the money to be creative. Innovation is also prominent in younger generations, as they are less committed to a career and do not yet have families of their own. It is a luxury to be part of an innovative society, and we should encourage younger generations to learn, imagine, and create.

Do you think Ottawa has the potential to become national leader in innovation? Why or why not?
Yes, "It's 2015". We have a lot of smart people and local innovators who have had their own successes. It is important that these people are willing to mentor and provide insight to those just getting started.

Entrepreneurship is a highly creative process—creativity is developing ideas, drawing from inspirational start-ups, and the ability to take something and change the content in which it exists.

Why Is Innovation Important?
Innovation is important on a social scale as it has been and will continue to be an evolutionary process for the human race. In our society, it is healthy to reinvent, to clear out the cobwebs—in this respect, change is good as it helps make the next

generation better. Many societies have shifted their political structures, monarchies to democracy, and whatever will come next. In many ways, we expect this type of reinvention to be a positive one, especially when we are able to open our eyes to past inventions. Change is not revolutionary, it is just change—that is why we need innovation, to decentralize power, generate opportunity, and move past the political.

What Role Does Innovation Play in Your Organization?

Innovation is a primary business strategy. In the region that your organization exists, you need to try to out-innovate the other players in that space. In the IT industry, innovation is present on a weekly basis, and as a highly innovative industry, change is a constant. Software is so interesting because there are really no business models, sunk costs, or capital costs like there are in the manufacturing industry. Software development is not limited to the building or mechanics that the manufacturing sector experiences. For example, the oil refinement industry is expensive to get into because of all the upfront costs like funding the factory and machinery, and once you have funded all these upfront costs, the outcome is limited to one thing: oil refinement. However, in IT you do not need all these expensive upfront costs, just two guys and an idea. Without this overhead cost, IT is able to develop software cheaper and cheaper.

How Is Innovation and Its Respective Strategies Managed Within Your Organization?

Innovation is understood and explored rather than managed. We aspire to discover and capitalize on that discovery. In many ways, it is a random process—think of people that manage innovation, they are often venture capitalists. For example, if you have a pot of one hundred ($100) dollars, and you allot ten ($10) dollars to ten companies; a likely outcome is that seven companies go under, two produce mediocre profit, and one is hallmark. When you manage innovation, you often don't know what is going to turn out to be innovative and success. Through exploration and deductive exercises, you can identify which companies have the most potential to not only be innovative, but also be successful in their market.

Innovation Market: Critical Factors Needed to Aid in Success

A critical factor needed in an innovation strategy is a market aligned with your idea. Involving the right people is also important as the idea transcends your ability to execute upon it. An idea that can withstand partial execution and still be successful has the qualities of a great innovative market.

Measurable (Metrics-Based) Innovation Management to Support a Culture of Innovation

Innovation management as an entrepreneur is exploration; innovation management as a business strategy is standard and lacks innovation in and of itself. People with ideas, people who explore, they do not try to manage their innovation, they actually innovate. By refining the product in partnership with the market place and focusing on delivering the best product, you and your users will be able to "live life in the fireworks".

Nurturing a Culture of Innovation in Your Workplace Through
Imagination and risk-taking—get people to image in a concrete way, a scientific way while still encouraging risk. The risks must be narrow as no matter how good your idea is; if it is not the right place and time, it will not succeed. If you look at science, innovation has played out over a long period of time. In this sense, six months of risk-taking amounts to less on the larger scale of innovation. Even if this is the case, you have to be in the right mindset to learn and give yourself leniency to try new things as you will always get something out of it. This is where the culture emerges, the political and social context in which innovation can occur—open mindedness, willingness to experiment, and a participatory environment.

4.8   Interview with

David Coletto

CEO at Abbacus Data

Overview

ABACUS DATA

In your own words, what is innovation?
I didn't even look it up online, although I thought about it because it is not the clearest concept. Innovation is embracing change and utilizing that change to improve the quality of our work, technology, and processes. In many ways, it is about constantly learning and putting into practice the new things that you are learning. Innovation is not a new thing; we have been innovative for thousands of years.

Entrepreneurship and innovation as an important aspect of community strategy, success, and culture
If you are innovative and have entrepreneurial characteristics, then you will sever your clients better and the business will be stronger. This is the basis to developing a company or entering an industry. You need to constantly learn and focus on improvements—this is what innovation is. The better off your clients are, the more successful your business will be; service and consultation are dependent on each other.

Innovative workplace culture as an important aspect of business strategy and success
We started off with the mindset that we would be different and try new things, and I am happy to say we are still doing that. It is important to push the comfort level in the industry and explore new ways of doing things, in our case, measuring voting behaviour.

> **How "affordable" is it to be innovative?**
> Being innovative is affordable; however, there are limits to what you can do. Affordability will differentiate between industries, but in our industry, it is affordable to be innovative; we use innovation to fuel our business. In many ways, "*It is unaffordable to not be innovative*".
>
> **Do you think Ottawa has the potential to become national leader in innovation? Why or why not?**
> We have amazing potential. Looking at demographics, we have the most educated population in Canada, we have great education institutions, and we have organizations like Invest Ottawa directed at developing entrepreneurial opportunities. Ottawa is a very livable city; I just wish it was a little warmer.

Abacus Data is an innovative, fast-growing public opinion and marketing research consultancy. The company uses the latest technology, sound science, and deep experience to generate top-flight research-based advice to their clients.

What Role Does Innovation Play in Your Organization?

Innovation drives everything—in the market research industry, changes in technology can be disruptive. There has been significant change in the technology that people use and how they use that technology to communicate, for example: the decline of landlines in homes. It is fundamental to acknowledge these changes as knowledge has changed both sides of the business—the fall of the telephone and the rise of the Internet. The ability to collect random samples is being affected by this change; before the shift towards Internet, it was easy to select a random set of phone numbers and people were generally happy to talk to you about their opinions and thoughts. In today's modernized world, it is more difficult as people are able to screen calls and are busy with their own lives. The industry has responded to this challenge by shifting towards online surveys; however, the shift does come with challenges of its own like producing random samples and the avoidance of spamming. Due to innovation and evolution, the industry has moved past the once acceptable and gold standard of the telephone and is moving towards online research.

This shift is not only in the technology we use, but also the methodologies surrounding it. Organizations that have not innovated their methodologies are most likely facing more problems than those who have embraced online research and surveying. Technological and methodological shifts need buy-in as research validates and application produces credible results. As the academic community begins to explore a methodology, it generates buy-in and helps to validate the change.

How Is Innovation and Its Respective Strategies Managed Within Your Organization?

As a small business, innovation is on our minds; however, there is no formal way that we manage innovation. The competitive market that we are in and the size of our company enable us to be flexible, learn, take calculated risks and, as result of

those things, produce innovative outcomes. We don't need a change process or have scheduled meetings to discuss innovation; instead, we keep abreast of emerging issues, commonalities and changes in our work, and the evolving needs of the client.

We are aware of the need to stay innovate—it is challenging when large companies like Facebook and Google, the big data buys, offer similar insights, but with different data sources.

The ability to collect data on a large scale and accurately predict human behaviour is a powerful tool. However, this kind of large-scale collection and analysis will not replace the custom research that we do; there is value in the ability to analyse data and produces recommendations based on the "why"—why people do, say, and think what they do. Further, by examining qualitative data, we are able to better anticipate human behaviour and opinion, but more importantly, why they behave or think the way they do—that is the added value of our work.

Why Is Innovation Important?

Innovation can be short-term, competitive, and profitable. We are always looking for ways to reduce costs and become more competitive in our industry. To do this, we identify ways to position ourselves that will attract clients. Across the industry, our product doesn't differentiate, so we focus on the people, not the product. We utilize the product to collect the data, but it is the people who are important as they are the ones who interpret, organize, and make recommendations—people add value. Since innovation is all about learning, we seek people with a natural curiosity and who want to continue learning. I believe that the market research industry is the innovation industry because it is all about moving the ideal and understanding consumers, voters, and individuals so that we can move a product, service, or brand forward. If we as an industry aren't innovative then we can't help make our clients more innovative—this is what people hire us for; to be innovative, to produce good results and, more importantly, good recommendations.

Innovation Strategy: Critical Factors Needed to Aid in Success

There are three critical factors required: willingness, resources, and time. If your organizational leaders are willing to be innovative and recognize the value in doing so, success will follow. This willingness goes beyond discussions; it is also an integral part of the day-to-day activities in which there is openness to failure and recognizing risk in opportunity. Secondly, innovation requires investment, so being able to allocate monetary resources towards innovative activities is critical. Lastly, time—I would say this is the most critical; running a business and serving clients can easily take up the majority of your time. As a result, it can difficult to take the time to think about what is next so diligence is important when organizing your time. It is important to take a step back—read studies and alternative viewpoints in your field, talk with colleagues, and talk with other industry leaders. If you have the ability to travel internationally, do so. Look globally and meet with other industry leaders who are not in direct competition with you. This way you can have open discussions and share knowledge; these discussions can have a lot of value. In Canada, the market research industry is extremely competitive and in the public

eye; as a result, there is often hostility in sharing knowledge and strategies. Instead, look globally—participate in the knowledge transference across borders.

Nurturing a Culture of Innovation in Your Workplace
Although we remain a small company, we look for individuals who are naturally curious and want to solve problems on their own. Many of our employees are millennials and we appreciate the natural entrepreneurship among younger team members and their disposition to analyse and solve problems. As a result, an innovative culture doesn't have to be nurtured—they are already instilled in the teams we've brought together. The culture of the organization stems from the people you hire and innovation flows from their ability to learn and apply new skills in new ways.

4.9   Interview with

Cheryl Jensen

President & Chief Executive Officer at Algonquin College

Overview

Why is Innovation Important?
Community colleges are here to make sure there is significant academic prosperity regionally and nationally. A report on productivity shows we haven't moved the needle in a long time—around twenty years. Innovation is going to be incredibly important as we move forward in a competitive and international market. In order to increase our productivity, we need to develop a culture of innovation and entrepreneurship—characteristics we hope to embed into our students. We are not saying that every student should start their own company, but if we produce students who perform like it is their own company, then productivity can be maximized. As President, there is an obligation to instil this type of culture in students; a practical and applied experience, an innovative idea they can build on, the courage to execute a plan—this is how colleges keep their innovative edge.

Enhancing the culture of entrepreneurship
There are so many examples of students who have become leaders in their field; theses students have taken what they have learned and developed their own business. It is amazing when a student's spirit is able to flourish in our programmes.

> **Do you think Ottawa has the potential to become national leader in innovation? Why or why not?**
> Ottawa has extreme potential. We have a stable infrastructure, a growing IT sector, and world-class post-secondary institutions. Additionally, we also have a mayor that supports innovation and invests in Ottawa's future. Alongside our leaders, we have a community that sees they are the way of future, the mark of Ottawa.

Algonquin College is a college oriented towards transforming the potential and interest of students into knowledge and skills that will aid in the successfulness of their career. The college is also well known for being a global leader in digitally connected applied education and training.

In Your Own Words, What Is Innovation?

Innovation is made up of two things: a culture of continuous improvement and the consideration of new opportunities. A culture of continuous improvement identifies how things are done, questions why things are done a particular way, and develops different strategies with better outcomes. This process is the art of the possible. The second element of innovation, the consideration of new opportunities, takes courage. The path less travelled can be daunting, for example, imagine a raspberry patch—in your pursuit for the berries, you will get scratched but in doing so, you learn and create new paths for others. At Algonquin, we evaluate programmes and their delivery as well as the outcomes of online learning; we are also in the process of moving to a responsibility management business model and identifying areas where we can utilize entrepreneurial opportunities. We use these entrepreneurial opportunities to bring benefits back into the unit's area of development. This mindset balanced with fiscally responsible models is a powerful combination for the college and has allowed us to develop and stabilize a large E-textbook database for Algonquin students for half the price. It has also enabled us to develop what we would consider a bold and innovative international strategy for exporting Canadian education—making the Algonquin quality accessible to other countries.

How Is Innovation and Its Respective Strategies Managed Within Your Organization?

This is an important question; chaos can often be associated with innovation. In a strategy, innovation can become a common thread in which concepts are bridged into a lean, standardized process. The process must address standard problem-solving procedures and techniques and direct procedural thinking towards innovative solutions. This requires training and creative input from employees, a common focus, and attainable goals. This goal must be embedded into the strategic plan and communicated to individuals so that they are aware of their expectations. Alongside these expectations, it is important that people have the confidence and the freedom to innovate; that they will not be penalized for particular ideas or less desired outcomes.

Nurturing a Culture of Innovation in Your Workplace

By integrating an innovative international strategy, Algonquin College is able to increase the onshore of international students attending the college. Innovation is occurring all over the world and is limited when ideas are constrained within boarders. By sharing and building upon ideas, our dialogue and our conversations become more diverse and rich—the possibilities are endless. Algonquin College also has an entrepreneurial working group. The group was provided with an unstructured, but highly visible space in which they were able to paint and renovate. The purpose of the space is to foster ideas across all programmes—there was the opportunity to integrate the group into the School of Business; however, the intent of the entrepreneurial group is that it represents all programmes and areas within the college.

We even have an Entrepreneur in Residence to assist students with their ideas. This Entrepreneur in Residence is paid by the student association as they are equal partners in the centre; this governance fosters community, responsibility, and excitement among the students.

Innovation Strategy: Critical Factors Needed to Aid in Success

People need to be able to see the vision. With clear intended outcomes, the individual is able to see how their efforts will contribute to the vision—this is the responsibility of the leader, to build a strategy and demonstrate how their actions reflect their intended outcomes. Due to scarce resources, it is important that all resources are appointed to priorities. At Algonquin College, we are oriented towards digital innovation and in many ways much of what we do speaks towards this innovation. There is no one executive with the mandate to promote innovation; instead, we have developed a specific position to be the champion for innovation across all programmes and strategies.

Innovative Workplace Culture as an Important Aspect of Business Strategy and Success

Space really matters—you have to demonstrate the core belief here that people are valued. By developing centres and spaces where people can gather and collaborate, you are able to slowly integrate an innovative workplace culture. Culture takes a long time to develop; you have to ensure that the culture we want to promote is reflected in your own day-to-day activities. Consistency and patience are also keys—you need to provide people with the right vision, tools that enable them, and time to make a difference.

Challenges Faced in Developing a Culture of Innovation in Your Organization

Buy-in is important and can become critical when there is a challenge in communication. It is important to listen—to allow people the time to express their ideas, their challenges, and their solutions. Even after years of experience, take the time to listen to the individuals and groups who make up the organization; by listening to experiences, challenges, and recommendations, it is easier to gain understanding of the organization and the people committed to its success.

4.10   Interview with

David Ibbetson

Vice President and General Manager—General Dynamics Mission Systems—International

> *Overview*
>
>
>
> **In your own words, what is innovation?**
> There are various ways to look at it. Typically, innovators look for technical breakthroughs as a means of innovation. But it is more than that. Innovation is a breaking ground in a particular field which can range from technical, process, management, manufacturing, or any aspect of human endeavour. In many ways, it is like standing on the shoulders of giants; building on those who came before us; and pushing the envelope of the art.
>
> In business, innovation is driven by competition. Knowledge tends to move around in industries; however, it is not completely open. When the bar is raised by competitors, businesses have to innovate to regain positioning or risk being left behind. Businesses have to be vigilant and hone their ability to compete in these environments—innovating and committing to new ways of creating advantageous outcomes.
>
> **Why is Innovation Important?**
> Innovation is important to stay ahead of the game. If you cannot maintain a competitive edge, then you risk losing business which further reduces your ability to invest.
>
> **Do you think Ottawa has the potential to become national leader in innovation? Why or why not?**
> Yes, it has and will continue to be a national leader in innovation. Ottawa has great potential—education, cost of living, and infrastructure. It has the right recipe to attract and retain the top people through investment in different business portfolios.
>
> **How "affordable" is it to be innovative?**
> The business must innovate and therefore must create the funds necessary to support innovation. This is about a relentless focus on execution underpinning sustained customer satisfaction and sound financial performance.

General Dynamics Mission Systems is a defence systems integrator with a portfolio of innovative solutions for land, airborne, and maritime applications. General Dynamics has expertise in engineering, manufacturing, and programme management, as well as ongoing investments in research and development, and collaborates with commercial and military systems industry leaders.

Innovation Strategy: Critical Factors Needed to Aid in Success
The ability to identify what is important and create priorities is a critical factor. You can't just guess about where you are putting your investments and where you want to innovate; it is a cycle in which you have to perform to create financial headroom to invest. You can have the right ideas, but without financial resources to take those ideas to fruition, there is no innovation.

Internally, it is important to provide freedom and creative space for individuals who are making decisions. Innovation occurs in the right environment; one that questions the status quo, generates ideas, and supports thoughtful risk-taking with leaders who can align people behind their courses of action. This is why success is driven by the right people, who are fully engaged and whose leadership is aligned with the organization's philosophy; innovation is a human function, not machine driven. In order to engage the right people, you have to have visibility into the dynamics of the organization, you have to develop a culture that fosters engagement, and you have to remove obstacles that limit engagement.

To do this, General Dynamics Mission Systems' senior leadership team is personally involved in fostering an engagement environment that leads to not just innovative thinking, but also contributes directly to high performance execution. Innovation is not necessarily caused directly by managers; however, managers directly impact the environment experienced by employees, thereby unleashing their creative talents. That is core to our belief system—to engage individuals to perform to the best of their ability and, in so doing, innovate. Managers and organizational leaders need to detect that innovation, provide appropriate support, and help make it happen. This culture embraces innovation, but understands that not all innovation is going to be successful—you need to accept that certain ideas will not pan out and learn from that to be a successful innovator.

Entrepreneurship and Innovation as an Important Aspect of Community Strategy, Success, and Culture
Entrepreneurship is the free thinking ability to generate ideas, mobilize support, and implement opportunity. Part of a business is mobilizing support from individuals and communities through outreach. At General Dynamics Mission Systems, we have Edge Centres around the globe in which we invite parties to participate in innovative problem solving. These centres foster international communication on real world issues like Arctic sovereignty and critical infrastructure security. Most importantly, they ignite a conversation between industries, initiate relationship building, and stimulate innovative thinking in individuals.

Measurable (Metrics-Based) Innovation Management to Support a Culture of Innovation
We have implemented various quantitative methods in the past with limited and varied success. I prefer to focus on the basics of business and look at how lines of business and their leaders perform over time.

We have used tools to measure employee engagement, to help us gauge the internal culture in the business, and to assess how it supports what we are trying to accomplish. These tools do add value and give us important visibility into how we're doing as leaders. Looking forward beyond near-term horizons, you have to try to objectify the market and, due to the cyclical nature of our business, continue to analyse investment decisions as the national and global political environment shifts.

The Ease in Integrating Innovative Strategies and Their Outcomes
It is relatively easy to motivate employees who are working on new and exciting projects that have material impact on the business. A clear benefit of this is that our employees are invested in the work they are doing and, as a result, they feel more connected to the organization. Employees are naturally inclined to want to succeed in their field of expertise, so by keeping them motivated to achieve, you contribute to a great work environment.

4.11   Interview with

Chris Bachalo

Chief Technology Officer, Juniper Canada

Overview

In your own words, what is innovation?
Innovation is the engineering of new solutions using new or existing science to solve problems.

What role does innovation play in your organization?
Innovation plays a critical role in our industry—it has elements of competitiveness and dire outcomes. Our customers continuously drive us to introduce new differentiating features, while simultaneously cutting costs to ensure their own survival in the extremely competitive global telecommunication markets. They have two key goals in mind: reduce time to revenue for new services and lower the operational overhead of introducing and managing these services. This competition is never ending and fosters an "innovate or die" environment.

How is innovation and its respective strategies managed within your organization?

Innovation is enabled through a focused research and, more importantly, by establishing a corporate culture, which promotes innovation and risk-taking. However, it is difficult to maintain differentiation through innovation as the telecommunication hub in the Silicon Valley has high churn rates, and as a result, knowledge transference is high across companies. Ottawa employee churn is significantly lower than both Silicon Valley and India.

How "affordable" is it to be innovative?

"Innovate or die". There really is no choice. Going bankrupt is not an "affordable" option.

Do you think Ottawa has the potential to become national leader in innovation? Why or why not?

Yes, especially in the telecommunications industry. Ottawa has the right people with the right skills concentrated in an attractive city that supports work–life balance.

Juniper strives to create innovative technologies that help their customers connect their ideas, compete, and thrive in an ever-changing world. Juniper understands that we are moving to a new era of connected ideas. In order to capitalize on the new pace of innovation, businesses need advanced networks with the intelligence to connect data to ideas and ideas to real business value.

Why Is Innovation Important?

Innovation is important because it is highly correlated with customer satisfaction. In our field, it is important to provide the customer with what they want, which is reduced time to revenue and lower total cost of ownership. In parallel to this constant push from customers, we must drive the industry direction through the exploration of new technologies and solutions. This is a fine line as you engage and invest in both customer demands and leading market direction. However, having a vendor with a monopoly in a given technology is not good for the market, since their dominance limits competition and increases control over customer and standards direction. This approach does not foster competition and, as a result, hinders innovation.

Innovation Strategy: Critical Factors Needed to Aid in Success

Striking a balance is a critical factor when executing an innovation strategy. In our industry, you have to maintain a balance between customer needs and your own operational visions and philosophies. If the balance shifts to one extreme or the other, innovation is hindered. For example, if you take your direction solely from a market-dominant customer through an exclusive relationship, then there is little competition and hence no push beyond the limited scope of customer demand. This unbalanced approach does not promote innovation.

Another critical factor is to maintain an open platform in which academia, researchers, and industry can all contribute to development. This open-source strategy fosters collaborative creativity and allows for organizations with limited budgets to access the latest technologies. True innovation often comes from the new market entrants and entrepreneurs with a bright idea and a strong drive to make a reality.

Innovative Workplace Culture as an Important Aspect of Business Strategy and Success

If you do not create an entrepreneurial environment in which employees are encouraged to take calculated risks, then innovation will be stifled. A risk-limited environment promotes thinking outside the box. When there is fear of challenging the status quo and suffering the consequences associated with creating ripples in the organization, there will be no opportunities to change for the better.

Also, brainstorming needs to be done in a "safe" environment where new ideas, however bizarre they may first appear, are not ridiculed by the team.

Entrepreneurship and Innovation as an Important Aspect of Community Strategy, Success, and Culture

Ottawa is the Canadian centre for telecommunication research and development and is a world leader in the number of R&D employees per capita. The nucleus is here for an innovative culture; however, there is limited opportunity to work together due to the extreme competiveness of the industry; as a result, there is limited collective benefit today. If there was a collective focus in the community that addresses people skills, training, company incubation, collaboration, and partnerships, while protecting competitive differentiation, then we could create an even stronger environment for innovation in the community. Initiatives like CENGN (Centre of Excellence for Next Generation Networking) are a good step in the right direction.

Nurturing a Culture of Innovation in Your Workplace

A good first step is to understand and emulate the characteristics of other successful highly innovative environments, such as Google.

Challenges Faced in Developing a Culture of Innovation in Your Organization

The challenge is to encourage intelligent risk-taking through formal business discipline. Decisions must still be challenged to ensure due diligence is taken before the risk is accepted. Of course, the more strategic the decision, the more challenge there is in accepting the associated risk and hence more effort needed in the due diligence process. Corporate culture is built from the ground up based on employee behaviours, and innovation is impacted by the decisions they make.

The first step in creating this culture is to educate management on how to foster an innovative, low risk, and business-disciplined environment. Collectively, the organization is shaped by the coaching and philosophies used in the decision-making process—this is what creates the corporate culture.

Elements to Ensure the Success of an Innovative Strategy

Financial resources play a large role in the success of an innovative strategy. An organization has to prioritize hiring the right people and providing them with access to state of the art resources, and this can prove to be costly. Through hiring and retaining the best talent in the industry, the odds of success through innovation improve, especially when there is an entrepreneurial environment for them to thrive in and be recognized for their contributions.

4.12   Interview with

Dr. Mark Kristmanson

Chief Executive Officer, National Capital Commission

Overview

In your own words, what is innovation?

Innovation *is* context. By that I mean that innovation is a creative response to highly specific constraints and opportunities.

What role does innovation play in your organization?

Northern geography and climate, a growing population, and hosting the seat of national government: these are key factors that frame Ottawa's context. For us, innovation is directed to attracting and retaining a high-level regional workforce by building a culturally rich, naturally protected, picturesque, and vital national capital.

How is innovation and its respective strategies managed within your organization?

Over the past two years, the organization has adopted a learning posture. International best practices for smart cities inform our work in urban planning, design, architecture, ecology, archaeology and heritage, parks and land management, and the fostering of national symbols in the capital. Through the NCC's *Capital Urbanism Lab,* leaders and thinkers in these fields are invited to help foster knowledge new networks.

How "affordable" is it to be innovative?

Innovation is first and foremost a state of mind. It is surprising how modest allocations of resources can activate meaningful new activities.

> **Do you think Ottawa has the potential to become national leader in innovation? Why or why not?**
> The potential exists, the basic institutions exist—both public and private—and the external markets exist. In our context, I am looking to the public sector to rise to this challenge.

The National Capital Commission has a unique role in building the most northerly G7 capital as a cosmopolitan urban region that is also an attractive portal into an adjacent northern wilderness of great pristine beauty. As the planners and designers of the federal capital, as well as the stewards of more than 500 km^2 of its territory, we see a remarkable potential to leverage innovation across a broad front.

Why Is Innovation Important?

Innovation is a key to creating a vital and sustainable national capital region in an era when Canada faces stiff competition from rising city regions around the globe. We need to learn from these examples and incorporate their best practices into our way of doing business. I believe Canada's arm's length federal crown corporation model is among the best vehicles for innovation within the public sector. Combining rigorous federal standards with the opportunity to recruit external expertise on its board of governors, the crown corporation can pursue broad policy objectives beyond short-term election cycles, including the smart city agenda.

Innovation Strategy: Critical Factors Needed to Aid in Success

Innovation derives primarily from *knowledge* and not from *information*. Knowledge accrues in value over time, whereas information's value decays quickly. There is wisdom in investing in accrued knowledge by actively engaging with and supporting our many institutions of higher learning, fostering our own research, adopting new technologies, deepening our skill sets, and taking advantage of our unique 50-year planning horizon to channel future development.

Innovative Workplace Culture as an Important Aspect of Business Strategy and Success

Innovation forms an important part of our talent management process. Out of 400 employees, a group of thirty professionals put themselves forward in 2014 to create the *Capital Urbanism Lab* that has gone on to become an important regional hub for discussions about Ottawa and Gatineau as innovative cities of the future. This professional development opportunity has built capacity both inside and outside the organization, and it augurs well for incorporating an innovation agenda more broadly within Canada's public sector in coming years.

Entrepreneurship and Innovation as an Important Aspect of Community Strategy, Success and Culture

The National Capital Commission is positioned to help create the conditions for a sustainable culture of innovation in the national capital region. This is possible by affecting the built urban form to foster collaboration as well as competition and to

help attract new talent and industries to the region. It can act as a useful intermediary between the federal government and the private sector, and between Ottawa and Gatineau, adjacent cities operating in different provincial jurisdictions.

Nurturing a Culture of Innovation in Your Workplace
In addition to points already mentioned, I will offer two thoughts. One is the importance of linking a performance management framework to an innovation agenda. For example, recently we have made great progress in building a social media platform to connect with our stakeholders. The second is to foster employee exchanges, education leaves, and advanced training and provide opportunities to share what has been learned.

Challenges Faced in Developing a Culture of Innovation in Your Organization
In an organization that, like many of its federal counterparts, has faced budget freezes and cuts over a number of years, there is a challenge at the NCC to carve out the critical additional capacity required to nurture innovation.

Elements to Ensure the Success of an Innovative Strategy
In the case of the NCC as a quasi-commercial corporation, innovation fortunately can be directed to help increase its earned revenues. In turn, these can be reinvested to strengthen the capacity to innovate. This needs to work hand in hand both with a talent management strategy and with effective investment in technology. Most of all, the "tone from the top" must support risk-taking and the exploration of new ideas.

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Chapter 5
Seizing the Initiative

Barry Gander, Bruce Lazenby, Charles Duffett, Greg Richards,
Mark Hoddenbagh, Mark Kristmanson, Ritch Dusome,
Sarah Linkletter and Sorin Cohn

Abstract The most difficult barrier to creating a Smart City is finding the right way to take the first step. Based on its experience as an award-winning Smart City, with knowledge of developments around the world, the example of Ottawa can be used to help provide a play-book for Smart City movements. The first and critical step is to establish the Governance of the Smart City project, the framework that aligns leaders from many sectors to fulfil the Smart City mission. Once established, a status-check is useful in determining the city's current position along the Smart City continuum. This involves assessing how each sector of the community views its progress. Each sector is then challenged to provide a vision of where they would like to be in 3–5 years time, assuming that they had adequate broadband infrastructure to support their goals. The visions are linked, a final plan is drawn up, and a network map is created. The network is the final stage, for in the last analysis, the creation of a Smart Community is 90 % social, and only 10 % technological. The job for social leaders is to tame this and create for citizens an "intentional future"—a framework that puts them in control of their lives in a time of unparalleled turbulence.

B. Gander (✉)
i-CANADA, 1919 Pereau Road, Canning, NS B0P 1H0, Canada
e-mail: barrygander@yahoo.com

B. Lazenby
Invest Ottawa, 80 Aberdeen St, Ottawa, ON K1S 5R5, Canada
e-mail: blazenby@investottawa.ca

C. Duffett
City of Ottawa, 110 Laurier Ave W, Ottawa, ON K1P 1J1, Canada
e-mail: charles.duffett@ottawa.ca

G. Richards
Telfer School of Management, IBM Centre for Business Analytics and Performance,
University of Ottawa, 55 Laurier Ave E, Ottawa, ON K1N 6N5, Canada
e-mail: richards@telfer.uOttawa.ca

5.1   Getting Started

How does a city move from having an actionable framework, to actually taking
action? What are the first steps? What are the barriers to getting underway? Is there
a framework for goal-setting?

For many years, Ottawa has been an officially designated Intelligent Community.
This chapter will draw on Ottawa's experience to address these issues, so that other
cities can more easily obtain a Smart Economy. Ottawa has been in a dialogue with
many other successful cities, and this chapter will draw on their experience as well
to illustrate appropriate points.

Creating a Smart City is a different kind of task than (e.g.) paving a road.
Building a traditional infrastructure is relatively straightforward, because the course
of action is clear and defined by a history of development.

A Smart City, however, is something new and all-embracing. The most difficult
part in creating one is in finding the first steps to action.

Smart City creation, for example, is not something that can be handed off to one
municipal department. There is a tendency among political leaders to hand off the
job to the City's Chief Information Officer, on the assumption that a Smart City is

M. Hoddenbagh
Partnership and Applied Research, Algonquin College, 1385 Woodroffe Ave,
Ottawa, ON K2G 1V8, Canada
e-mail: mark.hoddenbagh@algonquincollege.com

M. Kristmanson
National Capital Commission, 202-40 Elgin Street, Ottawa, ON K1P 1C7, Canada
e-mail: mark.kristmanson@ncc-ccn.ca

R. Dusome
Centre of Excellence in Next Generation Networks, 555 Legget Drive,
Tower a, Suite 600, Ottawa, ON K2K 2X3, Canada
e-mail: ritch.dusome@cengn.ca

S. Linkletter
EPSI, 6 Sainte-Marie, Gatineau, QC J8Y 2A3, Canada
e-mail: SLinkletter@epsi-inc.com

S. Cohn
Conference Board of Canada, 255 Smyth Rd, Ottawa, ON K1H 8M7, Canada
e-mail: scohn@rogers.com

all about Infrastructure. That is unfair to the CIO, because the Smart City is an act requiring total community involvement.

So how does a community's leadership address the issue of "Getting started"? There are two big hurdles:

- Finding the right leader/group to *own* the process, and
- Finding the right steps to take.

These two problems are the most common stumbling-blocks in getting underway. They are compounded by the mounting urgency and stridency of the challenges facing city leaders today.

The global population is poised at the moment in a time between certainties, where the old is dying and the new has yet to be born.

A world of isolated individuals and villages is changing to an urban unity; once-homogeneous societies are embracing new minorities and cultures; human knowledge is doubling every 13 months and with the Internet of Things will soon double every 11 h [1]; and the rate of change being driven by innovation is accelerating so fast that we are facing "a rupture in the fabric of human history" [2].

The job for social leaders is to tame this and create for citizens an "intentional future"—a framework that puts them in control of their lives in a time of unparalleled turbulence.

How did Ottawa seize the initiative and impose order over this onrushing future?

Ottawa's response is to harness the sectors of its community to work together on a consensual plan. This involves a build of:

- **Governance**
- **Self-assessment**
- **Programmes for Advancement**
- **Infrastructure Delivery**
- **Continuous Improvement [history/desc of ICF applications—show how we sized the initiative and created a Smart Community]** (Fig. 5.1).

5.2 The Central Role of Governance

The key to taking the first solid step to creating a Smart City or Intelligent Community is *governance*—the framework that aligns leaders from many sectors to fulfil the Smart City mission. In Ottawa, many organizations work together to harness the city's knowledge sector. Invest Ottawa, the City of Ottawa, the academic community, business organizations—they all are involved in futures-facing programmes. The co-authors of this report, for example, were deliberately chosen to represent the major sectors. For Ottawa, a Smart City is more than a pure academic or technological exercise—it is an inclusive movement. The reason to go to this extra effort is because a Smart City programme has to go on for decades and thus requires the buy-in of all major sectors of the community.
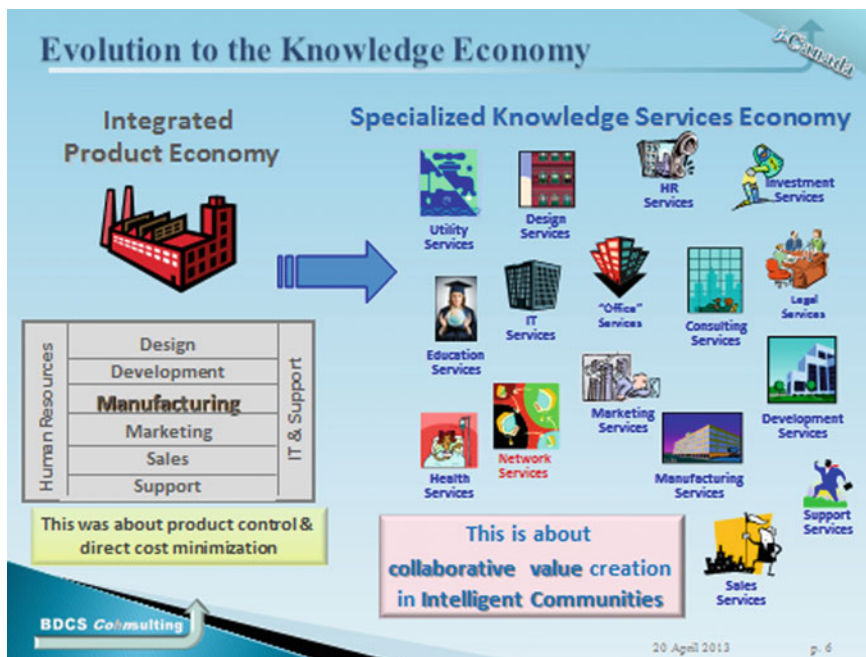
Fig. 5.1 Development goals for a Smart Community. *Source* BD *Cohn*sulting

Many cities around the world have already launched "Smart City" initiatives to support sustainable urban development, improve economical and employment growth, increase social innovation. Successes are already achieved and early lessons learnt. While there is no "one best model"—each successful community develops strategies based on its unique history and challenges and overcomes specific local obstacles to put programmes into place—successful strategies share one common trait: good governance.

There are three reasons:

- **Complexity**: The number of organizations interacting in today's Knowledge Economy is far greater than in the past Manufacturing Economy;
- **Focus**: The disparate elements that make up functioning units can be automated and networked individually, but to align them to create an Intelligent Community structure, requires advanced Governance; and
- **Momentum**: Creating an Intelligent Community is a never-ending process, requiring a structure that will sustain and channel enthusiasm over decades.

5.2.1 *Complexity*

In a traditional Manufacturing Economy, business Governance was command-and-control: fairly simple straight-line Governance that was understood by all sectors. Governance for projects of the size that that mobilized entire communities also tended to command-and-control, such as the construction of the St. Lawrence Seaway.

In the rising Knowledge Services Economy, the actors are much more numerous and diverse. Wealth-creation takes place within complex networks that span the entire social ecosystem.

> *Mumbai and Chicago municipal corporations operate with almost identical amount of fund, but the structure of governance is very different in both the places. In the case of Chicago, you know the city mayor is responsible for all the work, but in the case of Mumbai, you don't know which agency is responsible for a particular piece of work* [3].

A new type of Governance is required for this open-network model. This new Governance model takes cognizance of the fact that each actor no longer works in a straight-line manner; interaction creates success. Complexity creates a need for Governance in a Knowledge Services economy that engages and aligns all the players in society: business, social, public sector, academia, and general public.

To harness *complexity* Governance must:

- Embrace all groups
- Be participatory as a democracy with community-embraced evolution roadmap
- Strive to create a holistic value that all can subscribe to, in terms of quality of life.

5.2.2 *Focus*

While technology gives new power to organizations in all sectors, it does not by itself produce alignment. The Education sector may empower students by delivering digital content, and the Healthcare sector may reach outlying citizens through new tele-medicine, but by themselves these are acts in isolation. Each may be "Smart"—but that is not enough. An Intelligent Community is one where the goals of both sectors are aligned and reinforcing, such that (for example) student projects in the digital space aim at supporting tele-medicine.

Unless a Governance model encourages alignment, the power delivered by technology will further atomize a social system instead of building it.

To *focus* alignment, the Knowledge Service Governance must:

- Encourage cross-sectorial involvement
- Establish a leadership forum for continuing dialogue
- Consensually create benchmarks to measure success and provide feedback.

5.2.3 Momentum

The drive to create an Intelligent Community has an "open future"; there is no finish line. As technology continues to change at an ever-increasing rate, in fact, it is sobering to understand that *today we are at the slowest point we will ever be!* Tomorrow, change will be faster, and faster still the day after.

Governance obviously needs to provide mechanisms, so the community can match the momentum of change. There has to be a structure that carries enthusiasm, that provides all citizens in all sectors with the most efficient tools to move fast, and that constantly scans the globe for best practices that can be improved and absorbed.

In providing a structure to support *momentum*, Governance must:

- Create a structural framework that provides for the coordination of all activities
- Interconnect all operations functions
- Systematize the acquisition of new tools that help provide a 'success outcome' for change

In sum, the Governance structure for an Intelligent Community is very different than that of more traditional economic eras. Communities seeking Intelligent Community status must provide Governance to:

- Embrace all groups
- Be participatory as a democracy with community-embraced evolution roadmap
- Strive to create a holistic value that all can subscribe to, in terms of quality of life
- Encourage cross-sectorial involvement
- Establish a leadership forum for continuing dialogue
- Consensually create benchmarks to measure success and provide feedback
- Create a structural framework that provides for the coordination of all activities
- Interconnect all operations functions
- Systematize the acquisition of new tools that help provide a 'success outcome' for change

Ultimately, by providing the structure to access the knowledge-based digital economy, Governance turns local culture into a *product* for the global economy, and in doing so, preserves treasured languages, histories and ways of life that give life meaning.

Once the Governance is established, leaders of the important sectors of the community are recruited.

5.3 Self-assessment

The i-CAT **self-assessment surveys** of community groups has already been covered, but to recap briefly each sector of the community gives its views about its development progress towards being a Smart Community. Sectors might include, for example, Municipal, Business, Residential and Youth representatives. In this manner, a complete picture of the community emerges, plus an indication of where challenges lie between different sectors.

The ***Municipal Staff*** for example might give the community exemplary ratings for Broadband, Innovation, and Entrepreneurship. ***Business Representatives*** might indicate that these areas are in need of improvement, but that Community Assets and Health and Safety were marginally better. ***Residents*** might give praise to Finance, Community Assets, and Living but be critical of Digital Workforce, e-Solutions, and Social Cohesion. ***Youth*** might give a thumbs-up to e-Education, e-Government, Learning, Playing, Environment, Finance, Community Assets and Utilities, but be less happy with the knowledge-age ecosystem from Broadband to e-Community, e-Recreation and Digital Workforce, and the social environment factors like Community Involvement, Governance, Social Cohesion and Health.

These Strengths and Weaknesses profiles are used by the sectors as starting-points for their definitions of programmes that would put them in the first-mover category for global advancement.

5.4 Programmes for Advancement

Each sector is challenged to provide a vision of where they would like to be in 3–5 years time, assuming that they had adequate broadband infrastructure to support their goals. As a starting-point to visualize the goals and to inform the sectors about the relevance and promise of the Smart City, experts are selected from industry who can provide a narrative, with examples, of how the Smart City will change the lives and business methods of specific sectors. One way of doing this is to hold a series of one-hour webinars on applications that encourage engagement within the community, for information, business enhancement, and social well-being. A webinar would illustrate topics such as:

- Business
- Tourism
- Education
- Health

- Government
- Social Services

The Self-assessment plus the Goals sessions give a reference point to that are needed to give the community the infrastructure that it needs to execute on its vision. Expert moderators, ideally armed with digital "envisioning" tools, can then funnel ideas from group brainstorming sessions, into concrete plans with actionable and prioritized steps. These individual sessions can be held with stakeholders in (e.g.) Education, Healthcare, Government, Youth and Business.

The sessions are held regularly and generate a continuous production of programme ideas according to the strategic priorities.

Once these programme ideas are outlined and prioritized, the scope of needed networks can be assessed and costs estimated.

With this in hand, a financing model can be suggested, with recommendations on how to obtain funds. Public–Private Partnerships, for example, are coming forward as a viable way to obtain the resources needed to construct the immense networks that are needed.

5.5 Infrastructure Delivery

For the overall network, Ottawa follows these principles:

- That high-speed networks are no longer optional
- That competition in networks leads to progress
- That communities must enjoy self-determination (the right to consider all options)

Ottawa is making use of both traditional telecommunications carriers (telcos) and new models of network development. The challenge of providing adequate infrastructure is so immense today that the expertise of every group is needed to supply and distribute the bandwidth. In its heritage as a communications capital, Ottawa has benefited greatly from pioneering work by telcos. The newer winners of the Most Intelligent Community award from the Intelligent Community Forum have all be cities that developed and controlled their own telecommunications network.

An example of a self-driven infrastructure can be seen in Ottawa's collegial city of Chattanooga TN.

In Chattanooga, the electric utility EPB drove creation of Smart Community.

Starting with a 1 Gbit network overlaid on its electrical grid, it has now come to the stage where is offering business and residents access to a 10-Gbit network, with low prices.

It is currently the largest American city to have community-wide fibre.

In President Obama's words, Chattanooga is setting itself up for "a tornado of innovation".

Here are some of the business and social benefits in terms of Return on Investment from Chattanooga's transformation into a "giga-community":

- *Total new revenues: $865.3-million*
- *Numbers of additional people employed: 2800*
- *Influx of Venture Capital Funding: (from zero in 2009): $50-million (2014)*
- *Energy savings from becoming "America's first true Smart Grid": $50-million/year*

This does not include the new businesses being enticed to Chattanooga, such as Volkswagen and Amazon—businesses with a need for Big Data transmission.

There are more options today that allow communities to obtain broadband. Community-provided broadband is undergoing a surge of interest. Several provinces in Canada support community fibre networks, and centres like Fredericton NB have led the way with adoption of independent fibre networks. The US "Next Century Cities" project has 120 member cities with non-telco solutions. It includes Boston, Boulder, Kansas City, Oakland, Palo Alto, Pittsburgh, and South San Francisco. Google is spreading gigabit service to 34 cities. Twenty-two communities in Massachusetts are building their own gigabit networks. In Connecticut, 46 municipalities, representing more than half the state's population, are making Connecticut the first Gigabit State.

Bristol, Virginia, serves most of its residents and businesses with fibre, praised as "a good example of the potential of community broadband in rural America."

The public-run municipal network model is very common in the Nordic countries (from Stockholm to Suupohja in rural Finland) and has led to very successful deployments, in terms of coverage, service availability, end-user sign up, competition levels, and financial sustainability. The Stokab network in Sweden, for example, is owned by the City of Stockholm. Since its establishment it has expanded into 27 other communities around Stockholm. The organization provides "dark fibre", or basic fibre networks, which are then used by telcos and others to provide services.

> *"The Gig wasn't coming here anytime soon without us doing it. It was going to go a lot of places before it came to Chattanooga. For us, like a lot of cities, you either decide to do it yourself or you wait in line. We chose to do it ourselves."*
>
> *—Andy Berke, Mayor, Chattanooga*

These communities have their eye on the fact that *all of the winners of the Most Intelligent Community Award presented by the Intelligent Community Forum have created their own broadband network*. As noted for Stockholm, the telecommunications companies often provide the services, but the backbone network itself is the result of cities that *seized the initiative* and took the network into their own hands.

Here are a few examples from the Intelligent Community Forum:

Riverside CA: Riverside was challenged by land-intensive low-technology businesses, low median per capita income and a relatively low number of residents with college degrees. After study, its response was to form a technology park with an incubator to foster start-ups; provide a single point of contact within local government to attract and retain high-tech companies; expand fibre to the technology park and make Wi-Fi available throughout the city; and establish a technology master plan for the city. It has now installed fibre at every major city location as part of a USD 1.6 billion investment in parks, roads and facilities. The fibre ring has been upgraded to provide a 10 Gbit/s backbone to the city's largest facilities and 1 Gbit/s to all branch offices. Internet access is via a 1 Gbit/s Time Warner primary circuit and a 50 Mbit/s Opt-man secondary service from AT&T. High-speed public Internet over fibre is provided to all libraries and community centres [4].

Seoul, South Korea: Seoul set out to create higher-paying high-tech jobs by establishing a reputation as the world's leader in broadband deployment—a title it captured in 2001. This achievement is the product of strong government policy in support of broadband services. The government began to invest in networks for its agencies, schools, and universities and offered US$400 million in loans to carriers for infrastructure construction. This led first Korea Telecom and then its competitors to invest an estimated $10 billion in network development. Today, there are more than 70 broadband service providers, led by Korea Telecom, Hanaro Telecom, and Korea Thrunet. Under the combined pressure of government policy and competition, access prices are kept low—users pay either a flat fee or a usage-based price only slightly higher than dial-up service. Yet revenues from broadband applications and services generated US$3.5 billion in 2001.

Mitaka, Japan: In the 1950s, Mitaka was threatened by the move of high-tech manufacturing lower-cost sites. Fortunately, the city began to attract a different kind of organization: universities, corporate research centres and data centres, drawn by Mitaka's proximity to Tokyo. As a result, over the next decades, the city developed a social and political culture that prized technology and considered R&D of high importance. It was the first city in Japan to host a field test of fibre-to-the-home, and its cable TV company became the first ISP in Japan to offer broadband in 1996. The community has a tradition of active citizen participation when it comes to developing its infrastructure.

Taipei, Taiwan: For Taipei, the challenge of the twenty-first century is to run faster in a fast world. Mayor Ying-jeou Ma challenged Taipei to become what he called a CyberCity, focusing first on building broadband infrastructure and using the Internet to improve public services. Within five years, 84 % of the government's total document traffic was moving through its electronic document exchange. Its Internet portal was offering over 400 services used by an average of 3500 citizens per day, and over 5200 small-to-midsize companies had created websites on a free Taipei Business Net portal. The government also deployed a municipal wireless network to mass transit stations and all elementary and middle school campuses, where each class was equipped with its own website to facilitate

teacher–student communications. Plans call for extending the network to 90 % of the city.

Ottawa has also won Intelligent Community awards from the Intelligent Community Forum, using the same methods as its sister cities. Ottawa is a stellar example of what can happen when a community focuses on linkages and innovation. From Ottawa and other award-winning global Smart Cities, the lessons for the creation of a Smart Community crystalize into channelling solutions to:

- *Seize the initiative* and establish a Governance structure;
- *Seize the initiative* and asses your community's needs;
- *Seize the initiative* and tap into the vision of the sectors of your community;
- *Seize the initiative* and create the right network for the vision that is custom-designed by your community.

Ultimately, these steps will be create the linkages that have allowed centres like Ottawa to prosper in the Innovation Economy, as a Smart City

Your reward, also, will be a new Smart City—urban or remote, large or small—that will be a great place to live and to do business.

Today, there is no choice. Around the world, other cities are exploiting the value of linkages as the driver of innovation and Smart Cities. They are designing movements so powerful that they often transcend national boundaries. The Clinton Global Initiative and Connected Cities, for example, is a programme to help 100 US cities integrate smart technologies and break down cost and complexity barriers, so cities know how to invest in efficiency and sustainability. This is a linkage programme on a grand scale, where cities can leverage other participants' experience and jointly architect their smart initiatives.

Similarly, the role of focus in successfully harnessing innovation has been demonstrated at the company and community level. Measureable innovation-related metrics now exist that can provide snapshots of progress towards a Smart Community and a successful company.

You can act on it, you can govern it, you can measure it, you can effect it. These are the keystones to creating an Innovation Economy in a Smart City.

Seize the moment—the future is yours.

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Part III
China-Hong Kong Hksar

Chapter 6
Introduction to Hong Kong's Development

Sujata S. Govada, Widemar Spruijt and Timothy Rodgers

Abstract Hong Kong is a unique city state that, partly due to its strategic location in South-east Asia, has grown into one of the top-ranked global cities in terms of per capita GDP. Its mountainous terrain and limited supply of buildable land resulted early on in urban areas with extreme population densities. The compact urban form was further stimulated by using mass transit as the backbone of urban development. Different urban rail systems were integrated, and smart technology was introduced early on to stimulate its use. Today, Hong Kong has one of the highest public transport modal splits in the world. Hong Kong has developed high-density transit-oriented developments, but these TODs are not always well integrated into their urban contexts, creating barriers for pedestrians. Hong Kong also has a relatively high rate of telecommunication connectivity, which has facilitated the growth of the economy and enabled the population and businesses to be fully connected to the global economy.

Keywords Population density · Nature parks · Colonial rule · Special administrative region of the People's Republic of China · Compact city · Mass transit · Smart technology · Transit-oriented development (TOD) · Electric cars · Green economy · Telecommunication · Population growth

6.1 Background

Hong Kong is a compact vertical city, a world-class financial, trading and business centre and one of the top-ranked global cities in terms of per capita GDP. Located on the coast of South-east China, Hong Kong is strategically placed to provide an important trading link between the East and the West and has been doing so for

S.S. Govada (✉)
School of Architecture, Chinese University of Hong Kong, Hong Kong, China
e-mail: sujata@udpcltd.com

S.S. Govada · W. Spruijt · T. Rodgers
Institute for Sustainable Urbanisation, UDP International, Hong Kong, China

decales. At the end of 2015, Hong Kong has a population of 7,324,300 people [1]. Hong Kong has a land area of 1104 km^2 consisting of three major territories: Hong Kong Island, Kowloon and the New Territories, as well as over 260 outlying islands. As shown in Fig. 6.1 only about 25 % of Hong Kong is developed as urban area with the remaining 75 % consisting of protected country parks and nature reserves (40 %) and rural countryside (35 %) [2]. As a result, Hong Kong has an overall land population density of 6603 persons/km^2 (66 people/ha), but the more relevant density is 26,317 people/km^2 of urbanized area (263 people/ha). The urban density, however, is often much higher and can be up to 130,000 persons/km^2 in certain areas (1300 people/ha), which is among the highest urban densities in the world.

Hong Kong has come a long way in a relatively short period of time, from being primarily a fishing village to a military outpost, a burgeoning manufacturing centre after the Second World War, a major entrepot with its current position as global shipping centre and an international financial services hub. The city has undergone significant growth in population and GDP, as well as a major transformation of its economy and industry facilitated by technological advancements and a changing political climate. From the early nineteenth century up until the end of the twentieth century, Hong Kong was under colonial rule by the British and in 1997 transitioned to its current status of Special Administrative Region of the People's Republic of China under the One Country Two Systems arrangement for 50 years. During the mid-to-late 1900s, Hong Kong was able to grow its industrial manufacturing base
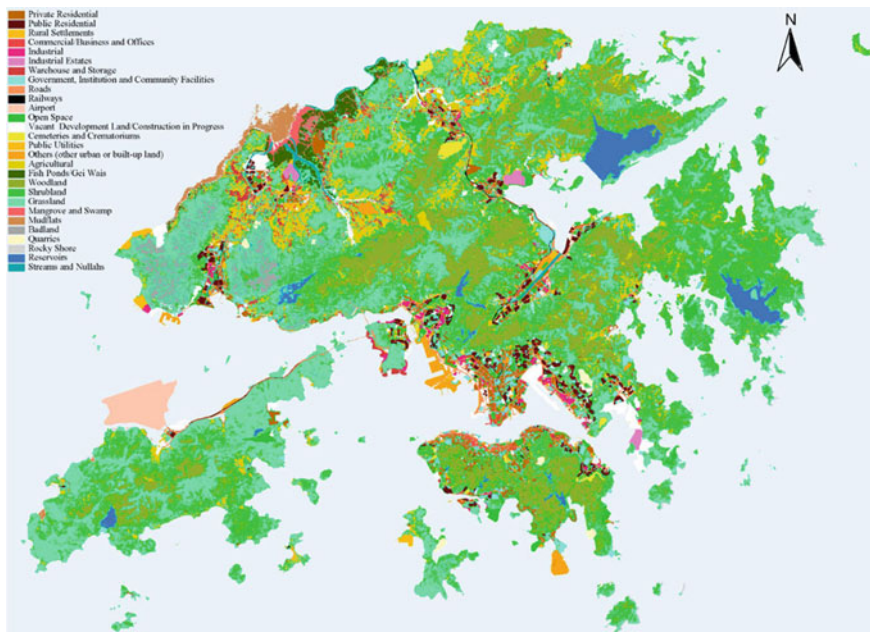
Fig. 6.1 Land use pattern in Hong Kong, 2014 (*Source* Hong Kong Planning department)

and establish itself as an important trading hub between Europe and the emerging Asian markets. The shift to a financial and logistics hub in the past half-century has resulted in technological developments in relation to urban form, transportation networks, quality of life and governance. Since the handover in 1997, the city has also become special for the people of Hong Kong with a new sense of identity and a strong sense of community emerging.

Currently, with a growing economy and established finance, commerce and logistics industries, the Government is beginning to develop more interest in improving other aspects of society and the environment through the adoption of technology and sustainability initiatives. Existing smart growth planning in the latter half of the twentieth century paved the way for an extremely accessible and efficient transportation network utilizing railways as the core mode of the network, complemented with a strategically planned transit-oriented development (TOD) with higher-density station-related developments. In addition, the importance of Hong Kong as a finance and logistics hub facilitated the need for a well-connected and high-speed telecommunications network, which has become advantageous in supporting the population in becoming tech-savvy individuals.

With these essential foundations in place, the Government is currently tackling other measures such as enhancing the quality of public spaces, encouraging Smart City initiatives and technology integration and adopting environmental sustainability targets to reduce energy consumption and improve the air quality [3]. The Smart City concept is well suited to approach the Government's economic, social and environmental objectives that benefits from Hong Kong's advantageous position as a dense, fast-paced, highly connected city inhabited by hardworking, tech-savvy citizens eager to utilize technology to improve their quality of life. Hong Kong's successful economy, efficient transportation system and high broadband penetration will further enhance its productivity, mobility, growth and sustainability with the adoption and integration of Smart City initiatives into new and existing city infrastructure and urban developments.

6.2 Hong Kong's Population Growth and Urbanization

Throughout the twentieth century, Hong Kong has undergone rapid industry transition and population growth. Influenced by the trade and business activities of Colonial Britain and the opening up of trade with China in the latter half of the century, economic growth brought many migrants to the city [4] and increased fertility rates, leading to consistent population growth during the twentieth century. At the beginning of the century, Hong Kong had a population of 460,000 in 1911, which grew to 840,000 million in 1931 and increased to 1,800,000 at the end of the war in 1947 as people returned to the territory [5]. Detailed data on population changes as well as other indicators only became available from 1960 onwards, and as a result, the data in this chapter will focus on the period post-1960. In 1961, Hong Kong had a population of 3,168,100 people [6]. The population increased to 4.04 million in 1971,
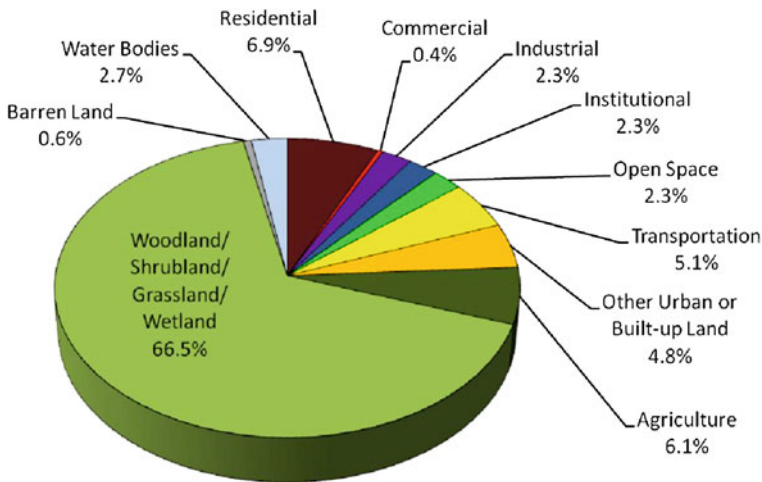
Fig. 6.2 Land uses in Hong Kong (*Source* Hong Kong Lands Department, June 2011)

5.75 million in 1991 and grew further to over seven million people at 7.07 million in 2011. At the end of 2015, the population stood at 7.324 million people. Population growth has been slow in the last 20 years, as annual population growth over the last 25 years was about 1 % per year between 1989 and 2014, compared to an average annual population growth of 2.4 % from 1960 to 1985.

As a result of the comparatively small land area and strict measures to protect country parks, only around 25 % of Hong Kong's land is dedicated to urban development including an urban core and new towns, with 40 % devoted to country parks and an efficient transportation infrastructure (Fig. 6.2).

This has led to Hong Kong having a high and increasing population density as the population increases over time. Moreover, due to the efforts to preserve country parks, new developments are prevented from being developed on country park land through rezoning, and hence, developers are encouraged to build upwards and increase densities within the existing urban area to meet growing demand for housing, retail and office spaces. Hong Kong also has significant experience with land reclamation, expanding its land area by reclaiming land on the harbour edges and ocean coastline adjacent to major population centres for new town development [7]. The population of Hong Kong is considered to be 100 % urban, reiterating the importance and benefits that Smart City initiatives would have on the city (Fig. 6.3).

6.3 Hong Kong's Transition to a Finance Centre

During the mid-to-late 1900s, Hong Kong was able to grow its industrial manufacturing base and establish itself as an important trading hub between Europe and the emerging Asian markets. In the 1970s and 1980s, Hong Kong's standard of
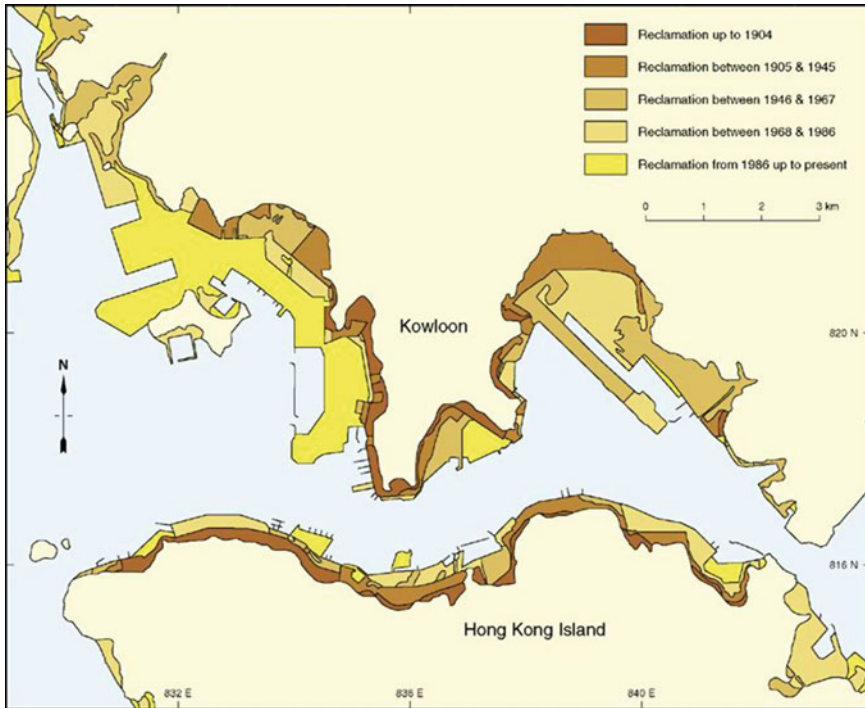
Fig. 6.3 Map of reclamation areas in central Hong Kong (*Source* CEDD, Government of Hong Kong)

living was on the rise, increasing life expectancy, literacy rates, per capita incomes and other socio-economic factors attest to its economic growth under the British rule. Consequently, as China's economy gradually became more open, and with rising salaries in Hong Kong, much of Hong Kong's manufacturing base relocated to Mainland China. This led to a shift in Hong Kong's focus towards becoming a commercial and tourism centre in the region.

Following the handover, in 1997, Hong Kong enjoyed certain autonomy under the "One Country Two Systems" structure, which allowed Hong Kong to retain its independence from China over areas such as governance, economy, social programmes and the media. Although beset by a period of uncertainty and pessimism regarding the return to Chinese rule, the Hong Kong economy overcame significant economic slowdowns in the early 2000s and 2007/2008, as well as disease outbreaks such as severe acute respiratory syndrome (SARS) in 2003 [8] and H1N1 influenza ("swine flu") in 2009 [9], to continue its economic growth and urban development throughout the first decade of the twenty-first century into the global commercial, financial centre, tourism and shipping hub it is today.

In 2014, Hong Kong had a GDP of HK$2144.6 trillion, which has been growing consistently since 1960 from HK$91.2 trillion [10]; further, an unemployment rate

of 3.3 % signifies a stable job market, which has been consistent for the past 5 years. Hong Kong's labour market is a knowledge-based economy with a focus on high value-added service industries, with 25.9 % of those employed working in the public administration, and social and personal services industry, 19.7 % employed in the financial and insurance, real estate, and professional and business services industry, and only 2.9 % employed in the information and communications industry in 2014 [11]. The second largest industry in terms of employment distribution is the import/export, wholesale and retail trades, which commanded a 24.1 % share of the total employment in 2014, propped up by Hong Kong's prominent trading and logistics industry as a result of its position as a gateway hub to Southern China. The manufacturing industry has been deteriorating since the late twentieth century, and in 2014, only 2.8 % of total employment was in the manufacturing industry.

6.4   Smart Growth Planning

The economic success of Hong Kong in the past half-century can be attributed to effective rural and city planning and policy making, especially in the realm of smart growth planning of urban areas and transportation infrastructure. Since the mid-twentieth century, strategic planning initiatives and smart growth principles have been implemented and pursued due to the size and density of Hong Kong's land and population.

In 1948, the Abercrombie Report, the first strategic plan for the territory of Hong Kong under the British Colony, addressed projects such as the Cross Harbour tunnel, land reclamation and New Town Development in order to resolve urban growth issues and improve connectivity between Hong Kong Island and the Mainland. Following this, the 1972 Ten-year Housing Programme and Initiation of Country Parks Programme facilitated a balanced approach to smart growth of both agglomerative development and nature conservation, leading to the formulation of planning standards and guidelines which set out more comprehensive territorial plans incorporating both economic and social considerations. Since 1887, Hong Kong has reclaimed a total of 69.47 km^2 of land, with the 48.58 km^2 of reclaimed land located in the New Territories, 13.42 km^2 of land reclaimed in Kowloon and 7.25 km^2 of land reclaimed on Hong Kong Island [12]. This strategy has enabled Hong Kong to expand its land supply for development while retaining significant portions of its land area for the preservation of Country Parks. Country Parks are popular and used extensively for leisure and recreation and to protect the natural habitats of many of Hong Kong's plant and animal species.

In the 1980s and 1990s, further strategic planning initiatives incorporating environmental considerations were adopted. The Territorial Development Strategy and its Review, developed in 1984 and 1996, respectively, have "explicitly forged a strategy for urban growth and conservation of rural and marine areas of high landscape and environmental value" [13]. This includes initiatives such as

environmental baseline and impact assessments, integrated land-use transport planning with railroads as the backbone of the public transit system and urban development, which promoted an "environmentally friendly, compact, hierarchical urban form with higher development density around rail stations" [14].

More recently, in 2007 the Hong Kong Development Bureau and Planning Department publicized "Hong Kong 2030: Planning Vision and Strategy", which prioritized social, environmental and economic sustainability. Further, an emphasis on smart growth and smart management of resources was adopted, facilitating the promotion of a quality living environment aimed at "strengthening local character and identity, respecting heritage and cultural characteristics, cherishing natural endowment, smart use of space and the built fabric, and encouraging the recycling of land and buildings" [15].

These are the essential foundations for the continued smart growth pattern and sustainable development of Hong Kong, on which Smart City technologies can be implemented and integrated into the smartly planned built environment. Hong Kong has successfully planned and implemented an urban growth and development strategy integrating transportation infrastructure with widespread New Town development. The areas of transport and urban development complement each other further through a focus on transit-oriented development (TOD) in bringing enhanced economic growth, productivity and competitiveness to a city and region.

Hong Kong is well known for its modern and highly efficient mass transit system with stops within easy reach of a majority of its citizens. A wide network of franchised bus and minibus routes, as well as a tram network, supplements the mass transit lines. Public transport interchanges are planned to accommodate inter-modal access. Hong Kong benefits from a sustainable overall modal split, with a relatively low percentage of daily trips undertaken by private transport, 25 % by rail and 55 % by bus and tram, while 8 % is by taxi. Less than 1 % is by walking [16].

Hong Kong has affordability schemes for sensitive groups such as the elderly and other eligible persons, who are entitled to a concessionary fare of $2 when riding any public transport mode in Hong Kong [17]. It also makes use of smartphone applications for public transportation, providing users with information on route planning, scheduling and notification systems.

One of the Hong Kong's greatest successes in transportation has been with its extensive and highly efficient Mass Transit Railway (MTR) subway system. In 2014, the MTR commanded a 48.1 % share of the franchised public transport market and boasts a 99.9 % on-time train delivery service rate [18]. The Government of Hong Kong has adopted a Rail Development Strategy that adopts railway as the backbone of the passenger transport system [19], greatly speeding up passenger flow and reducing the reliance on road-based transport.

By planning and constructing New Town developments along railway corridors and mixed-use developments surrounding MTR stations, ridership of railway services is increased, which reduces the need for private automobile travel. This approach simultaneously supports the viability of the MTR Corporation in providing high-quality coverage and service and limiting the environmental concerns of road-based polluting transport.

The Mass Transit Railway Corporation was set up by Government in 1975 to build and operate a mass transit system. In 2000, a renamed MTR Corporation Limited was listed on the Hong Kong Stock Exchange after an initial public offering, with the Government of Hong Kong maintaining ownership of 76 % of the shares [20]. Up until 2007, there were two companies in the business of running mass transit lines: the MTR Corporation running seven lines and the Kowloon-Canton Railway Corporation (KCR) which ran three lines and was wholly Government-owned. In October 2007, a merger was brokered between the two (valid for 50 years) to create a single network of mass transit for Hong Kong, simplifying ticketing, routing, management, etc. By now, the MTR is a profit-making company with large real estate holdings in Hong Kong and also running mass transit systems in Shenzhen, Beijing, Hangzhou, London, Stockholm, Melbourne and Sydney.

Almost all new developments in Hong Kong, both residential and commercial, are designed and built in regard to principles of mixed-use, transit-oriented and high-density development. Due to expensive land premiums and a shortage of housing supply, developers are focusing on high-dense, mixed-use and transit-oriented developments. These large-scale developments are typically designed with a large podium on the ground floor that occupies the first few floors of the structure. The podium level typically comprises of commercial and retail activities such as shopping malls, restaurants, cinemas and car parks, facilitating the TOD approach and lifestyle of the residents living in the residential towers above. This strategic approach to planning the urban environment of Hong Kong has resulted in a highly dense and compact city, with significantly accessible and mobile population as a consequence of a focus on sustainable and efficient rail transportation network combined with smart transit-oriented development.

This strategic smart growth planning has laid the foundations to effectively develop and implement a Smart City strategy that facilitates a sustainable, highly connected and environmentally aware population.

6.5 Integrated Land Use, Transport and Environment Planning

As mentioned in Sect. 6.4, the city has successfully developed an extensive and efficient urban transportation system with a focus on railway as the backbone for urban mobility. Core to this success is the integration of rail transit investments and urban developments, exploiting the economic and social benefits accrued by TOD that lead to increased ridership and additional revenues gained by the MTR Corporation (MTRC) from commercial and property developments. The MTRC operates on what it calls a "Rail+Property" model of development and finance, the key feature being the Government giving land rights above and adjacent to stations to the MTRC. A key design and development feature of the MTR station network is

the development of shopping malls, offices and residential developments in the vicinity of the stations, and because the MTRC owns the land these developments are built on, it is able to realize the incremental value that the railway itself has generated.

The MTRC realizes these potential economic, social and environmental benefits of TOD by focusing high-density living and commercial spaces around stations and allocating open spaces between urban development hubs that are used to support green zones and other forms of sustainable development. In addition, they aim to revitalize older areas and establish new centres of activities such as New Towns, and by creating synergy between the rail network and local communities, continuous patronage can be established. By integrating the transport operator and real estate developer roles into the same corporation, it enables the transport authority to fund new rail projects, extensions, upgrades, operation and management itself without the need for Government subsidies or cash injections. Therefore, in addition to fare and station advertising revenue, the MTRC earns revenue from the mixed-use, residential, commercial, office, hotel and entertainment developments it owns and manages around the MTR station. These property values are typically higher and expected to rise with closer proximity to transit stations due to the greater accessibility to public transport and other essential community services [21].

This continuously creates more and more value and revenue for the MTR, which can then choose where it wants to invest in next, between expanding rail service, improving current service or developing large-scale property and commercial developments, creating a cycle of more riders and more revenue. The MTR's fare revenue and passenger patronage have been consistently increasing on an annual basis for the past 5 years, with profits from property developments and commercial rents contributing to total operating profits, as shown in Fig. 1.4. Investment into this mechanism is proven highly successful in Hong Kong's densely populated context from a financial perspective and also generates highly sustainable and efficient integrated communities. Although over recent years with more emphasis on development, this has become more like "Development-Oriented Transit".

By prioritizing a rail-based public transportation strategy and mixed-use transit-oriented developments, it enables the population of Hong Kong to easily and seamlessly navigate the dense, vertical and congested urban fabric of the city, albeit with the support of a sometimes convoluted pedestrian footbridge and subway network. To maintain the efficiency and flow of vehicles on the surface, in more popular and congested parts of the city, there is a planned separation of pedestrians and vehicular traffic. On major thoroughfares and trunk roads, street-level crossings are replaced by overhead pedestrian bridges or underground pedestrian subways to ensure smooth flowing pedestrian and vehicular traffic. While this can be inconvenient for pedestrians simply wanting to cross the road, many of these footbridge and subways are interconnected to form a larger pedestrian network that also form connections to major buildings, shopping malls and even MTR stations. This aims to facilitate a safe, comfortable and weather-protected environment to meet the public's everyday needs within an integrated network of residential and commercial developments, without the need to drive or

own their own cars. However, with this strategy, the ground level vibrancy typically found in the older districts is lost in the new development areas.

6.6   Technological Innovations in Transportation

Dense land use and a large population have required Hong Kong's transportation system to be as efficient and extensive as possible. There are many aspects of the transportation network that are technologically advanced and utilize IT to enhance operational performance and customer experience. However, there are aspects that continue to lag behind other cities regarding sustainable active modes of transportation and full-scale real-time travel and arrival information. The MTR subway system utilizes many technologies that improve its operational efficiency as well as enhance the user experience for its customers: from computer-operated driverless trains and platform doors to real-time train arrival times and smart contactless fare payment system. One of the Hong Kong transport's biggest success stories is the Octopus card, a contactless stored value smart card that uses Radio-Frequency Identification technology, which allows users to store monetary value and make quick ticket fare payments at station turnstiles. The Octopus system was launched in September 1997 in joint collaboration with several public transportation companies in Hong Kong including commuter rail, bus and ferry services, and since then, its popularity and usage have grown tremendously, starting off with 3 million issue Octopus cards in the first three months to about 17 million Octopus cards in circulation in August 2008. As a result in 2008, more than 95 % of the Hong Kong population possessed at least one Octopus card [22]. Furthermore, the success of the Octopus card has translated into its usage in many other commercial transactions and aspects of life in Hong Kong. The Octopus card can be used to pay for items from convenience stores, supermarkets, vending machines, parking meters, car parks, fast food restaurants, other small monetary transactions such as charity donations and even for non-monetary identification purposes such as school attendance and access control to over 200 residential and commercial buildings [23]. This high penetration rate of smart card usage has enabled public transport users to more conveniently use public transport services by speeding up the boarding time of buses, trams and ferries and improving passenger congestion flows within MTR stations during peak periods. By enhancing efficiency, convenience and the quality of life for the majority of residents, the Octopus card has become an integral part of everyday life in Hong Kong, actively contributing to the Smart Living and technologically enabled element of a Smart City. The success of the Octopus has seen its model implemented in other major cities such as London and Dubai, with their respective Oyster and Noll cards [24].

Technological advancements to improve convenience, mobility and information dissemination have been implemented in the realm of road transportation as well. The use of intelligent transport systems (ITS) has been increasing in recent years, with innovations such as automatic Electronic Toll Collection systems, Journey

Time Indication System (JTIS), Speed Map Panels and car park space availability. ITS technologies and services can be substantial in improving the driving experience as well as increasing traffic efficiency and safety drastically and reducing environmental impacts. By providing drivers with more information, it presents them with the knowledge to make informed smarter decisions on their route choice, and technologies such as electronic toll collection and parking space availability information can substantially reduce their waiting times at tolls and time spent cruising for a free parking space.

These technologies will have greater benefits in enhancing the economic productivity of individuals and business of Hong Kong since their journey times can potentially be reduced with the help of greater information and data collection for effective traffic management. Furthermore, the Transport Department continuously collects data on road conditions through roadside monitoring stations and CCTV cameras that send this information back to a Transport Information Centre for enhanced traffic management capabilities. This information is also released to the public through mobile applications such as "e-transport", a point-to-point public transport route enquiry service [25], and "e-routing [26]", a point-to-point route search and real-time traffic information service, both useful for pre-trip planning.

In addition to technological enhancements in public transport, Hong Kong has been experiencing a boom in the number of electric vehicles on its roads. Electric vehicles can significantly reduce the amount of roadside air pollution and reduce greenhouse gas emissions. Hong Kong has been experiencing deteriorating air quality in recent years, and as a result, the Government has been promoting the use of zero emission vehicles and a green economy. As of the end of 2015, there were 4198 electric vehicles registered on the road, a substantial increase from 2010 when there were only around 100. Contributing to this growth in electric vehicles have been Government incentives to encourage consumers and businesses to purchase and use electric vehicles. The First Registration Tax for vehicles in Hong Kong is waived for electric vehicles until the end of March 2017, which then electric vehicles will be subject to the 100 % First Registration Tax imposed on all non-electric vehicles, and enterprises that procure and utilize electric vehicles are permitted 100 % profits tax deduction for the capital expenditure on their electric vehicles for the first year [27]. Furthermore, the Government set up a HK$300 million Pilot Green Transport Fund which has been active since March 2011 to facilitate transport operators and non-profit organizations to encourage their clients and goods vehicle owners to try out innovative green and low-carbon transport technologies.

Ultimately, the Government aims to have zero emissions buses operating across its entire territory, as buses in Hong Kong are a major source of roadside emissions and can negatively affect the pedestrians walking environment. To facilitate this policy objective, HK$180 million has been allocated to franchised bus companies to purchase 36 single-decker buses for trial runs in order to assess their operational efficiency and performance under local conditions. According to the Environmental Protection Department, five electric buses commenced operation by the end of

2015, and the remaining electric buses are expected to be rolled out throughout 2016 [27].

To support and encourage the increase in electric car usage, the number of electric vehicle chargers has been increasing, with currently about 1300 eV chargers available for public use. The chargers can be found over all 18 districts, predominantly within the car parks of all kinds of Government and commercial buildings, to ensure that drivers of electric vehicles have some peace of mind when needing to recharge their vehicle battery. Electric taxis are also being promoted, as the Government launched a pilot scheme enabling electric taxi suppliers to install quick chargers at car parks administered by the Transport Department.

However, the implementation of ICT, ITS and an efficient rapid mass transit system is not the sole measures for a smart transportation system, nor is it enough to ensure a fully sustainable and balanced city. Hong Kong lags behind other North American and European cities in its encouragement and infrastructure development of active transportation systems, namely cycling and walkability. Active transportation modes have numerous benefits in terms of health, happiness, quality of life and environmental protection [28].

6.7 Globally Connected Population

An important consideration and measure of the economy of a Smart City is how connected and technologically literate a city and its population are. A city that measures and collects data and information from its built environment, such as traffic conditions, pollution levels, water and electricity monitoring, can only fully realize its potential when the citizens are able to easily and effectively access, visualize and use the data to improve their everyday productivity and quality of life. This highlights the importance of big data being open data, and for this data to be convenient and straightforward to access and use, either through their own personal smartphones and computers, or displayed on LCD/LED monitors throughout the city at prominent locations.

Hong Kong boasts one of the most advanced and sophisticated telecommunications systems in the world, and its liberalized market with no foreign ownership encourages fair competition ensuring the best capacity, quality and price for consumers. Fixed broadband services in Hong Kong offer some of the fastest speeds in the world utilizing fibre optic networks with coverage to almost all commercial buildings and residential households. The city has a high broadband penetration with 83 % of households using broadband services and the highest average peak connection speed in the world at 87.7 Mbps (megabits per second [29]. Furthermore, the Government is promoting the provision of free city-wide public Wi-Fi hotspots across the 18 districts of Hong Kong, ranging from Government premises to public areas such as libraries, public parks, transport facilities and tourist attractions to name a few. The public and visitors to Hong Kong can access these hotspots completely free of charge or free for a limited amount of time, and

there are plans to extend the coverage further to include more public areas such as beaches and waterfront promenades [30].

Furthermore, at the end of 2015, Hong Kong had a mobile penetration rate of 228.5 % [31], indicating a highly technologically connected population that has the potential to utilize ICT and open data in the form of mobile applications and constant online connectivity. The deployment of 4G Long-Term Evolution (LTE) technology across all mobile networks in Hong Kong has enabled mobile service subscribers to benefit from increased data download speeds of around 300 mbps, allowing for faster and higher-quality video streaming and Web browsing while on the go. In addition, affordable mobile tariff rates facilitate this high mobile penetration, and in 2015, Hong Kong was ranked first in the world for the most affordable mobile tariff rates [32].

According to "The 10 Smartest Cities in Asia-Pacific" by Urban Business Media (UBM)'s Future Cities, Hong Kong is ranked first, based on "*smart mobility, smart people (21st century education, inclusive society, embrace creativity), smart economy (local and global interconnectedness, productivity, entrepreneurship and innovation); smart environment (green urban planning, green energy, green buildings); and smart governance (ICT and e-Government, transparency and open data, enabling supply and demand side policy)*" [33]. However, Hong Kong did not score so well for indicators regarding smart living (culturally vibrant and happy, safe and healthy).

According to Brand Hong Kong, Hong Kong achieves a high global ranking for IT infrastructure including, from the 2015 World Economic Forums Global Information Technology Report ranking second in International Internet Bandwidth, fourth in Asia under the Network Readiness Index and third in the world for 4G LTE mobile network coverage [34].

6.8   Collaborative Innovation Initiatives

In September 2015, the Hong Kong University of Science and Technology signed a framework agreement with Digital China to build a Smart City Research Institute, with the aim to facilitate the development of Smart City in Hong Kong and Mainland China. This will combine the academic rigour, research talents and facilities of top 20 world-leading universities, with China's largest integrated IT services provider offering comprehensive service capabilities and business coverage specializing in integrated Smart City services, ranging from framework design and planning, IT infrastructure implementation and Smart City operational services.

The Wise City Hong Kong Project, established in 2013, is a collaborative initiative between various stakeholders with interests in developing Hong Kong as a Smart City. Consisting of the Hong Kong Government, universities, businesses, engineering, environmental and Technology companies, and key city stakeholders, the project aims to investigate how increased cooperation and integration across city

functions such as transportation, buildings, water, waste and digitalization through innovative technologies can deliver added value to the citizens of Hong Kong.

The initiative and stakeholders identified 5 strategic axes that are believed to add value to Hong Kong and improve its Smart City status:

- Solid Waste Management
- Water Supply and Waste Water Management
- Mobility
- Building
- City Platform for Government and Citizens

Through collaborative workshops, symposiums and meetings with the Government, Wise City aims to establish a joint view on the current state of Hong Kong as a Smart City, to understand the challenges, programmes and priorities in regard to the 5 strategic themes, to investigate and create concrete recommendations and creative solutions for the sustainable and Smart City strategy.

6.9   Hong Kong's Future Positioning

As evidenced by the aforementioned details, Hong Kong has the foundations to build a highly technology enabled and integrated urban environment that efficiently utilizes the technological capabilities and convenience of Hong Kong's high smartphone penetration rate, broadband speeds and Wi-Fi coverage. This enables Hong Kong with the potential to adopt and take advantage of these infrastructures and facilities to develop a highly productive, knowledgeable and information-aware Smart Economy that maximizes the value created economically, socially and environmentally.

In his 2016 Policy Address, the Chief Executive of Hong Kong C.Y. Leung stated that the newly established Innovation and Technology Bureau (ITB) "*will, in collaboration with research institutions and public and private organizations, study the development of a 'smart city', which includes providing free Wi-Fi services at bus stops and shopping arcades, opening up more public data to facilitate development of user-friendly mobile applications (apps) for the public, and developing intelligent homes. The ITB will formulate a digital framework and standards for the development of a 'smart city'*" [35].

The chief executive stated in the Policy Address that the "*Hong Kong would expand the coverage of free Wi-Fi services by doubling the number of hotspots to 34,000 within three years to provide such services at all public rental housing (PRH) estates, public hospitals, markets, parks, sitting-out areas, promenades, tourist spots, public transport interchanges and land boundary control points*". Furthermore, Wi-Fi services would be provided in all youth centres and study rooms that are run by Government and NGOs, and the Government will work with schools to improve the quality of Wi-Fi services and to support e-learning.

Hong Kong is poised with the knowledge, capital, technology and talent to develop into a truly Smart City. There are many areas that Hong Kong excels at exhibiting Smart City characteristics, but also areas that Hong Kong performs poorly at when assessing it in relation to the indicators of the elements that make up a Smart City. These elements will be discussed in further detail in next chapter, and a more detailed description and assessment of Hong Kong as a Smart City is presented in Chaps. 3 and 4.

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Chapter 7
Smart City Concept and Framework

Sujata S. Govada, Widemar Spruijt and Timothy Rodgers

Abstract Existing Smart City models are briefly analysed and a different approach is proposed which places a central focus on People, Place and Planet by highlighting the importance of Smart Thinking, Smart Planning and Smart Design. Technology is seen as an enabling force to help develop smart and sustainable cities. The model uses six Elements (Smart Economy, Smart Governance, Smart Mobility, Smart Infrastructure, Smart Environment, and Smart Living) to categorise different smart city initiatives.

7.1 What Are Smart Cities?

Many cities around the world, both newly planned and existing, are taking the plunge towards adopting Smart City principles and integrating the use of information and communication technologies (ICT) with both hardware and software. As more than 50 % of the world's population now live in urban areas, cities are growing and continued growth at current levels of resource allocation will only place further strains on cities. The aim is that, through the use of technology for accurate real time monitoring, assessment and information dissemination, the productivity, efficiency and growth of city functions will be enhanced, making

S.S. Govada (✉)
School of Architecture, Chinese University of Hong Kong, Hong Kong, China
e-mail: sujata@udpcltd.com

S.S. Govada · W. Spruijt · T. Rodgers
Institute for Sustainable Urbanisation, UDP International, Hong Kong, China

better use of existing resources and leading to benefits for economic growth and quality of life. It is important to make all of the information collected about the city open and accessible to the public because this will facilitate the possible use of this "Big Data" about the city and its functions to make more informed and timely decisions in their daily lives, planning, management and operation. The Big Data should become "Open Data" to be shared and made easily accessible to everyone and is easy to monitor, which can be done through, for example, the use of smartphone applications or public LED screens.

7.2 Existing Smart City Concepts

There are many different definitions of what constitutes to being a "Smart City", many different frameworks and approaches to the product and process of building and becoming a smart city [1]. These range from solely focusing on technology as the tool in developing smart cities, to the only answer for smart cities, and to concepts of enhancing quality of life, a sharing economy, as well as transparency of data and governance, amongst others [2–4].

Our view of most current Smart City initiatives is that they rely too heavily on technology/ICT as the focus and ultimate factor in designing and constructing Smart Cities. While technology can clearly play a significant role to improve the efficiency and accessibility of certain city functions, such as e-governance, energy and water monitoring through the use of sensors, or real time public transit information with the help of GPS and mobile applications, these individual 'smart' initiatives divert attention away from the overarching characteristics that enable a city to be truly smart and sustainable.

One of the most prominent concepts and characterizations of Smart Cities was identified by Giffinger et al. [5] and developed further by Boyd Cohen in his Smart City Wheel [6]. Giffinger et al. identified six key elements that characterize a Smart City: Smart People; Smart Economy; Smart Environment; Smart Governance; Smart Living; and Smart Mobility. Boyd Cohen developed the Smart City Wheel in 2012, and by combining aspects and findings of Smart City research previously studied, the framework he constructed was one of the first to enable readers to easily understand what classifies as and comprises a Smart City. Different criteria and indicators define these Six Elements and facilitate comparisons between cities. Cohen's Smart City Wheel and other similar concepts are a good start in forming a holistic framework of city development, as Cohen includes and emphasizes the importance of all six Elements to the success of Smart Cities. It is considered, however, that a different approach would be required to develop an enhanced framework to more closely approximate the purpose of a Smart City (Fig. 7.1).
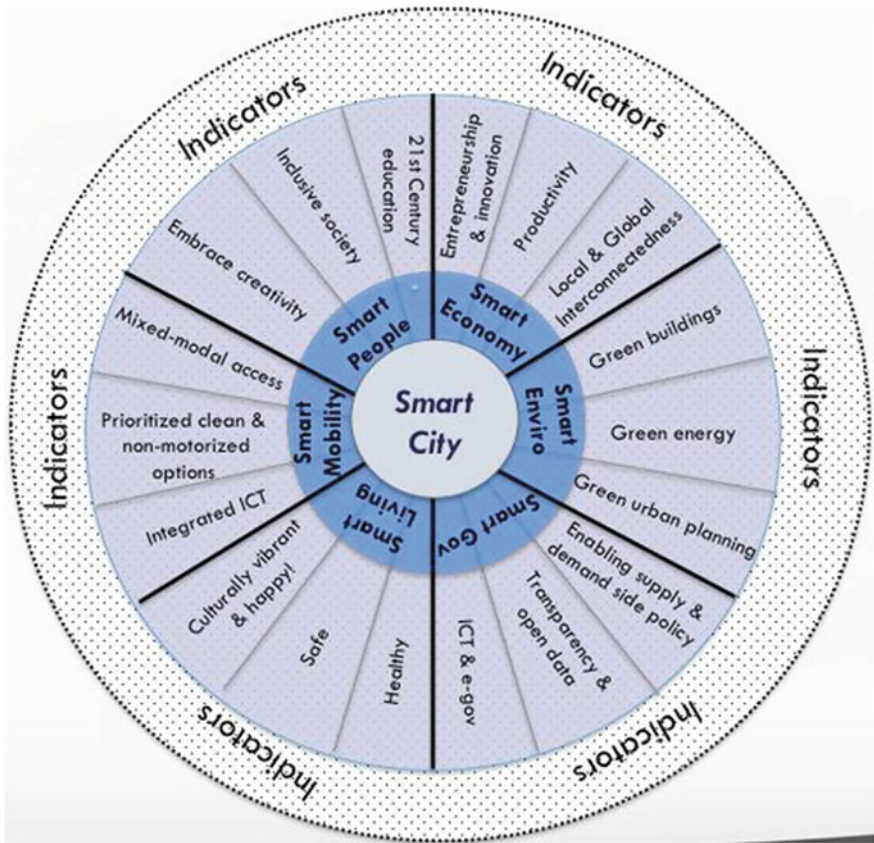
Fig. 7.1 Boyd Cohen's Smart City Wheel (Cohen 2012)

7.3 An Enhanced Smart City Framework - People, Place and Planet

After much consideration, we argue that by having the Smart City itself as a central focus an emphasis is unduly placed on the technological hardware that may make a city 'smart'. We believe that the Smart City framework should be further enhanced by focusing on People, Place and Planet while highlighting the importance of **Planning and Design** with '**Smart Thinking**' as central themes in developing successful and sustainable cities, i.e. Smart Cities. These themes combine with three core values '**Smart People**', '**Smart Place**', and '**Smart Planet**', to offer a holistic view of existing and future development. Like Cohen's model, there are six elements of city development, but "Smart People" is elevated to a higher level to signify its greater importance and contribution to developing truly smart cities. The values and indicators regarding Smart People remain the same, the only difference is its position and ranking within the Smart City Framework is heightened. An important new element, "Smart Infrastructure", is introduced following the

elevation of People as a core value thereby maintaining the six smart city elements as represented in Cohen's model. Smart Infrastructure comprises of the both physical (example road network, public realm, electricity, water, drainage, sensors etc.) and non-physical infrastructure (ICT, internet). Indicators that are able to evaluate and also encourage the planning, development, implementation of advanced both soft and hard infrastructure that support the vision of a smart city by ensuring a well-integrated and highly connected physical network and technologies for data collection and dissemination. This technological infrastructure must be well thought out, planned and designed, allowing for the efficient and ease of use while at the same time ensuring the safety and security of the data and information collected. Throughout the whole model, ever-advancing technology is viewed as an enabling factor to bring the potential of the elements to fruition, yet not the core factor that defines a Smart City, see Fig. 7.2.

Our model highlights our belief that technology is a tool and should not be the primary focus to steer city development. A badly planned and designed city that does not focus on the people, place and planet, yet which is technologically advanced and wired well cannot become a Smart City as the fundamental premise of the city is lost. The current global attention to Smart Cities in its tech-driven connotation is in danger of overshadowing good city planning concepts and models. The Smart City idea is being hailed as the modern way forward for any urban area, new or existing both in the developed and the developing world. But it is very important that it is based on
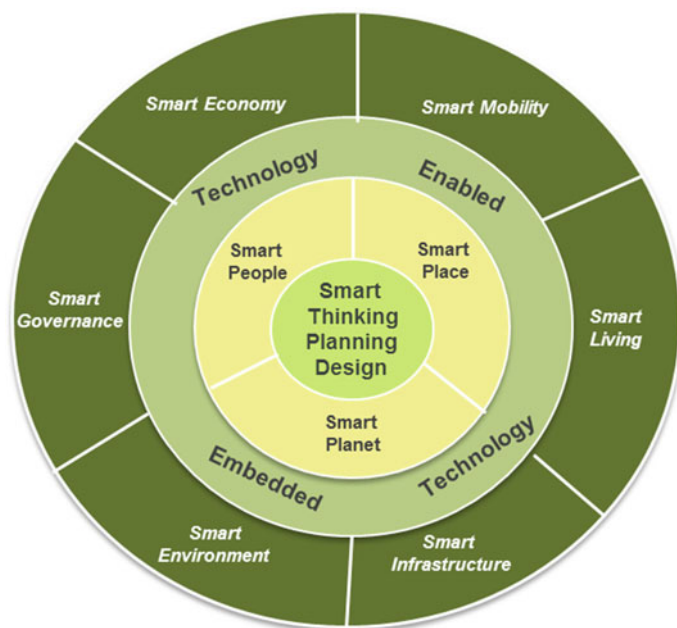
Fig. 7.2 Smart city framework wheel with People, Place and Planet as core values. *Source* ISU/UDP International

smart thinking with a focus on people, place and planet and technology enabled rather than being technology driven with little or no emphasis on sound planning and design principles. This new enhanced Smart City Framework attempts to point out that a truly sustainable urban environment depends much more on the more basic aspects of people, place and planet than on integrating the newest technological invention. Keeping the central focus on people, place and planet with Smart Thinking, Planning and Design, we argue, would enable a more comprehensive approach to our existing and future development of both urban and rural environments.

7.4   Smart Thinking

Certain fundamental aspects can decide the direction and trajectory of a city towards or away from truly smart status, and we believe that overall '**Smart Thinking'** of the city, with the people that constitute its authorities, businesses, organizations, institutions and its citizens, to be the foundation of the existing Smart City criterion. This 'Smart Thinking' refers to the preliminary **thoughts, ideas, visions and processes** of developing a Smart City and how the city, its people, its public and private sector, academia, professional and community organisations operate, manage and engage with the city.

The concept of Smart Thinking should be applied to all aspects and all stakeholders of the city, this includes individuals and groups with or with no connection to Government or the industries related to the smart city phenomenon. We are referring to the society as a whole, from individual citizens, small businesses to multinational corporations. In any decision or action, the way of thinking should reflect the principles and values of a sustainable community with a vision for a better future as stipulated by the principles and indicators that have come to characterize Smart Cities.

7.5   Design and Planning

Smart Thinking is incorporated in the design and planning of the city, as approaching broader issues of society, the built and the natural environment with the mindset of being "smart" will naturally lead to the decisions and for example, the city should be planned and designed in such a way so it:

– Ensures strategic positioning and vision planning
– Encourages sound planning and sustainable development
– Promotes good architecture, urban design and place making
– Encourages integrated mixed-use development and land uses
– New development that is sensitive to urban regeneration and heritage conservation

– Promotes non-motorized, active (walking and cycling), and public transportation
– Provides high quality public realm, with an open space network of parks, abundant public space and urban greening
– Promotes development that includes the human scale and liveable density sensitive to traditional character, city image and identity sensitive to existing urban fabric
– Promotes social awareness, economic viability, and environmental sustainability

By planning and designing urban areas within the context of the urban rural continuum in a sustainable, effective and efficient manner, it ensures environmentally sustainable urban and rural living environments. Good planning and design will allow cities to start at a more progressive baseline when it comes to developing Smart City characteristics and measures and reduces the reliance on technology for the wrong reasons. Studies have shown that the design of the built environment, such as decisions on land-use patterns and transportation networks, can influence the physical and mental health of its inhabitants [7]. Charles Montgomery has researched and written in-depth about how the right urban design of cities and urban places will impact our well-being in positive ways by enhancing the social interactions that take place [8]. These ideas have a place in the Smart City Framework as part of the Smart Living element, where quality of life, health and happiness and social cohesion are promoted. Furthermore, if principles of Smart City design and thought are instilled at the beginning and throughout the master planning and design, implementation and construction stages of new developments, it will be much easier to implement the technological infrastructure required to cultivate a 'smart' culture and environment in everyday life.

7.6   Smart People

The attitudes and behaviours of the people themselves in all walks of life can propel a city to Smart City status, or keep it lagging behind the rest of the competition. The people of the Smart City need to have **Smart Thinking** in order for them to be '**Smart People**' be it in the public, or private sector, professional, academia, community etc. This Smart Thinking should be in the form of a mind-set of environmental protection, sustainability and a healthy lifestyle, which encompasses aspects such as recycling, water and energy saving, preference for active or public transportation over private cars, and so on. The 'smartness' of a Smart City's people can have dominant effects on the adoption and utilization of the Smart City elements. Important in shaping these behaviours within citizens is to ensure that they are put first in Government decision making, enabling the public to participate and engage in public discussion, be consulted and collaborate with major Governmental and private infrastructure and development projects. Citizens should be educated and have sufficient knowledge and be aware of key social, economic, environmental

and technological issues, facilitating their inclusion into society and participation in public and civic life. Additionally, Smart Citizens should be able to embrace innovation, creativity, engagement with others, and be cosmopolitan and open-minded about public and social issues. Technology, data collection and monitoring can only achieve so much on their own. The ability of citizens to make use of, and benefit from, the extensive integrated ICT network and infrastructure depends on the user's engagement and utilization of these applications, which is equally important.

7.7 Smart Place

There can be many factors that influence the outcome and usage of a place or a city, and for a place to be attractive to people it typically needs to be accessible, well designed, and connected with provision of amenities for people that together produces a 'sense of place'. Therefore, a '**Smart Place**', must consider the core values 'Smart Thinking' and 'Smart People' in its design and planning process. The city should be planned, designed and built at the **human scale**. The urban environment can include medium to tall buildings but should ensure proper street level interface with sensitive design based on human metrics. Considerations such as the length of city blocks, density, intensity, land-use mix, with proper transportation planning, with public amenities, social services, institutions, and public space provisions should be planned in accordance to the **input, needs, aspirations and preferences of its people**; the pedestrians who enjoy the city experience, will walk the streets and residents and visitors have a higher quality of life within the Smart City. If the infrastructure and environment is built and designed with people and their needs in mind, they are more likely to engage in the types of Smart City activities and behaviours that have positive externalities and lead to a better quality of life, or 'Smart Living'.

7.8 Smart Planet

Once again, the approach of 'Smart Thinking' applies to the location of the Smart City, taking advantage and using efficiently and sustainability the lands natural resources. The consequences of environmental degradation and global warming need be understood, and mitigation measures should be developed and enforced where necessary to reduce the impact on the natural environment. A '**Smart Planet**' is one in which the **natural assets and the built environment work together** in harmony with resilience to complement and offset the negative impacts of urban development. The well-known mantra of "reduce, re-use, recycle" should be used as a basic starting point to structure public policy and initiatives. Environmental sustainability should become an integral part of the actions and

decision making process regarding all elements of the Smart City Wheel, and not confined to the realm of Smart Environment.

7.9 Technology Enabled, Embedded Technology

The four core values described above provide the planning and design foundations for the value of Smart City projects and initiatives to be realized. From this level, **technology should be embedded** into the planned and designed urban infrastructure of the 'Smart Place', allowing the 'Smart People' to be **technologically enabled** to use the digital data that is measured and monitored by integrated technology in all aspects of Smart City life. The aim is to ensure a well-organized ICT infrastructure, with appropriate levels of technology integration that is developed throughout the city. By establishing an integrated ICT network with a technological foundation of equipment such as sensors, GPS, information screens etc., combined with open data provision and a set of common evaluation metrics, all Smart City initiatives related to any of the 6 Smart City elements can be effectively and efficiently planned, implemented, managed and monitored through the integrated ICT infrastructure by people, companies and authorities involved.

7.10 Six Smart City Elements

Once the fundamental values of what we believe constitute a Smart City have been considered, assessed and implemented to the highest possible degree, the remaining six elements of a Smart City should be incorporated and exist as branches complementing the Smart People, Smart Place, and Smart Planet as core values.

As noted earlier, we decided that 'Smart People' was more important than to be just one of the six Smart City elements, therefore we elevated it to an inner circle on the Smart City framework wheel. Smart People is a core value that provides the foundations for the facilitation and success of the following 6 elements, which now also includes a new element 'Smart Infrastructure', these are outlined below:

7.10.1 Smart Living

Smart Living encompasses all aspects of human life that have an influence on the quality of life. Smart Living should aim to provide the maximum quality of life possible, with a priority placed on the people. A smart city that exhibits Smart Living characteristics should foster an inclusive society and social cohesion amongst all members of society. No one person or group of people should be feel excluded or discriminated against in any way, as social equity and equality are of

important consideration. A Smart Living environment must also ensure the safety and security of its citizens and the urban environment. The public should not have to fear for their safety at any time of the day and night, and should feel protected by the authorities that are responsible for safeguarding the city. A healthy and liveable environment as well as quality educational facilities is also a key indicator of Smart Living in a smart city, as these will influence the general population and future generations. Aside from accessible and affordable healthcare and education, there should be adequate provision of quality public spaces such as parks, streets and plazas etc., with abundant green spaces and greening. Similarly, the urban life in the city should cultivate a civic culture between the public and Government, where citizens express characteristics of pride in their nation, freedom of speech, value in public participation in the decision making process and to be treated fairly by authorities. Furthermore, a Smart Living environment implies there exists the provision of affordable quality housing, so everyone no matter of status or income have a minimum standard of living that they can afford themselves.

7.10.2   Smart Governance

Smart Governance refers to the characteristics exhibited and services offered by the Government of a smart city. These include transparency and inclusiveness to ensure that all people can participate in the shaping of their society in an equal manner. Public services are provided in a clear and efficient manner, using e-governance as an integral tool. Public policy should be developed, utilizing the collective knowledge and experience of all relevant stakeholders, to improve the city for all residents and workers. These policies should be implemented by effective public leadership for effective city management, to inspire towards positive change, ensure equitable policy implementation and to ensure quick problem resolution.

E-governance is integral to Smart Governance and should aim to provide adequate and appropriate public services of the highest possible quality and to ensure that services are offered to all the people in an efficient manner. Smart Governance also involves the provision of certain services to enhance efficiency of public services as well as the transparency of Government decisions and information, which can be achieved through integrated and accessible e-governance.

7.10.3   Smart Mobility

Smart Mobility concerns the sustainable movement of people. Cities are by nature hives of activity and this activity should be encouraged to be as sustainable as practical. The most sustainable modes of transport are walking and bicycling and these should form the basis for most movements. Given the large numbers of people moving about an urban environment, mass transit and other forms of public

transportation are key ingredients of smart mobility. Public transportation can readily be integrated with specific ICT services such as smart provision of information on schedules, routing etc., and real time tracking of public transport modes. A certain amount of private travel is inevitable but smart mobility should discourage inefficient modes of transport, in particular motorized vehicles. Zero-carbon forms of transportation, such as electric cars, taxis and buses, should also be encouraged to reduce roadside emissions and improve the pedestrian walking environment. Freight travel can be regulated in smart ways to avoid excessive road side air and noise pollution. All of the above is not possible without smart city planning that gives a central role to mass transit, walking and, where possible, bicycling. Pedestrian and Transit Oriented Developments could be a way forward as development model. Smart mobility also ensures that the city has high levels of accessibility on local, regional and international scale levels.

7.10.4   Smart Economy

Smart Economy concerns an open, transparent, varied economy that adds value to the smart city. Characteristics include diverse employment opportunities with labour market flexibility, diversification promoting entrepreneurship and innovation as well as more productivity through local, regional and global interconnectedness. These characteristics A smart economy embodies a high level of competitiveness globally as well as locally, and is well-connected to the global economy. A Smart Economy will facilitate an efficient and effective business environment, one that promotes and encourages innovation regardless of the outcome. It will also ensure a stable employment market with the resources and ability to adapt and transform if needed. A Smart Economy guarantees the economic success and growth of a city, as well as the livelihood of its citizens. As such it should be a focus of any Government to be forward thinking, innovative and with a global outreach with regards to economic policies in order to remain attractive and competitive in the global economy.

7.10.5   Smart Environment

Smart Environment encompasses concepts of sustainable development concerning the natural environment in the city. A smart environment implements smart resource management for public open space, in which ecology and biodiversity should play an important role as a balance to the urban city and to provide a stimulating milieu for people to live, work and spend leisure time. Open spaces should be plentiful and abundant in greenery, as these spaces provide a place for social interactions and leisure activities, facilitating an inclusive and cohesive society that will provide physical, psychological and social health benefits for

individuals and communities. A smart environment also encompasses the built environment, promoting and encouraging Green Building designs and sustainable neighbourhoods that implement energy saving techniques, utilize sustainable materials, and manage waste, water and electricity usage efficiently can influence behavioural changes and significant energy savings. The Government of a smart environment should also substantially advocate for environmental protection and play a leading role in educating the public of the dangers of unsustainable living, and also in introducing policies and regulations to safeguard the natural environment from excessive development or detrimental emissions, such as pollution control and management.

7.10.6   Smart Infrastructure

Smart Infrastructure comprises physical elements (road network, public realm, utilities, sensors, meters etc.) as well as non-physical infrastructure (ICT, internet). Both the physical and non-physical infrastructure are connected to one another and integrated with a software application that enables the communication and transfer of data to assist the efficient management of resources. Smart Infrastructure enables smart resource management for water, energy and waste through smart grids, sensors, and sustainable monitoring and usage of public utilities. Smart applications provide transparent data management for the public, business, organizations and government. By utilizing the advantages of the Internet of Things (IoT), the data and information acquired from the built environment and connected products should be able to be accessed by anyone through the Internet or smartphone applications. A smart city should also have Resiliency and Disaster Management systems and procedures to react in the case of an emergency, and also provide rigorous security from cyber-attacks.

The enhanced smart city framework proposed herein (starting with Smart Thinking with a focus on People, Place and Planet emphasizing the importance of Design and Planning, with the six elements of Smart Living, Smart Governance, Smart Mobility, Smart Economy, Smart Environment and Smart Infrastructure enabled by technology) provides a comprehensive approach to urban development. Using this new framework, cities can be assessed to see where they excel and areas where they need to improve so that cities can work towards becoming smart and sustainable. In the next chapter Hong Kong is assessed using this framework to see how it performs in the various elements and what Hong Kong can do to become a smarter and more sustainable place.

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Chapter 8
Assessing Hong Kong as a Smart City

Sujata S. Govada, Widemar Spruijt and Timothy Rodgers

Abstract The growth and development of Hong Kong from an industrial manufacturing centre into an international finance hub has advanced in many aspects of the society. The Government has encouraged and facilitated the advancement of the city's transportation, telecommunications and technology sectors through effective public policy, incentives and collaboration. This chapter identifies the areas that Hong Kong both excels in and lacks at with regard to the six Smart City elements established in Chap. 7. Hong Kong does well with certain aspects of Smart Mobility, Smart Economy and Smart Infrastructure but has room for improvement with most aspects of Smart Living, Smart Governance and Smart Environment.

Keywords Smart city · Mobility · Transportation · Telecommunications · Quality of life · Environmental sustainability · Smart economy · Urban development · E-governance

8.1 Introduction

As Hong Kong makes strides in growing as an international financial hub, the Government has taken initiatives in recent years to promote advancements and innovations in technology, telecommunications, transportation and the environment. While Hong Kong already exhibits many characteristics signifying its Smart City potential, there remains a great deal to be done in certain areas for Hong Kong to reach its Smart City potential.

The Hong Kong Legislative Council recognizes that there is no universally adopted definition of a Smart City. Rather, they observe two common features of a Smart City based on definitions adopted by different places and institutions. A 'Smart City' is one that:

S.S. Govada (✉)
School of Architecture, Chinese University of Hong Kong, Hong Kong, China
e-mail: sujata@udpcltd.com

S.S. Govada · W. Spruijt · T. Rodgers
Institute for Sustainable Urbanisation, UDP International, Hong Kong, China

1. 'Leverages on the information and communication technology (ICT) infrastructure and uses innovative solutions to address issues in one or more aspects of the city including governance, economy, mobility, environment, living and people;
2. Aims at improving the quality of life of the citizens and enhances the sustainable growth and competitiveness of the city through "smart" initiatives' [1].

Recognizing the importance of these two aspects in what constitutes a smart city forms the foundations for the decisions, in terms of investment, policies and development, that the Government will make or support in the future of Hong Kong is essential in facilitating an integrated and constructive approach to building a smart city.

While the Hong Kong Government recognizes that improving the quality of life of citizens is a top priority, the emphasis seems to be on the implementation of technologies and smart city initiatives, the same approach currently being adopted by many other countries and smart cities around the world.

High density and Smart Growth Planning has set Hong Kong up with the foundations to be able to take advantage of a compact, highly mobile and well-connected population and establish an effective ICT infrastructure that enhances the efficiency of public services and competitiveness of Hong Kong's business environment. As a result, Hong Kong exhibits 'smart' characteristics in the fields of transportation, telecommunications, the economy and governance [2]. Challenges remain, however, in these and other fields. In the sections below, a brief analysis is given how well Hong Kong is doing on the six identified elements of a Smart City, using a broad interpretation with the intention to offer a holistic analysis.

8.2 Smart Living

Smart Living refers to all issues related to the physical and mental well-being of the people living and working in the Smart City. These include quality of life, inclusive society, social cohesion, safety and security, healthy, liveable and affordable quality housing, educational facilities, public spaces (parks, streets, plazas, etc.) and civic culture. A person's quality of life is determined by a wide number of aspects, for example besides quality housing, employment opportunities, education, community and medical facilities, access to a clean environment, good government, mobility, civic culture, a transparent and inclusive society, a network of parks and public space, high-quality open space and ecological biodiversity.

Each person will have their own benchmark for what constitutes a good quality of life and to what extent the above-mentioned functions are necessary. A Smart City, then, comprises a wide range of these functions and facilities to cater to as many people as reasonably possible. No person can expect to live in a perfect world, but each person should expect a truly Smart City to offer choice and different options to achieve a good quality of life in a nurturing environment.

In terms of safety from physical harm Hong Kong does very well. In 2015, crime in Hong Kong fell to its lowest rate since 1979 [3]. A total of 66,439 crimes were

Table 8.1 Relative safety of Hong Kong

	Hong Kong	London	New York
Population	7,030,000	8,630,000	8,491,000
Robberies rate	3	251	199
Murder/homicide rate	0.30	1.24	4.15

reported, down from 67,740 in 2014, which represent a crime rate of 910 crimes per 100,000 people, or 0.9 %. Overall there were 223 reported robberies in 2015 (rate 3 per 100,000 people), including one with a fire arm and three with a 'pistol-like object'. There were 22 homicides (rate 0.3), down from 27 in 2014.

As methodologies to measure crime vary greatly city by city and therefore comparison between cities is unreliable. Even with this caveat, a brief comparison with other big cities shows that a person is relatively safer in Hong Kong from the types of crime listed above. For the same period in London a total of 21,705 robberies were reported (rate 251 per 100,000 people), and a 107 homicides were committed (rate 1.24) [4]. In 2015 in New York, there were a total of 16,931 robberies and 352 murders were recorded, both at historically low rates [5] (Table 8.1).

Although a person is relatively safe in Hong Kong from the types of crime listed above, a person can be subjected to a number of other factors that adversely impact a person's well-being. In a dense city such as Hong Kong, there are many pollution sources that may affect people's quality of life. Air pollution, noise pollution and light pollution are, in some respects, inevitable in a dense urban environment. In some instances, illumination and sound are even desirable, for example those used for the city skyline. However, Hong Kong lacks comprehensive regulation to control these sources of potential nuisance, in particular with regards to local sources. There are, however, also external and regional factors involving cross-border issues that may be more difficult to address.

The urban planning process in Hong Kong includes measures to control and maximize air ventilation, which plays a role in 'flushing out' airborne pollutants. A number of airborne pollutants are consistently higher than WHO standards, with PM2.5 and sulphur dioxide among the pollutants raising concern [6]. Section 8.5 elaborates on sources of air pollution.

A person's well-being in terms of physical health will have a positive impact on their mental health. The reverse is also true, which is why it is important that a smart society spends adequate effort on social cohesion, civic culture, adequate affordable housing for all income groups, green open space, etc. [7].

With an ageing population, Hong Kong Government is just beginning to address the needs of the elderly with an aim to provide appropriate housing and health care for the elderly but a lot more needs to be done. Another factor is the population, which is per 2015 census is 7.3 million and due to a low birth rate may actually shrink, that may lead to opportunities to provide more space per person as the current standards for living space and open space are rather low compared to regional or international standards. Since the handover in 1997, the people of Hong Kong have a higher sense of ownership and are actively involved in the planning

process. There is also an increase of visitors from Mainland China, and although beneficial in some ways this also puts a strain on the city's resources. What exactly will happen after 2047 when Hong Kong is set to become a part of the People's Republic of China and the implications this will have on the city is not even under discussion as yet.

8.3   Smart Governance

Smart Governance is arguably the most important element of a Smart City since the content of a public policy, or the lack thereof, will have a leading role in whether a particular issue is tackled 'smartly' or not. Smart Governance includes a common vision, public participation; public services, transparency; access to information; public–private and community partnerships; e-governance; proactive public policy and effective leadership.

Hong Kong can be credited with a high level of availability of information, transparency, access to information and public services. The different Government Bureaus and Departments are relatively accessible and offer a wealth of information in both Chinese and English (with consultation documents also offering other languages) both in paper and online.

Essential functions such as visa applications, birth registration, police inquiries, planning inquiries, business registration and other issues that are the responsibility of a single department are, on the whole, swiftly dealt with. Forms can easily be downloaded online, and many matters can be submitted online.

Public participation is possible through different avenues. Most policy initiatives or project development come with a multiple-stage public consultation exercise that ordinarily takes more than a year to complete. People are given ample time and opportunity to let their opinion heard, online as well as in person. There is limited recourse, however, for unpopular decisions once the consultation is finished. If the decision-making body is the Legislative Council, then political consequence could be expected at the next election except for those members who are appointed by the chief executive. Of the 70 seats in the Hong Kong Legislative Council, 35 people are directly elected and represent a geographic constituency, while the other half represent a 'functional constituency' and are elected by a select number of people representing those functional constituencies, for example members of professional institutes.

Other decisions, however, are made by the Departments themselves or the Town Planning Board, whose members are appointed by the Government. The ultimate decision-maker is, of course, the Chief Executive of the Hong Kong Administrative Region, but for the moment the person for this function is elected by a 1,200-member Election Committee, consisting of individuals and special interest groups that are 'broadly representative' (according to the Basic Law) of Hong Kong. In 2012 the current Chief Executive, Mr. C.Y. Leung, was duly elected with a total of 689 votes [8]. The Chief Secretary for Administration was tasked with developing an election reform package, but this proposal was voted down in the Legislative Council, in June 2015 [9].

Although there is ample public participation in Hong Kong, the connection between public input and eventual decision is not always clear. There is a perception that, whatever the public input, the eventual decision will be taken in favour of big developers or other private interests. The set of parameters on which decisions are made are not well established. However, public participation is part of the planning process, but included more recently after the handover in 1997, the process is still evolving and will take time to mature, as is the case in other cities across the world. There is a lack of policy documents that give strategic guidance to Bureaus and Departments on how to integrate the various relevant sectors of society in individual projects. Apart from broad-brush visions most planning decisions, for example, are made on the basis of an extremely detailed zoning plan. Individual projects are developed to fit in the zoning plan without a requirement to fully consider more strategic goals or objectives in terms of how an individual site is integrated within the district and its surrounding context. So although Hong Kong is open in its public participation processes, the decision-making processes are less open.

Good examples of the community and civil society influencing and shaping the city are the Heritage Policy and Harbourfront Planning. The current Harbourfront Commission was initially set up more than 10 years ago as the Harbourfront Committee by the current Chief Secretary after listening to Citizen Envisioning @ Harbour, a group formed by sixteen organizations to ensure that harbourfront planning is undertaken in a collaborative manner rather than going to courts for issues related to reclamation. The protection of the Harbour Ordinance was formulated after a Society for the Protection of the Harbour advocated against further reclamation. The current heritage policy was a result of citizen involvement after the demolition of the Star Ferry and also continued unhappiness with some of the urban redevelopment projects undertaken by the Urban Renewal Authority (URA). The URA was also formed as a result of several complaints by the people about the urban redevelopment projects undertaken by the previous Land Development Corporation.

Hong Kong is known as an 'open economy' and utilization of a 'hands-off' policy that tends to be reactive, but what Hong Kong needs is a proactive public policy. Arguments can be made, however, that the Hong Kong society is more hands-on than it would appear [10]. There is policy and regulations that govern virtually all areas of society. The question is whether public policy is developed and implemented with the main values of a smart city as the central focus.

Public policy in Hong Kong is in first instance formed by the annual Policy Address by the Chief Executive, delivered most recently on 13 January 2016. In the Policy Address, the CE sets out his vision for Hong Kong and prioritizes initiatives.

Irrespective of the positive elements of the Policy Address, there is a lack of policy to proactively implement a focus on People, Place and Planet and use smart thinking and principles of sustainable development:

- There is no requirement to monitor water usage. As a result, many office buildings or public bathrooms still have lavatories that flush continuously.
- There is no public policy to make recycling of materials an everyday part of life, resulting in one of the lowest recycling rates in the developed world, as well a relatively high waste production [11].

- Affordable housing is in the form of public housing primarily rental housing at subsidized tares providing affordable housing to about 50 % of the population, but there is every little public housing on an ownership basis that is affordable. Most often public housing is used as a driver for new town development with massive amounts in Tin Shui Wai being dubbed at the 'City of Sorrow' with an unusually high rate of suicides.
- There is no public policy to include affordable housing in urban redevelopment schemes by the URA or private developers or transit-oriented development by the MTR. As a result low-cost housing in older buildings at redevelopment sites is being replaced by high-end luxury and upmarket housing, pushing the low-income households to the outer areas of Hong Kong, which increases the time and money they have to spend on transport. Over time this also decreases the heterogeneity of the city in terms of income which increases social segregation.
- There is no effective pension fund, which means that anyone who does not own the house they live in has to seek additional income to pay for rent, including heavily subsidized public housing. A greying population and delayed delivery of new public housing will exacerbate this issue.
- Hong Kong has a world-class mass transit system operated by the MTR, and more than 95 % of the city is accessible by transit. There is multi-modal transit system with Public Transport Interchanges typically at MTR stations.
- Although there is relatively low car ownership and usage, there is no public policy to decrease motorized traffic in the inner urban areas where most pedestrians move around. As a result, pedestrians in these central areas often have to deal with overcrowded sidewalks, circuitous routes and exhaust fumes due to narrow sidewalks and traffic congestion on streets.
- It is common to see footbridges all over the city, especially after the successful footbridge network in Central initiated by the Hongkong Land, one of the larger developers in the city. However, extensive footbridge networks make the ground-level sterile and these come in all shapes and sizes, resulting in the good, the bad and the ugly examples that are to be found throughout the city.
- The Mid-Levels escalator system provides useful connectivity up and down the steep slopes of Hong Kong Island. Although its design is not great, it is very functional with its interface with the street level at several locations. This has influenced the sensitive urban regeneration of the SOHO area, but in some cases the resulting quality of public open space has been compromised.

The Government launches many initiatives to 'encourage' certain policies, but without a clear recourse those policies may remain as good intentions and do not alter society in a meaningful way. 'The market' is compelled to provide justification for shareholders, and a wider public interest is thus often the victim of a hands-off approach to governance.

Smart Governance operates in a structure that facilitates efficient planning and implementation but a strong and effective leadership is the key. The current Government structure (Fig. 8.1) includes a Chief Secretary for Administration as the second in command and 15 secretaries who head up the different Bureaus. These
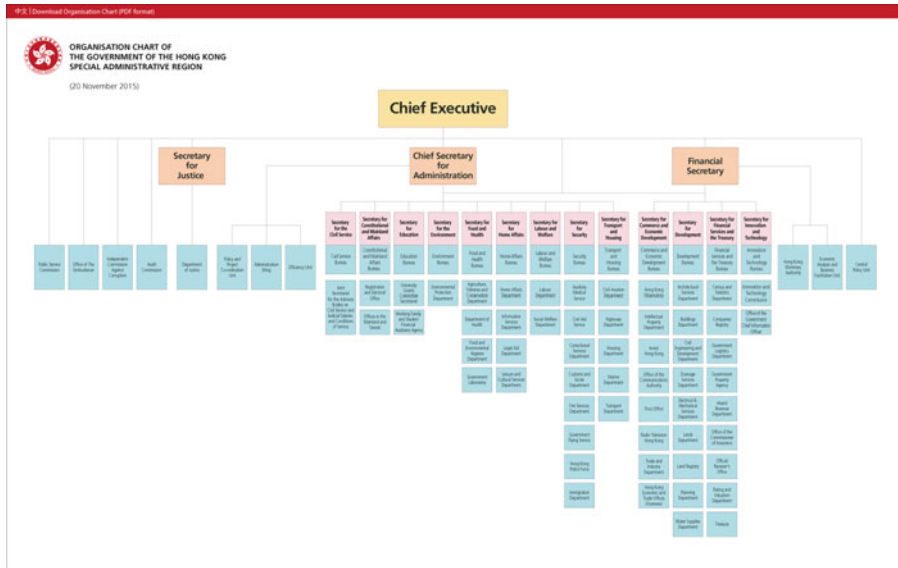
Fig. 8.1 Organization chart of the Hong Kong special administrative region (SAR)

Bureaus develop policy, while a number of Departments are tasked with implementing the policy. Figure 8.1 indicates which Department falls under which Bureau.

Any urban project or topic is a complex undertaking and therefore multiple Bureaus and Departments will be involved. As with almost all big organizations, however, communication and coordination is much less effective horizontally between the different 'silos' than vertically within them. People up and down the organization are in first instance inclined to maximize their own remit and topic, even if their mission might call for cross-coordination to optimize the outcome. 'Silo-thinking' is a common and well-researched phenomenon that hinders efficient delivery of complex projects and stifles quality. It takes very effective leadership to cut through the silo-thinking and make sure the different departments work in synch with each other towards a common goal. In Hong Kong, there is need for more evidence that this kind of leadership is taking place to promote organized and structured decision-making.

The Chief Executive of the Hong Kong Special Administrative Region has a function similar to a head of state. The function is to represent Hong Kong in discussions with the Mainland, abroad and to set broad policy directives. A smart city would, however, also have one person that primarily concerns his or herself with the implementation of that policy. Most cities have a Mayor, and this person usually has the authority and mandate to force different silos to work together. This coercion, however, requires a hands-on leadership style and active involvement in sometimes detailed project matters. The function of Chief Executive is clearly not suitable for this nitty-gritty departmental work. The function of Chief Secretary for

Administration is ideally placed to perform this duty, but, for whatever reason, there is little evidence of the effectiveness of this cross-functional role. More often than not, though, Bureaus and Departments are left to organize their plans, budgets and projects by themselves, which is usually inefficient in both time and money and resulting in a distinct lack of quality in the outcome.

City planning is an obvious channel through which the structure and content of public policy smart city objectives are or are not crystallized. A smart city adopts a comprehensive package of planning documents, ranging from a clear vision, a strategic plan to a more detailed set of plans. At each significant scale level (e.g. the city, a district and a neighbourhood), a smart plan would outline the most important elements and identify the various issues that inevitably are relevant at different scale levels. A smart city plan should neither be too vague (meaning that no development is legally bound by it and is therefore ignored) or too strict (meaning that any variation from the 'blueprint planning' requires a plan change), which is usually costly and time-consuming.

In order to implement public policy a development framework is required. In 2007, the Development Bureau and the Planning Department promulgated a document called 'Hong Kong 2030 Planning Vision and Strategy' [12]. This document included a comprehensive analysis of current development pressures and a strategic vision to steer development directions. Taken at face value it offers an overview of major projects the territory requires such as new MTR lines, new major roads and bridges, new New Towns to deal with population growth. The document does not, however, offer a strategic vision on district level. At a local level, planning decisions are legally only subject to the detailed Outline Zoning Plan, notwithstanding an urban design study that may have been done or required as part of the master plan development for a Comprehensive Development Area (CDA) zone. Strategic master plan-type plan documents are prepared for new towns in the New Territories or other CDAs but not for existing urban areas. The existing urban areas, however, are equally undergoing significant transformations and as such would benefit from a strategic spatial-functional and urban design plan.

This lack of plan-making between overall planning visions and extremely detailed Outline Zoning Plans (OZPs) which are often two dimensional often results in lengthy, and therefore costly, planning and design procedures. For a vertical city like Hong Kong this is not adequate, as eventual project realization will most often require a variation of the OZP. Such as rethink on the planning system would, however, not be possible without a fundamental rethink on land policy in Hong Kong. The Government is freehold owner of all land in Hong Kong (except one plot of land, which is occupied by St. John's Cathedral) and therefore has a direct interest in high land prices and profitable revenues from leaseholds. This model works well to create revenue for future rail projects, but it undermines the creating of an equitable urban society in which a wide variety of citizens as possible are included in urban regeneration and development.

8.4   Smart Mobility

Notwithstanding the wide usage of public transportation and low car ownership rate, Hong Kong has its share of problems associated with motorized traffic. The very reason mass transit can be so effective (high-density development on a relatively small land area) also means there is limited public space. The Government is able to determine how much of that public open space to dedicate to country parks, how much to urban parks, how much to roads and how much to pedestrian space, in addition to other public land uses.

Currently, the city suffers from a lack of public policy to curtail motorized traffic, and there needs to be a decrease in motorized traffic to enable reclaiming streets for people. The few cars that are in relation to the number of citizens are allowed to penetrate the most central of locations, to the detriment of pedestrian convenience. There were a total of 797,634 registered vehicles on the roads of Hong Kong at the end of 2015, with 567,886 of these registered as private vehicles [13]. Over the past 5 years, the number of private vehicles on the road has been growing, from 471,685 in 2011 to 567,688 in 2015. Moreover, the number of new vehicles registered each year is rising on an annual basis, from 44,567 new private vehicles registered in 2011 to 50,322 private vehicles in 2015 [14]. Currently, policies to reduce the demand for motorized traffic only exist in the form of a high 100 % First Registration Tax on new vehicles, fuel costs at just under US$2 per litre [15], the highest in the world, as well as a fuel tax of over US$6 per litre [16]. Further efforts to manage the number of private vehicles on the roads are much needed, especially during peak periods, to reduce traffic congestion and to improve roadside air quality for pedestrians and people living and working in close proximity to traffic. The Government is currently engaged in public consultation sessions regarding Electronic Road Pricing (ERP) in the Central Business District, which is a step in the right direction to managing road use, but will require extensive consideration and planning in order for it to be effectively implemented and successful in reducing congestion and to free up more road space for pedestrians.

In relation to motorized traffic, the promotion of electric vehicles by the Government is gaining traction and this will help to decrease roadside pollution. The Government increasingly recognizes the importance of alleviating the city's poor roadside air quality and encouraging a greener and more sustainable transport system. With support from the Government, the popularity of consumer electric vehicles is soaring with the development of more high-end luxury electric cars, combined with the policy to exempt electric vehicles from the 100 % First Registration Tax on all new electric vehicles up until 2017. In the first quarter of 2015, 2.3 % of total car registrations in Hong Kong were for electric vehicles, putting Hong Kong third in the world behind the Netherlands at 5.2 % electric vehicles and Norway, where 22.9 % of new car registrations were electric vehicles [17]. Although Hong Kong is doing well to promote the use of electric cars, the electricity used by the cars is generated in one of four power stations in Hong Kong: one coal-fired, one gas-fired, one diesel/gas-powered and one coal/gas-fired. The

electric cars are thus only 'zero emission' in terms of roadside pollution vehicles, and there is still much work to be done to improve roadside air quality, and ultimately tackle private car ownership and traffic congestion. It is encouraging, however, to see increasing support and incentive towards a transition away from carbon-emitting public and commercial vehicles. These include promoting the introduction of hybrid and electric franchised buses, and subsidies or tax breaks for businesses that procure and operate zero-emission vehicles as part of their fleet. Zero-emission public franchised buses and taxis, as well as clean emitting goods delivery vehicles, have the potential to drastically improve the quality of the roadside environment for pedestrians.

Ultimately, a sustainable transport system balances all modes including the promotion and facilitation of non-motorized forms of transport as part of a multi-modal transportation network. People do walk a lot in Hong Kong but in part by using public transport in very high percentages, but the walking experience is not very pleasant and often lacks in quality. Due to certain space limitations cycling is not prevalent within the urban area, and it is encouraged more in the New Territories. Due to Hong Kong's compact urban form, more cycle networks are being planned and implemented in the New Territories adding to the existing cycle networks. Also real-time information and GPS positioning of public transit vehicles such as buses are not currently widely available. Although, since 2014 the Kowloon Motor Bus Company (KMB), Hong Kong's largest bus company, has begun testing and introducing an 'Estimated Time of Arrival' feature for its bus routes. This feature can be accessed via their mobile phone app, website or TV screens at bus interchanges, and currently covers over 250 bus routes [18, 19].

Smart Cities should encourage sustainable modes of transport and more could be done in Hong Kong to enable cycling and walking. The two modes have different infrastructure requirements. Although cycling can have a multitude of benefits for society and the environment (zero emission, healthy lifestyle, etc.), the geography of Hong Kong does not offer a suitable environment for daily commuting by bicycle. Within the densely built-up urban areas there usually is not enough space to accommodate cycle lanes, and on mountainous terrain the roads are necessarily narrow and also cannot accommodate a viable cycling environment. In addition, the steepness of many roads and the subtropical climate pose obstacles for potential cyclists. In certain areas outside the dense urban areas cycling could be accommodated and the Government should actively encourage cycling. A viable cycling environment depends on secure storage at one's home (could be shared) and at one's work, as well as shower facilities at work, which are routinely included in office projects in cities such as London. Currently, cycling is predominantly considered for merely recreational purposes. To encourage cycling for more than just recreation, the Government should also make serious inroads on roadside pollution.

The mountainous geography and hot and humid climate also affect walking, but, in combination with public transportation, walking is a much more suitable mode of transport in Hong Kong for everyday travel because of the shorter distance, specifically regarding nitrogen dioxide levels in highly dense and populated commercial areas such as Central, Causeway Bay and Mong Kok [20]. In addition to the

lack of space and unfavourable climate, the local culture and social perception surrounding the use of cars as 'status symbols' and driving as a superior form of transportation have made it difficult to advocate for investment in cycling infrastructure and pro-cycling policies.

Many cities around the world have developed and implemented innovative bike-sharing schemes, including New York's Citibike system, London's 'Boris' bikes, and Montreal's Bixi system and Guangzhou's bike-share system along with its successful BRT system [21]. These bike-rental systems involve a similar concept and operational mode to allow the public to rent out bicycles for their own use, using a credit card to pay for a minimum of 24-h use, and up to unlimited use for a 7-day period. Bicycles can be rented from designated cycle docking stations around the city and can be returned to any other cycle docking station within that period of time. Additionally, mobile applications are developed to enable prospective users to easily find and hire a bike, as well as find the closest available docking stations to them and their destination location [22]. The provision of this option as an alternative mode of transport points towards visions of a healthier, more active population and a more sustainable urban way of life championed by city officials to encourage local non-bicycle owners and tourists to the city to commute and explore in a leisurely and environmentally friendly manner. Hong Kong is slowly introducing the concept of bike-sharing systems, with one system in place at the West Kowloon Cultural District Waterfront Park, and a proposed pilot scheme in Sha Tin [23]. However, the SmartBike scheme at the WKCD Waterfront Park is confined to the park and consists of a total of 80 bikes, a 1.8-km cycling trail, is not available 24/7 and is emphasized for recreational and leisure purposes only, severely restricting its potential [24]. Through proper planning and enhanced connectivity between the harbourfront and waterfront promenades, a more pleasant environment can be offered for walking, and the provision of cycle paths and bike-share stations along the waterfront can address the issue of the limited bike-sharing programme in the city.

As a result of the dense and mixed-use urban environment, as well as the presence of a well-developed public transportation network, Hong Kong has the potential to be very suitable for walking. As highlighted earlier, already a relatively very high percentage of homework trips is done by public transport, with walking on either end of the journey. For lunch and errands during the day people do not, on the whole, have to travel far, which stimulates walking.

Walkability, however, is a growing concern in Hong Kong. Dense congested areas of Hong Kong typically suffer from narrow pavements, walkways, obstructions, diversion railings and illegally extended shop fronts that further impede the heavy flow of pedestrianized traffic. When it comes to roads and streets, the Hong Kong Government maintains a high priority to vehicular traffic and emphasized the importance of separation between pedestrians and vehicles in the 2016 Policy Address [25]. These values lag behind the innovative policy and design directions found in cities in North America and Europe are taking, who are aiming to reverse this segregation of modes by promoting the idea of shared roads, also known as shared-space, in dense urban areas to encourage sustainable mixed modal usage and active non-motorized forms of transportation. Numerous cities have also taken

measures to pedestrianize streets where pedestrian traffic is most heavy and/or adopted policy to stimulate an increase in pedestrian traffic, as a way to decrease use of private cars and make inner urban areas pleasant places to be. Hong Kong has a few pedestrianized streets, but these do not form a comprehensive pedestrian network and thus lags behind other cities in prioritizing pedestrians over vehicles in urban areas.

Although separation of pedestrian and vehicular traffic is necessary in some cases, such as to traverse highways and trunk roads with higher levels of service and vehicle speeds, in the dense city centre and within compact walkable commercial areas allowing pedestrians to easily move around the street-level environment is key in cultivating a smart people-oriented urban environment with high local accessibility.

The Government of Hong Kong is continuing a policy of grade separation by advocating networks of elevated pedestrian footbridges and underground subway tunnels to connect urban developments and areas. Sometimes this is practical, for example where the city is built on a slope, or to connect different buildings that have public activity on upper levels, thereby keeping people out of the rain or searing sun. In Central, the CBD, an upper-level system of walkways offers a viable pedestrian environment, in addition to the pedestrian environment at street level.

Most of the time, however, the development of walkways and tunnels goes hand in hand with policies to prioritize the street level for motorized traffic, even in dense urban areas. The result is, in these cases, that pedestrians are forced to walk up and down along bridges and tunnels, which limits one's choice of route, more easily resulting in overcrowding, while vehicles have free reign at street level.

On the one hand, Hong Kong's compact and dense urban environment provides an ideal opportunity for pedestrian access and connections on multiple levels. While convenient in providing vehicle free accessibility to prominent buildings and commercial centres, navigating the vertical and horizontal dimensions of the networks can sometimes prove time inefficient when compared to a ground-level route alternative. The absence of a comprehensive bottom-up urban design and master planning approach has led to rather piecemeal pedestrian planning, where some networks are well connected internally, but lack convenient connectivity to other nearby overhead or underground pedestrian links. In addition, older existing walkways and subways suffer from equity issues, as they lack suitable infrastructure for the elderly and disabled who have difficulties climbing up and down staircases.

8.4.1 Smart Transport

The Hong Kong transportation sector utilizes integrated ICT services in the form of Intelligent Transportation Systems (ITS) to improve operational efficiency and service quality. These range from the use of stored value contactless smart cards to replace traditional tickets, Journey Time Information Systems (JTIS) for road transport users to estimate the time required to reach a certain district by taking

specific routes, automatic electric toll collection and real-time parking information systems [26]. Real-time arrival time information is currently available for the mass transit MTR subway system; however, real-time arrival and journey time information for road-based public transport such as franchised buses is lagging behind other global cities, but is in the conceptual development and trial phases on a few franchised bus routes. Real-time travel and arrival information for public transport systems can effectively help to improve ridership, as providing this information to commuters reduces the uncertainty involved with waiting for the bus, as well as the traffic congestion en route to the final destination, hence improving level of service and enhance the operation and management of the bus fleet [27] (Fig. 8.2).

Local, regional and international accessibility is well served in Hong Kong through its airports, via sea and land transport networks. Hong Kong citizens and businesses are connected to about 190 destinations around the world, including 50 in the Mainland, through Hong Kong International Airport's (HKIA) 1,100 daily flights and over 100 airlines. HKIA handled 68.5 million passengers and 4.38 million tonnes of air cargo in 2015, making it one of the busiest passenger airports in the world, and in 2014 was the busiest airport in the world for handling air cargo [28]. Moreover, since 1996 HKIA has held the position as busiest airport for international freight cargo, signifying Hong Kong's position as an essential international trading hub and gateway to China. To achieve this position, HKIA has maintained high standards of safety and security and undertaken innovative initiatives to enhance operational efficiency and effectiveness. As a result HKIA is a hub for eight major cargo operators, including Asia Airfreight Terminal Co Ltd., DHL Aviation (HK) Ltd., Hong Kong Air Cargo Terminals Ltd. and Cathay Pacific Services Ltd, whose collaboration is facilitated by a streamlined customs process

Fig. 8.2 ITS speed map panels in Hong Kong. *Source* Transport Department

that provides an integrated Electronic Data Interchange linkage between the eight major air cargo operators and the Customs and Excise Department [29].

Critical to the competitiveness of HKIA is its efficient, integrated and stream-lined processes that utilize innovative technologies to improve operational performance and customer satisfaction. In line with becoming a Smart City, HKIA was one of the first airports to implement a Radio Frequency Identification (RFID) system baggage handling to replace traditional barcode-only baggage tags. RFID technology allows the bag tag data to be stored in electronic tags and remotely received using radio waves. The benefits of RFID technology for baggage handling are improvements to bag tag read rate reliability, up from 80 % to a 97 % read rate, increase data capacity, and the ability to be read more quickly from a distance or at an angle [30]. Due to current capacity constraints of airport infrastructure, in March 2012 the Hong Kong Government approved the option to expand HKIA from a two-runway system to a three-runway system [31], and in May 2015 plans for the project were approved with the Lands Department issuing a Government Notice for the commencement of reclamation works for the third runway [32]. Current projections estimate that HKIA will reach its maximum practical capacity of hourly aircraft traffic movements (ATM) of 68 ATMs per hour at peak periods in either 2016 or 2017, indicating the need for increasing capacity to maintain competitiveness [33]. The provision of a third runway would significantly increase air traffic handling capabilities to an estimated 102 million passengers, 8.9 million tonnes of cargo and a total of 607,000 aircraft movements per year by 2030 [34].

Although controversial for its environmental impact on marine life due to the need for land reclamation, the economic contribution HKIA brings to Hong Kong outweighed the possibility of allowing HKIA to lose international competitiveness. HKIA is essential to Hong Kong's economic competitiveness in the global economy, as it supports Hong Kong's four economic pillars–trading and logistics, financial services, tourism, producer and professional services, which combined contributed 57.8 % of Hong Kong's GDP in 2013. Furthermore, the third runway is expected to bring economic benefits of HK$455 billion more than the two-runway system generates [35]. The third runway adds to the operational efficiency of HKIA, which is further enhanced with technological innovation.

With regard to ground transportation, Hong Kong is making moves to its regional connectivity and accessibility with the Pearl River Delta (PRD) region by constructing a high-speed rail link to connect to the Mainland's growing National High-Speed Rail Network linking Kowloon to Shenzhen and Guangzhou, and reducing the travel time to Guangzhou from over an hour and a half to 48 min [36]. Dubbed the Express Rail Link, high-speed railways utilize the most advanced technologies, newest composite materials, extensive technical expertise and enormous capital investment to provide an environmentally friendly railway service on dedicated tracks at speeds of up to, and in excess of 300 km/hour.

High-speed railways provide a viable alternative transportation option for travel of short to medium distances, as they are less prone to delays, less weather dependent, can carry more capacity, provide greater comfort and have the ability to

locate stations in closer proximity to city and the various urban centres within. The Express Rail Link between Hong Kong and cities in the PRD is expected to bring greater social and economic integration, development and cultural exchange between Hong Kong and the Mainland, as well as reducing the time and monetary cost of travel for passengers and freight, leading to increased productivity and economic spillovers elsewhere. This plan sounds ideal on paper, but in reality there exists a conflict between the Government and the public on the amount of resources dedicated to the project, and whether it is justified by the benefits felt by the people of Hong Kong.

There is opposition to the Express Rail Link due to its astronomical price and delays which have put the price at HK$85.3 billion as of latest estimates [37], Government funds that some believe could be used to improve the livelihood of Hong Kong residents. However, the Government continues to reiterate the importance to consider the long-term economic and social impacts the project will have on Hong Kong and the PRD region. These include HK$87 billion in economic benefits in 50 years, 42 million hours of saved travel time annually and 11,000 employment opportunities during construction [38].

By providing a new high-tech, low-emission alternate form of transportation to connect to cities on the Mainland, Hong Kong is expanding its public transportation network, continuing its focus on railway as the backbone of the system, and improving its global and regional interconnectedness. This indicates innovative forward thinking about the future of Hong Kong's economy and also its dedication to technological advancement and performance enhancements in the realm of transportation. With the Express Rail Link, Hong Kong is joining the small yet growing number of countries and cities developing and implementing a high-speed rail connection among large population centres to move the masses faster, more efficiently and more sustainably. For a city on water, Hong Kong has limited water connectivity, and not much besides the Star Ferry and the ferry services to the outlying islands. This is an area of growth, and Hong Kong could see more water transport in the form of water taxis in the near future.

8.5 Smart Economy

As mentioned previously, Hong Kong is a highly connected city, both physically and virtually. Well-connected air and rail routes combined with high broadband speeds and affordable mobile data communications provide a multitude of opportunities for employment, communication, productivity and information exchange. The position of Hong Kong as an international passenger and logistics hub, and gateway into China and much of Southeast Asia exemplifies the opportunities and access to a large diverse global talent pool, financial resources, suppliers and logistics providers that are vital to any business function within a first-world economy. However, over time Hong Kong's transition to a predominately service-based economy and dwindling industrial base, combined with high

operating costs including rent and wages, is beginning to hinder the creation and development of an environment conducive to innovation.

Hong Kong has an advantage as a location for entrepreneurship and business development, as it benefits from a pro-business environment, financial and technical support from the Government, a hard-working workforce and a leading network infrastructure, providing businesses and entrepreneurs with the resources and business climate to grow. In Hong Kong, the corporate tax rate is 16.5 % [39], signifying a pro-business approach from the Government, which may be seen as an incentive to work and earn income in Hong Kong. With a greater proportion of earnings retained after tax, it can encourage entrepreneurs to choose Hong Kong as a location for start-ups and small businesses.

In addition to business climate, the local and international transportation connections should make Hong Kong ideal for establishing a business with the vision to expand globally into new markets. Although Hong Kong continues to be a global leader in international passenger and air freight transportation, the city's competitiveness in the Southeast Asia region is being challenged by nearby growing global Asian cities such as Singapore and Shanghai, a booming Mainland aviation network, and the need for increased flight capacity at Hong Kong International Airport. The opening up of China's skies through the granting of an increasing number of beyond air traffic rights, such as fifth and sixth freedoms of air, to international airlines has greatly increased the competitiveness of international airports on the Mainland to compete with HKIA in providing international routes and layover points for global aviation operators [40]. For China, fifth freedoms of air signify an important step towards growing China's global aviation network connectivity. Fifth freedoms of air allow foreign commercial airline carriers to stop at Chinese airports and load or unload passengers or freight before continuing on to a final destination in another country. This development may cause a shift of international air routes originating and departing from Asian countries to choose a Mainland international airport as their point of transit instead of HKIA, for reasons that include lower airport operating costs on the Mainland and with excess supply in flight handling capacity at major airports, therefore increasing the pressure on HKIA to construct and begin operating the third runway system in a timely manner. On the other hand, complemented by a well-connected, high-tech professional economic environment, HKIA's global recognition as a trusted, efficient international passenger and cargo air hub may continue to anchor HKIA's leading position in the global air space.

Major infrastructure projects such as the Third Runway System, Express Rail Link, and in addition, the Hong Kong Macau Zhuhai Bridge, are evidence of the Government's support and push towards a long-term enhancement of social and economic integration with the Mainland, and especially the PRD region. Improving accessibility to the western region of the PRD via the construction of a 30-km dual three-lane carriageway bridge structure that also includes a 6.7 tunnel section is expected to have a positive impact on Hong Kong as the bridge reduces road-based travel time for passengers and goods to within a 3-h commuting radius. Whereas previously it would take around 4 h to reach Macau and Zhuhai from Hong Kong by road, the completion of the Hong Kong Macau Zhuhai Bridge will reduce this

travel time to 45 min [41], greatly improving accessibility and reducing transportation costs. The increased accessibility of Hong Kong is anticipated to benefit Hong Kong's tourism, finance and commercial sectors of Hong Kong's economy through increased business activity, and it aims to strengthen the city's position as a trade and logistics hub through the quicker and cheaper transportation of goods and passengers to Hong Kong's airport and container port. This requires increased cooperation and collaboration between Hong Kong and local Governments in the PRD region, reinforcing the Smart Economy values towards improved global competitiveness, local and international connectivity, as well as an expanding and diversifying the economy and labour market. These are hoped to have economic and productivity spillover effects, as Hong Kong is estimated to receive discounted total benefits of RMB 42.8 Billion for 20 years [42].

8.5.1   Entrepreneurship and Start-up Culture

In recent years there has been an increase in activity within the start-up business community, with many start-ups embracing the sharing economy culture that is spreading across western economies. In Hong Kong, the number of start-ups has grown rapidly to over 1,500 at the end of 2015, which was a 46 % increase from the previous year, and as a result only 5 of the top start-up ecosystems around the world are growing as fast as or faster than Hong Kong as of the start of 2016 [43]. This growth has been most distinct in the transportation, e-commerce, Internet of Things (IoT), and information and financial technology sectors. Hong Kong is strategically placed and possesses potentially more resources than the rest of the top 20 start-up ecosystems, a result of the city's close proximity to the Pearl River Delta manufacturing industries and highly developed international financial industry. Nevertheless, the start-up ecosystem in Hong Kong is in its early stages of development characterized by young founders, the majority of which are male, low ecosystem valuations, less impressive funding amounts, a talent gap and inexperienced start-up founders [44]. Other hurdles include losing young talent lured to the lucrative and traditional financial industry, as well as parents who are not convinced that entrepreneurship is a serious option for their children [45]. These challenges can be overcome as Hong Kong's start-up ecosystem develops, by capitalizing on its global market reach, attracting greater external investment and resources, and with an increase in the number of start-up 'exits', this will further affirm start-ups as a viable employment opportunity for youths deciding on their academic and/or career path. By further establishing the start-up scene, it will improve confidence in businesses and investors that investing in start-ups is a worthwhile investment opportunity, and individuals may not perceive start-ups with the same high-risk low-reward mentality as before.

One promising aspect of the development of a start-up ecosystem in Hong Kong is the both the political and financial support from the Government. The Government is keen to support start-up initiatives and events in Hong Kong, such

as the StartmeupHK Festival, and has committed HK$2 billion to the Innovation and Technology Venture Fund to boost innovation and technology and encourage private venture funds to invest in start-ups through a matching process [46]. Another HK$500 million was announced as part of the Innovation and Technology Fund for Better Living, in order to promote the advancement and financing of projects utilizing technology to improve the quality of life for citizens.

Start-ups rely on the hard-working, innovative, knowledge and information sharing of today's educated youth and experienced professionals. Vital to this is the collaboration and knowledge sharing among individuals, groups and organizations, and having the physical space to meet and exchange ideas and support is beneficial. As of the start of 2016, there are 35 co-working spaces in Hong Kong and 10 incubators or accelerators, with this number growing over time indicating the increasing recognition and support of start-ups, innovation and technology in Hong Kong. Of the total 1,912 entrepreneurs in 2015, 36 % of them founded their start-ups in public funded co-working spaces, incubators or accelerators, and 64 % were based in private facilities.

8.5.2 Need for a Diversified Economy

One major concern regarding Hong Kong's Economy is its long-term competitiveness as a global financial hub in the region. Much of Hong Kong's success is a result of China's unstable and inefficient domestic financial system, so many Mainland investors turn to Hong Kong to set up their financial companies and raise funds through initial public offerings (IPOs). In 2015, Mainland companies comprised 80 % of the funds raised through IPOs, signifying Hong Kong's dependence on Mainland firms in financial markets [47]. However, as China gradually enhances its financial system through reforms, deregulation and opening up of its market, there is a threat that the reliance on Hong Kong will diminish in the long term. Coupled with mounting social unrest, as is evidenced by the recent Occupy Central movement, is also rising cost of living and lack of promising future for the younger generation. Doing business, and uncertainty about the political future of the city come the end of the 'One Country Two Systems' arrangement with China, the competitiveness of Hong Kong as a preferred financial centre and multinational regional headquarters may lose out to other growing and maturing cities such as Shanghai and Shenzhen. In addition, as Mainland China opens up its economy and trading routes, there are fears that Hong Kong's position as an international trading hub are under competition from Chinese cities in southern China and the Pearl River Delta. It was found that from 2001 to 2011, Hong Kong's importance in handling direct cargo bound from southern China has declined from 76 to 39 %, resulting in a shift of focus to transshipment cargo which is less profitable [48]. There is a similar sentiment felt in the air industry as international airports in the Pearl River Delta Region invest and grow to meet the growing demand for air travel in China as a result of the opening up of its economy. Both Shenzhen and

Guangzhou International Airports aim to be 'international hubs', and with lower costs for airlines and the ability to handle a greater capacity of flights than Hong Kong International airport, there is a threat that Hong Kong could lose out on its position as a leading global trade hub [49].

This signals a need to shift the focus of the economy into other sectors and industries in order to diversify Hong Kong's talented workforce and maintain the city's economic competitiveness. Within the global economy, Hong Kong exhibits a comparative advantage over many major cities in relation to its financial, real estate and various professional services, which have led to its economic success today. However, domestically the economy suffers from a lack of competitiveness among local firms. Even though Hong Kong functions as a free market economy with low barriers to entry for new businesses, many sectors of the economy are dominated by a small number of large firms that essentially act as monopoly powers. This is the case in Hong Kong's most successful sectors, such as property development, telecommunications, public utilities and even with some food and school supplies providers, where large monopolies are so powerful they are suspicious of currying favours with the government for decisions to go in their favour, at the expense of small and medium enterprises [50]. These monopolistic characteristics of the economy would hinder the growth and development of Hong Kong's start-up scene, as start-ups and small-medium firms already suffer from the city's sky-high rents that continuously put local companies out of business. A recent step taken to combat this issue and to improve economic competitiveness locally was the commencement of the Competition Ordinance and Competition Commission in 2015. The Competition Ordinance aims to prohibit conduct that prevents, restricts or distorts competition in Hong Kong, and it will enforce this through three rules that (i) prohibits anti-competitive agreements; (ii) prohibits abuse of market power; and (iii) prohibits anti-competitive mergers and acquisitions for carrier licence holders in the telecommunications sector [51]. This signifies a hope that the Hong Kong economy will remain naturally open and competitive, giving all entrepreneurs and small- and medium-sized businesses an opportunity to compete fairly in the economy.

8.6 Smart Environment

Hong Kong has been undertaking efforts to develop and implement initiatives for energy saving as part of Hong Kong's 'Energy Saving Plan for the Built Environment 2015–2025+', which sets out energy-saving policies, strategies and targets. The two sectors which stand out in this effort are the 'energy efficient' transport sector since the 1980s and the green building movement that arose in the 1990s. Beginning in the early 1990s, the Hong Kong Government has been undertaking various measures for energy awareness through public education, data collection and dissemination, and social mobilization backed by legislative actions.

Hong Kong lags behind in sustainable resource management including water, energy, waste and recycling; however, there has been an attempt to promote awareness and environmental sustainability. An introduction to the history of Hong Kong's energy-saving initiatives begins in 1995 when the Voluntary Energy Efficient Labelling Scheme (VEELS) for home and office appliances, and vehicles was launched, bringing to public attention the impact of appliances and vehicles on the environment and their energy consumption. In 2006, the Government promoted the Energy Conservation Charter to involve school, non-Governmental organizations and businesses. In 2010, Hong Kong put forward a target to reduce the carbon intensity by 50-60 % from the 2005 level by 2020. According to the Government, as of 2012, Hong Kong's carbon intensity had dropped 19 % using 2005 as the base, and a reduction of about 50 % by 2020 is expected [52].

In 2015, the Government released the 'Energy Saving Plan 2015–2025+' with guidelines to save energy in all sectors for greater sustainable development of Hong Kong. The Energy Saving Plan targets for a 40 % reduction by 2025 [53], and the major strategies adopted are

- Government buildings to take the lead in green building and public housing to be built on green building norms.
- Government buildings to reduce 5 % electricity consumption by 2020.
- Periodic review and expansion/tightening of existing energy standards.
- Engage schools and NGOs for awareness building.
- Appoint energy wardens in Government departments to encourage energy saving.

The Energy Saving Plan also highlighted the use of Advanced Metering Infrastructure, or smart metres, in its targets for Hong Kong. Smart metres will provide more detailed information about a building, business or apartment's energy use than conventional metres. By allowing customers online access to their energy-use information through their mobile phones and apps, it can encourage users to save energy more efficiently. Currently, smart metering is only in the pilot phase in Hong Kong with CLP, one of Hong Kong's largest electric companies, operating a pilot scheme since 2013 involving 3000 residential customers and 1400 small- and medium-sized business customers [54].

The Environmental Protection Department (EPD) runs a Hong Kong Waste Reduction Website, on which the different recyclables is explained and advice on where and how to recycle. According to the EPD, Hong Kong has a municipal solid waste production of 18,000 tonnes per person per day and a recycling rate of 49 % in 2011 with the remaining 51 % disposed of at three landfills. All three landfills are reaching capacity in the next few years, however, and the Government is considering building a waste incinerator to deal with the volume of non-recycled waste. The Hong Kong Waste Reduction Website stimulates waste reduction and makes clear that most materials can be recycled through different channels.

There are informed sources, however, that estimate the overall recycling rate to be not higher than 30 % [55] In particular, low-grade and bulky materials such as

wood or glass bottles lack recycling infrastructure partly because of high rents and large facilities required. A number of private recycling companies operate in the territory but lack resources and infrastructure to make a significant impact.

There are recyclable waste collection points throughout the city, but their use is inconsistent and the waste streams are not always kept segregated after collection. Overall, the concept of waste reduction and waste recycling is not a significant part of everyday life and food waste is a large component that is given much needed focus by the present government, under the able leadership of K.S. Wong, the secretary, and Christine Loh, the undersecretary, for the environment. However, a bigger investment would be required to bring waste management to the level of, for example, Singapore, where 1,370 tonnes is produced per person per day, with an overall recycling rate of 60 % [56].

Hong Kong's efforts at pollution control and management with regard to air quality, water quality and noise pollution have not been without challenges. Hong Kong faces two air pollution issues, namely a regional smog problem and local street-level pollution. 'Diesel vehicles are the main source of street-level pollution. Smog, however, is caused by a combination of pollutants from motor vehicles, marine vessels, industry and power plants both in Hong Kong and in the Pearl River Delta region' [57]. In March 2013 The Environment Bureau, in collaboration with the Transport & Housing Bureau, the Food & Health Bureau and the Development Bureau, released 'A Clean Air Plan for Hong Kong' to outline the challenges Hong Kong is facing with regard to air quality and to give an overview of the relevant air quality improvement policies and measures.

Roadside pollution is being tackled through the following measures and initiatives:

- *'Phasing out some 82,000 pre-Euro IV diesel commercial vehicles progressively by end 2019 involving an ex gratia payment of about $11.4 billion and setting from February 2014 a maximum service life of 15 years for newly registered diesel commercial vehicles;*
- *Subsidizing the replacement of catalytic converters and oxygen sensors of LPG taxis and light buses once. After that, we will strengthen emission control on petrol and liquefied petroleum gas vehicles by using roadside remote sensing equipment and dynamometers for emission testing;*
- *Subsidizing the franchised bus companies to retrofit some 1400 (subject to a more detailed assessment) Euro II and Euro III franchised buses with selective catalytic reduction devices to upgrade their emission performance to Euro IV or above level by the end of 2016;*
- *Subsidizing the franchised bus companies to procure six hybrid buses and 36 electric buses for trial; and*
- *Subsidizing under the $300 million Pilot Green Transport Fund the testing of green and innovative transport technologies applicable to the public transport sector and goods vehicles'.* [58]

Although the above initiatives are welcome and necessary, it is worth considering that other cities have taken more compelling measures to decrease air pollution. Singapore, in 1998, was the first city to introduce Electronic Road Pricing (ERP), which helped to minimize the presence of motorized vehicles in the centre of Singapore. In 2004 London introduced a similar scheme (Congestion Charge, with proceeds intended to improve public transportation), while in 2008 the Greater London Authority introduced the London Low Emission Zone (LEZ). While the Congestion Charge scheme only covered the centre of London, the LEZ covers the entire area of Greater London. Any vehicle that enters the zone and does not meet certain emission criteria pays a penalty, which ranges from 140 USD to 280 USD per day. The following types of vehicles are not charged: larger vans and minibuses that meet the Euro 3 standards; lorries, buses, and coaches that meet Euro IV standards; and cars and motorcycles. Monitoring takes place through licence plate recognition through cameras along the boundary. The Hong Kong Transport & Housing Bureau is currently seeking public opinions on the concept of Electronic Road Pricing in Hong Kong.

Recent efforts in promoting the design, construction and operation of sustainable Green Buildings have been quite positive and promising. The Hong Kong Green Building Council has come up with the Building Environmental Assessment Method (BEAM) Plus and Professional ratings, Hong Kong's own LEED rating for sustainable buildings tailored to the local built environment, climate, regulations and standards. BEAM Plus is available for both new and existing buildings, with new building projects needing to undergo a Provisional Assessment and Final Assessments, and existing buildings only requiring a Final Assessment. There are six criteria of new and existing buildings that the BEAM Plus assessment scheme uses to evaluate projects, which include Site Aspects, Energy Use, Indoor Environment Quality, Materials Aspect, Water Use, and Innovations and Additions. New projects and existing buildings are evaluated on a similar scale and are rewarded a rating of Platinum, Gold, Silver or Bronze, to reflect the level of commitment to environmental sustainability and a lower-carbon future. According to the Green Building Council, the benefits of a BEAM Plus certification includes [59]:

- Cost-savings through the more efficient use of energy and resources
- Increasing occupant satisfaction from healthy and productive accommodation,
- Enhancing corporate profile and marketability to potential building users,
- Providing a tool to improve purchaser choice and information,
- Integrating local and international best practice into new designs,
- Providing increased protection against environmental liability,
- Establishing a clear direction for continuous improvement and optimized performance.

As of April 2016, there are a total of 790 BEAM Plus registered projects and 355 assessed Beam Plus projects. Of the assessed projects, 45.1 % were residential, 18.1 % were commercial, 15.5 % were Government, Institutional and Community, 10.9 % were Mixed Use, 6.3 % Hotel, and the remaining consisted of Industrial

and Others. Among those assessed, 14.7 % are Provisional or Final Platinum rated, and 25.2 % rated Provisional or Final Gold [60]. The Hong Kong Green Building Council Neighbourhood rating system is being piloted and showcased in Kowloon East as a new sustainable and smart city initiative.

One successful sustainable low-carbon building example is the zero carbon building (ZCB), which has been designed to be 45 % more energy efficient than traditional buildings. To combat the increasing GHG emissions from the building sector, the first Zero Carbon emission building was constructed by Construction Industry Council (CIC), Hong Kong. It is designed to use renewable energy including biodiesel for tri-generation and solar panels. The ZCB is located in Kowloon Bay, and gives a 20 % energy saving through passive design and 25 % through green active system. The objective of the ZCB was to pioneer the transition to low-carbon buildings, and it aims to both 'serve as a platform for the construction industry to share knowledge and expertise in low-zero carbon building design and technologies, and raise community awareness about low-carbon living' [61]. However, for a dense vertical city with numerous high-rise high-density developments, ZCB is only scratching the surface and a lot more needs to be done to make significant improvements in this area.

Hong Kong is well known for its dense urban environment, yet out of the total 1 108 km^2 of land, it is not that known that only about 25 % is developed land and about three quarters is undeveloped countryside [62]. About 40 % of the land area is designated Country Park and special areas, comprising scenic hills, woodlands, reservoirs and coastline. A total of 24 country parks have been designated for the purposes of nature conservation, countryside recreation and outdoor education. The scarcity of buildable land places pressure on planning officials to allocate public land in a balanced manner. Land is required for housing, new hospitals, office space, etc,. and also open space. A smart city should provide a variety of public open space within its urban quarters, ranging from sidewalks and small-scale paved piazzas to landscaped squares to large parks. Ideally, these different types of spaces are linked up to form a comprehensive network that pedestrians and bicyclists can use to go around the city in an environmentally friendly, and healthy, manner.

The geography of Hong Kong is such that large-scale country parks are never far away. Hiking along well-maintained paths is a popular pastime for many citizens. There are four long-distance hiking trails that can also be enjoyed in segments.

Within the urban areas of Hong Kong, however, green open space is sparser. According to the Hong Kong Planning Standards and Guidelines (HKPSG), the standard for the provision of open space in urban areas is a minimum of 2 m^2 per person, apportioned as 1 m^2 per person for district open space and 1 m^2 per person for local open space. This is a much lower standard than the neighbouring city of Singapore, meaning Hong Kong needs to raise the bar in this regard given that it is an extremely high-density development.

An audit by the Hong Kong Audit Commission in November 2008 concluded that the overall provision of open space in the territory was 2.6 m^2 per person. However, at the district level, there were shortfalls in open space in 11 out of 18 districts [63]: overall shortfalls in 2 districts, and shortfalls in either local or district

open space in 9 other districts. To offset the adverse conditions stemming from a high-density urban environment (trapped air, lack of views, heat island effect, crowded pedestrian space, etc.) more emphasis should be given to public open space. In the busiest areas, space for motorized vehicles could be partially sacrificed in favour of accessible public open space. More emphasis should also be given to the interconnectedness of these public open spaces. A usable network of public open space and green space should be considered at district level, and a strategic development plan should be developed to guide future development. Currently, such a district-level master plan is lacking in Hong Kong except for new towns in the New Territories or other Comprehensive Development Areas, and proposed development is assessed on its own merits, without much consideration of the cumulative impact.

In January 2016 the Agriculture, Fisheries and Conservation Department launched a public consultation for the first Hong Kong Biodiversity Strategy and Action Plan, in which different actions and initiatives are described. For example, the Civil Engineering and Development Department (CEDD) has been implementing Greening Master Plans (GMPs) for all urban areas. These plans, unique for each district, guide planting along infrastructures or premises, for example, roadsides, footbridges, flyovers and promenades. A closer coordination than currently takes place with, in particular, the Planning Department would be required to fully implement objectives to enhance biodiversity.

Trees are important elements of biodiversity, and the Hong Kong Development Bureau has a Greening, Landscape & Tree management section that monitors old and valuable trees and maintains a tree register. A unique feature in Hong Kong is 'wall trees'; trees that grow on a steep slope or from a stone wall. In a dense urban area such as Hong Kong these trees offer shade, visual quality and habitat for birds and insects, while requiring minimal space.

In conclusion, although Hong Kong is focusing more effort to achieve a smart environment, it is clear that, after years of inaction by previous Administrations, the current Administration faces a substantial backlog of policy and initiatives. Policy that is being proposed now, such as the Energy Saving Plan and the Biodiversity Strategy and Action Plan will take some years to enable implementation, at which point coordination with other Departments and Bureaus will be key. However, Hong Kong is moving in the right direction but there is still a lot more to do with respect to the Smart Environment.

8.7   Smart Infrastructure

Hong Kong enjoys a steady supply of electricity in two geographic sections: power for Kowloon and New Territories, including Lantau, Cheung Chau, and most of the outlying islands are supplied by CLP (China Light & Power), using by three power stations (one coal-fired, one gas-fired and one diesel/gas-powered). Power for Hong Kong Island, Ap Lei Chau and Lamma Island is supplied by Hong Kong Electric,

Fig. 8.3 Fuel mix for electricity generation in Hong Kong in 2009 [67]
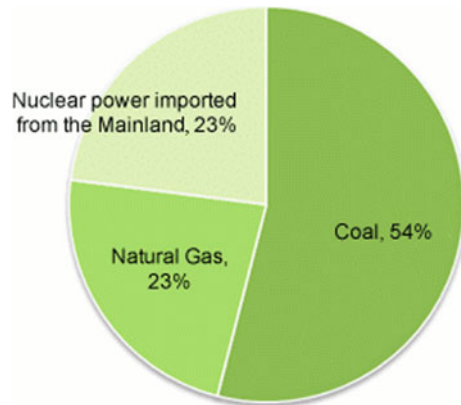
using Lamma Island power station (coal- and gas-fired). Gas is imported from Hainan Island through pipes under the sea [64].

In addition to the four domestic power plants, Hong Kong imports 23 % of its energy demand from mainland China from the Daya Bay Nuclear Power Plant in Guangdong [65], some 50 km from Hong Kong (Fig. 8.3).

Hong Kong seeks to minimize the use of coal-fired power plants and increase renewable energy, but so far there is only one commercial wind turbine, at the Lamma Island power station, providing circa 100 MW of power for Hong Kong Island and Lamma Island. Solar energy is increasingly used as a source of electricity through solar thermal systems (solar water heating, solar refrigeration) and photovoltaic (PV) systems. A number of small and stand-alone applications have been realized such as photovoltaic energy for remote weather stations. Currently, the largest photovoltaic system in Hong Kong was installed at the Lamma Island power station in 2010. This system is expected to generate 620,000 KWh of electricity annually.

In 2012 CLP completed Town Island Renewable Energy (RE) Supply Project, which powers a non-profit drug rehabilitation centre in the New Territories. The project comprises 672 solar panels, two wind turbines and 576 batteries, with a generating capacity up to 200 kW. As the system is not connected to the grid, it features batteries capable of storing over 1,000 kWh of electricity to provide a power supply lasting for around 30 h.

In spite of an increased awareness of renewable energy sources and the various costs and risks of power generated by coal, gas or nuclear fuels, no concrete effort is being launched to instil a culture to cut down unnecessary use of electricity. Different Departments seek to urge customers to decrease electricity through different means, but on the whole there is a lack of urgency with regard to decreasing demand. Hong Kong is located a tropical zone, and during several months is exposed to high temperatures as well as high relative humidity, which often makes the use of air conditioning a necessity for different purposes. More could be done, however, to mobilize different sectors of society to enable a shift from the old

standard way of resource management to a model that is in tune with the central elements of a smart city.

With regard to 'smart grid' development Hong Kong is in the initial phase. In 2011, CLP opened a Smart Grid Experience Centre to educate and showcase the features and benefits of smart grid [66]. In 2013 and 2014, CLP ran a pilot scheme called myEnergy. Around 3,000 residents and 1,400 small- and medium-sized enterprises participated to test how the availability of advanced technology would impact daily behaviour with regard to energy consumption. No further initiative from the Government or private sector has been proposed.

Hong Kong has no natural lakes, rivers or substantial underground water sources, and water demand is subject to rainfall and supply from neighbouring Guangdong Province in the People's Republic of China. Currently 70 % of the demand is supplied from China. Although water supply is thus limited (hampered by costly transport), there is little public policy to limit water demand. There is no requirement to monitor water usage. As a result, many office buildings or public bathrooms still have lavatories that flush continuously. There is, however, a substantial water supply system to use sea water for flushing and other 'grey water' purposes.

Hong Kong is well equipped to adequately deal with sudden unset of high volumes of rain water. An intricate system of drains, channels, nullahs and culverts is sufficient to prevent severe flooding. More could be done, however, to decrease the stress on this system by providing for more pervious ground cover to delay the suddenness of water run-off from impermeable surfaces.

Previous sections have elaborated on different types of hard infrastructure such as roads, rail and airport. It is clear that appropriate emphasis is placed on infrastructure in general. In particular with regard to rail infrastructure, Hong Kong has developed a highly efficient system. This research has also shown, however, how, in central urban areas, road infrastructure often impede pedestrian infrastructure. Extreme building densities will, in principle, encourage walkability because, given a mixed-use area, many destinations will be within walking distance from each other. Over-sized road infrastructure and a tendency to grade-separate traffic from pedestrians hamper walkability and decrease the quality of the public open space.

Previous chapters have also indicated that, in terms of ICT, Hong Kong is well developed. The level of digital interconnectivity is very high, with Government and companies striving to increase bandwidth and reach. However, it will take some years, significant Government support and effective collaboration with the private sector to implement Smart City infrastructure such as smart metering, low-carbon buildings, and an efficient waste management and recycling system.

8.8 Concluding Remarks

We have identified and discussed the different aspects of Hong Kong as a Smart City by conducting research on each of the six elements of the smart city framework and the initiatives that comprise each one. While many of the initiatives have

indicated a positive and promising outlook for the future development of Hong Kong as a Smart City, it has also exposed areas where Hong Kong lacks the necessary efforts, investment and innovation to really make the jump to truly smart city status. One of the main challenges is ensuring a fully integrated and cohesive approach to the development of smart city initiatives within the city and among the government, businesses and the public. Numerous different stakeholders, corporations, organizations and Government Bureaus are introducing smart city ideas, projects and initiatives but without any collaboration or integration among each other, and this is in turn hindering the overall success of Hong Kong as a Smart City. There is, however, an encouraging outlook in this regard, as in the next chapter we will introduce the development of Kowloon East, a former industrial district, into Hong Kong's future second central business district. The objective of Kowloon East is to regenerate the area including the redevelopment of the former airport at Kai Tak as a Smart and Sustainable City utilizing advanced technologies and smart city principles in its design, planning and operations. As this project aims to incorporate smart city initiatives from the initial stages of development, there are hopes that it will set an example for the future implementation of smart city initiatives elsewhere in Hong Kong as well as around the globe.

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Chapter 9
Kowloon East: Hong Kong's New Smart CBD

Sujata S. Govada, Widemar Spruijt and Timothy Rodgers

Abstract Kowloon East is an area undergoing rapid transformation and comprises of Kwun Tong, Kowloon Bay and Kai Tak Development. The government planned Kowloon East area was developed and grew substantially as a manufacturing and logistics centre throughout the second half of the twentieth century. Changing economic and social circumstances at the end of the twentieth century pushed Hong Kong to reposition itself and its strengths in order to maintain its competitiveness in the global economy. A shift of the economy away from industrial manufacturing towards more commercial and financial services and through policy initiatives rezoning and favourable incentives attracted developers to the area. This effort resulted in the redevelopment and revitalization of the old industrial areas with the current transformation underway in Kowloon East. Long-term goals for the area are for Kowloon East to become the second central business district for Hong Kong, providing much needed new commercial space and office supply, with high-quality open spaces, and the promotion of the arts and cultural activities to ensure the continued growth and competitiveness of Hong Kong's service-based economy. More recently, Kowloon East is also an area where Government started Smart City initiatives to ensure that the Kowloon East area is transformed in a smart and sustainable manner.

Keywords Smart city initiatives · CBD · Connectivity · Industry · Urban redevelopment · Urban revitalization · Kowloon East

S.S. Govada (✉)
School of Architecture, Chinese University of Hong Kong, Hong Kong, China
e-mail: sujata@udpcltd.com

S.S. Govada · W. Spruijt · T. Rodgers
Institute for Sustainable Urbanisation, UDP International, Hong Kong, China

9.1 Background

Kowloon East is a geographical constituency of Hong Kong that comprises two neighbourhoods, namely Kowloon Bay and Kwun Tong. KwunTong is Hong Kong's oldest and most important industrial district, Kowloon Bay also consists of several industrial, commercial and residential areas, and Kai Tak Development is the redevelopment of the old airport site almost entirely on reclaimed land. Once an important and vibrant industrial area during the peak of Hong Kong's local manufacturing industry, the government now aims to take advantage of a shift away from industrial manufacturing in Hong Kong and to redevelop the area into a new Central Business District (CBD). Dubbed CBD2 as an acronym for "Connectivity, Branding, Design and Diversity", it promises to increase the amount of commercial/office space in the wake of a shortage of supply and annually increasing rentals in the original CBD comprising Central, Wanchai and Causeway Bay, as well as in the de-centralized business areas of North Point and Quarry Bay on Hong Kong Island.

Kowloon East was chosen as the location for CBD2 with the older districts of Kwun Tong and Kowloon Bay along with the Kai Tak redevelopment due to its strategic location and MTR connectivity. Its spatial distance from the existing CBD in Central and other congested commercial areas such as Tsim Sha Tsui in southern Kowloon is also another factor. By encouraging future commercial development in Kowloon East, it enables the redistribution of employment away from congested areas on Hong Kong Island, reducing the number of commuting flows from the New Territories that contribute to the heavy flows along transport corridors in south Kowloon, across the Harbour, and on Hong Kong Island [1]. This will restrict employment growth in congested areas, limiting the increasing trend of road traffic congestion, and also alleviate some of the pressures on the Island and Tsuen Wan lines of the MTR which can become highly congested during peak hour periods. The new Cruise Terminal and the proposed Multi Purpose Sports Complex within Kai Tak Development and the road and transit infrastructure development in the form of the Central Kowloon Route and the Shatin Central Link MTR with new stations at Kai Tak and To Kwa Wan will further enhance the vibrancy and connectivity of Kowloon East (Fig. 9.1).

9.2 History of the Area

9.2.1 Pre-1950s

Before any development took place in the Kwun Tong Business Area, the area functioned as government salt yards and dumping ground for refuse up to the end of the Second World War. The Kai Tak Area started life as a reclamation project that failed and was subsequently acquired by the government for use as an airfield. From

Fig. 9.1 Kowloon East and the Kai Tak Development area

1924 onwards, it began use as an airfield and landing strip for the British Royal Air Force and other aviation clubs. In 1935, the first control tower and air hanger were constructed, leading to the establishment of the first domestic airline in Hong Kong in 1936 and landing of the first passenger flight. During the Second World War, the Japanese occupation of Hong Kong lead to the Japanese army to expand Kai Tak airport, building two concrete runways. After the war, China underwent a period of instability, a civil war began in 1946 and a transition in government occurred in 1949. This led to a large exodus of Chinese migrants from the country, many who decided Hong Kong was the best option to move to (Hkmemory.hk). Although many were unskilled labourers, their determination for work and survival became the support for Hong Kong's industries and their growth. Some migrants were heavily involved in industrial manufacturing, as such they brought labour expertise and advanced equipment with them which strengthened Hong Kong's industry and laid the foundations for the city's manufacturing industries.

9.2.2 1950s–60s

In 1953 and 1954, Kwun Tong was designated as a new industrial area. This involved extensive land reclamation from 1954 to 1957, creating the industrial area of Kwun Tong we know today. A total of 140 acres of new land was created along the shoreline, much of which was dedicated for industrial use. The selling of industrial and residential lands in the area took place in 1956, and upon completion of the reclamation the construction of industries and residences took place. This is

when the number of factories in Kwun Tong began to increase, with the industries comprising of mainly clothing, textiles, metal goods manufacturing, plastics and electronic appliances to name a few. Towards the end of the 1950s saw the beginnings of the provision of transportation infrastructure and an expanding public transportation network. The first bus line was introduced in Kwun Tong, route 11B which operated from Kowloon City dock to Yue Man Square, the town centre of Kwun Tong which is currently being redeveloped.

9.2.3 1960s–70s

Throughout the 1960s, Kwun Tong and Kowloon East experienced a continual increase in the number of factories and factory workers. Textiles and clothing became the dominant sectors, followed by rubber and plastics, and as a result, Hong Kong became the export centre for manufactured products in Asia [2], functioning as a gateway to Southern China. The increased development in Kwun Tong saw the formation of essential civic infrastructure and public buildings and services. The city centre of Kwun Tong was further developed, with clinical centres, police and fire stations, docks, roads, bus stops and public housing estates planned and design taking cues from Ebeneezer Howard's Garden City concept, by separating the different land uses from one another. In 1962, the first terminal building at Kai Tak Airport was completed, signifying the potential for increased passenger and tourist visits into and out of Hong Kong. The growth of Kai Tak Airport would lead to Hong Kong becoming more accessible to the rest of the world by air travel. The expansion of transport networks to and from Kwun Tong continued, with a ferry service between Kwun Tong and North Point established in 1963, providing a connection between Kowloon East and Hong Kong Island East (no road connection at this point in time).

9.2.4 1970s–80s

The 1970s and 1980s saw further growth of the industrial industry in Kwun Tong, along with the additional provision of civic services and infrastructure to boost the economy and aid society. In 1974, the United Christian Hospital was built and the Kwun Tong residents union was established. In 1976, the Kai Tak Airport air cargo terminal opened, establishing Hong Kong as a strategic trade port for Southern China. In addition, Kai Tak's proximity to Kwun Tong and other industrial areas in Kowloon East meant the air cargo terminal would greatly benefit the factories and manufacturing businesses in these areas. With high accessibility to the airport, these

industries were gradually opened up to markets outside of the territory. By this point, the population of residents and businesses in Hong Kong were growing, and to cope with this increase, the Kwun Tong MTR line was opened in 1979. The provision of mass transit improved mobility and accessibility of the area and allowed workers to commute to and from their places of employment more easily, alleviating pressure on the road system and bus network.

9.2.5 1980s–90

By the 1980s, 18 % of Hong Kong's industrial output was provided by the district of Kwun Tong. Industry was booming and the town was bustling with business and new residents. However, throughout the 1980s, the economy of Mainland China began to open up to foreign investment and trade as part of the Open Door Policy to shift to an export-oriented economy [3]. This led to and outflow of industrial businesses in Hong Kong, as many factories involved in labour-intensive production relocated their factory processes across the border to take advantage of the lower labour costs and cheaper land rents. As a result, property values for industrial spaces in Kwun Tong were negatively affected, and it led to a loss in the vitality of the district during that time. The exodus of manufacturing from Hong Kong to the Mainland is evidenced by Hong Kong's contribution of 64.7 % of foreign investment to Guangdong province from 1979 to 2005. In response to the decline in the district, in 1998, the Land Development Cooperation first announced the Kwun Tong City Centre redevelopment project. This involved the introduction of a new land designation by the Government, zoning code "Industrial/Office (I/O) buildings", which allowed for ancillary offices within the industrial building. By allowing more than just industrial (factory or warehousing) uses in Kwun Tong, it began the transition to more mixed-use buildings in the area, and as a result, developers started to see serious redevelopment potential in Kwun Tong. Unfortunately, the Urban Renewal Authority (URA) did not formally implement this project until 2008 [4].

9.2.6 1990–2000

The 1990s saw the beginning of the decline of the textiles industry in Hong Kong as factory operations moved overseas. Many businesses still maintained their offices in Hong Kong for banking, order processing and logistics functions, but in general factory, operations declined substantially throughout the 1990s. The Kowloon Bay reclamation project, which began in 1977, was completed in the 1990s, providing

increased land area in Kowloon East and near the harbourfront. However, due to the de-industrialization taking place, Kowloon Bay was repurposed as commercially used land, facilitating the development of commercial estates and shopping malls in the area. A significant milestone was experienced in 1997, when Hong Kong was released from under the British Colonial rule and handed back to China, spurring concerns about the stability and future of Hong Kong's economy.

9.2.7   2000–2010

From 2000 onwards, manufacturing industries further reduced its share of GDP and employment in Hong Kong. Factory owners downsized their operations and spatial usage, leaving much of the industrial spaces vacant or underused. Nowadays, a vibrant mix of industrial trading, commercial, cultural and leisure activities characterizes Kwun Tong's environment. As in 2001, the Town Planning Board rezoned the entire Kwun Tong industrial area as "Other Specified Uses" annotated "Business" zone [5]. This allowed a greater freedom of conversion for existing industrial buildings into a much wider range of uses, and enabled the construction of newer office and commercial buildings on previously industrial land. Following the new zoning specifications, in 2005, the first commercial shopping mall in Kwun Tong was developed, APM Mall, which also became the largest in the area [6]. The shopping mall is part of a larger property development called Millennium City, which consists of mixed-use commercial and office buildings. In part, due to changing demographics of the district, APM Mall's target clientele consists of young teenagers and adults with interests in a trendy lifestyle, as occupants include fashion brands, audio-visual electronics, personal care and lifestyle shops. It is also open late into the night, with most stores open until midnight and a few remaining open 24/7, signifying a push to establish more of a night scene in the area. This type of commercial development is indicative of the direction Kwun Tong is transitioning, towards revitalizing the area into an attractive and trendy new central business district for Hong Kong. In 2005, the URA also re-launched the Kwun Tong Redevelopment Project that had not made any physical progress since its inception in 1998, with the objective to transform Kwun Tong into the commercial and financial centre of Kowloon East [7, 8]. Extensive public consultations were held in 2005, and it was not until 2008 when the project was formally implemented. Another result of the de-industrialization that occurred in Kowloon East was the cultivation of an arts and cultural scene, which took advantage of the cheap unused older large industrial spaces, and turned them into music, movie and art studios throughout Kwun Tong. The creative industry was developed and the area became an important cluster for the Hong Kong film industry. Solidifying the creative presence in Kowloon East was the 2006 opening of the largest commercial contemporary art space in Hong Kong, called the Osage Gallery. By making use of an entire floor of an old industrial building, the gallery benefits from high ceilings and large open plan rooms to showcase its artwork [9].

9.2.8   2010–Present (2016)

In the 2009–2010 Policy Address, the Chief Executive (CE) announced policy measures to revitalize old industrial buildings in non-industrial zones that were vacant or under-utilized [10]. These were put into place in 2010 as the "Revitalization of Industrial Buildings" Policy, which consisted of incentive policy measures to encourage the revitalization of unused building spaces and optimize the use of land [11]. As this would lead to an increase in supply of commercial spaces, existing and future businesses would have benefitted from the more competitive rents in the area. In September 2011, a mid-term review of the revitalization policies was conducted, and it was decided to make some refinements to the measures and extend the application deadline for 3 years from 31 March 2013 to 31 March 2016, allowing more buildings and businesses to benefit from the policy measures [12]. As a result of the new policies and measures on redevelopment and revitalization of older industrial buildings, the supply of commercial and offices spaces in Kwun Tong has increased in recent years. At the end of March 2016, there had been a total of 248 applications received by the Development Bureau, 125 of which have been approved, and 98 that are still undergoing processing [13]. However, of the 125 approved applications, only 76 were executed, and 20 of the 98 applications under processing were withdrawn by the applications, indicating other factors that may be influencing the success of the scheme. This increase in supply subsequently attracts more businesses to set up or relocate parts of their operations in Kowloon East due to cheaper rental prices compared to more established business areas on Hong Kong Island. The 2011–2012 Policy Address announced the commencement of development in East Kowloon to transform it into a second premier business district for Hong Kong [14]. To establish the Government's commitment to developing Kowloon East, the Energizing Kowloon East Office (EKEO), an interdisciplinary government office was set up on-site to oversee the projects and ensure cohesive development takes place in line with the strategic vision of the Government. Furthermore, in the 2014 Policy Address, the CE promoted the identification of potential industrial and commercial sites to support the development of arts, culture and creative arts in Kowloon East and reiterated the role of EKEO in facilitating the development of Kowloon East into a distinctive business area to support the long-term economic development of Hong Kong [15].

All in all, the historical transformation of Kwun Tong from barren salt yards to industrial manufacturing zone, and now towards a mixed-use commercial central business district and a smart city has been influenced by both internal and external forces, those being political, economical and social. Government policy has facilitated the transitions of industry and real estate redevelopments that have been experienced over the years, and the most recent push in regenerating the district into a vibrant, sustainable mixed-use commercial district shows promise the ability of Hong Kong to reposition its strengths to ensure the continued growth and economic competitiveness of the Hong Kong economy.

9.3 Maintaining Economic Competitiveness

One of the major underlying reasons for the creation and transformation of Kowloon East from an industrial to commercial area is the inability of Hong Kong's core business areas on Hong Kong Island to meet the growing demand for office space. At the end of 2015, the grade A office vacancy rates in Hong Kong consisted of significantly low levels of 1.2 % in Central, 1.1 % in Hong Kong East, 2.2 % in Wanchai/Causeway Bay and 1.6 % in Tsim Sha Tsui [16]. According to JLL—a global real estate services firm—Hong Kong had an overall office vacancy of 3.0 % in the fourth quarter of 2015, comparatively lower than other global cities such as London, New York, Singapore and Tokyo, who had vacancy rates of 3.6, 9.5, 6.1 and 3.3 %, respectively [17]. Hong Kong's low office vacancy rates indicate there is huge demand for office space in Hong Kong, signifying confidence in the local economy, and the high property prices are a result of this lack of sufficient office supply meeting the demand. Much of the demand for office space in Central, Hong Kong's core CBD, comes from Mainland corporations looking to expand their businesses in Hong Kong as part of China's "Going Out" policy to encourage outward foreign direct investment in seeking new opportunities in overseas markets [18, 19].

The growing presence of mainland corporations in Hong Kong will only continue to grow as Hong Kong, and the Mainland enhances their economic and social integration in the long term, suggesting a need for more office supply. The highest vacancy rates in Hong Kong are currently located in Kowloon East, with vacancy rates of 5.5 % at the end of 2015, as real estate developers are purchasing land in Kowloon East and constructing new commercial, and office building developments have resulted in an increase in the office supply in this area, as well as offering competitive rental rates compared to locations on Hong Kong Island. Not realizing and meeting this demand could cause Hong Kong to forgo potential economic gains from new building construction, new businesses moving into Hong Kong, expansion of existing businesses, as well as the economic spillover effects that come with these such as greater employment, knowledge, innovation and competitiveness for Hong Kong as a hub for professional and financial services.

Over the years, the share of services contributing to Hong Kong's GDP is high and gradually increasing, from 2000 to 2013 services percentage of GDP rose from 87.5 to 92.7 % and industry as a percentage of GDP has fallen, from 12.3 % in 2000 to 7.2 % in 2013 [20]. These figures signify the importance of the service industry to Hong Kong's economy and future growth, which therefore should be facilitated through the provision of increased office space and commercial developments in the place of past manufacturing industries.

However, with large scale redevelopment, there will always be adverse effects incurred for certain local population groups and businesses that must compete with the new incoming knowledge workers and businesses. As a result of its transition to a second CBD, Kowloon East is experiencing a loss of businesses that once catered to the industrial economy and employment, such as cafes in industrial buildings and

hawker stalls. The consequences for these older, less lucrative businesses should not be cast aside, as their disappearance symbolises the loss of the past character and atmosphere of the industrial era of the district, one that aims to be preserved in Kowloon East's regeneration.

9.4   Establishing and Ensuring Community Engagement

The Government has set up the Energizing East Kowloon Office (EKEO) in 2012 to spearhead this transformation towards a CBD2, who are located on-site in Kwun Tong to facilitate public engagement and a bottom-up planning approach. The master plans for Kowloon East strategize "Connectivity, Branding, Design and Diversity" with five focuses of a "Walkable Kowloon East, Green CBD, Smart City, Kai Tak Fantasy and The Spirit of Creation." More specifically, the EKEO concentrates its efforts on three areas within Kowloon East, namely the Kowloon Bay Business Area, Kwun Tong Business Area and Kai Tai Development (KTD). In order to ensure the flexibility of the plans to meet the needs and expectations of all stakeholders and the public, the EKEO regularly holds public engagement forums, workshops and on-site events to encourage public participation in the decision making process and to promote awareness and use of improvements to public space that are being carried out over time.

According to the Development Bureau (2012), the major roles the EKEO are to:

(a) "Advocate the conceptual master plan of Kwun Tong and Kowloon Bay and continuously develop it to reflect the development needs of Kowloon East, and explore options for strategic refinement of the Outline Zoning Plan of KTD";
(b) "Engage major stakeholders and the public to promote Kowloon East and attract local and overseas developers and users";
(c) "provide one-stop advisory and coordinating support to land development proposals from project proponents that are conducive to private sector development for transforming Kowloon East into a modern and premier business district";
(d) "Undertake planning and engineering studies and implement small-scale projects such as road/traffic improvement works, improvement to pedestrian connections, streetscape, greening and promenade, waterfront enhancement, local open space, etc. in Kwun Tong and Kowloon Bay that are directly related to the urban regeneration of Kowloon East; and specifically to coordinate government efforts in releasing the two Action Areas for development" [21].

The decision to locate the EKEO and all related project staff on-site is crucial in ensuring transparency in progress, accessibility of the public to government and project staff and to establish a presence in the location undergoing the transition to facilitate a community driven approach to the redevelopment and revitalization process. This emphasis on people and the community is crucial to planning and

developing a successful and sustainable business district that will function efficiently and be utilized effectively by the individuals and businesses that will choose to locate in Kowloon East in the future.

Although the decision to locate in the neighbourhood signifies good intentions, from surveying and talking to individuals in Kwun Tong and Kowloon Bay there seems to be a consensus that the EKEO is not as well-known as they are made out to be. While a large amount of people may be aware of the vision for Kowloon East, the EKEO and participate in its public engagement workshops and leisure activities, there is still much of the population who are unaware of the role and importance EKEO is playing in the redevelopment of Kowloon East into Hong Kong's second CBD [22].

9.5 Visions for a New CBD

The KTD, a 320 ha site of the old airport in Hong Kong, is now currently under construction into a mix-use area with community, housing, business, tourism and infrastructural uses proposed. This includes about 1.70 million m^2 of commercial/ office space, 41,000 private and public housing units, government offices, an international cruise terminal and sports and tourism facilities. KTD poses a good opportunity to pilot a smart city vision and employ smart city initiatives from the ground up into the planning and design with the hopes it will cultivate enhanced efficiency, productivity, liveability and sustainability. The Kowloon Bay and Kwun Tong Business Areas will have technologies and sustainable initiatives implemented and integrated into the existing urban fabric, alongside the development of new commercial and office buildings in order to facilitate the transformation into an attractive CBD to sustain Hong Kong's economic development. The foundations to a CBD2 are underway with land-use rezoning of all industrial land to "Business" use in 2011, enabling the conversion and redevelopment of old industrial buildings for commercial and office use of which 2 million m^2 has been completed as of the beginning of 2015. Essential for improving Kwun Tong and Kowloon Bay in following EKEO's five major focuses are the enhancement of urban greening, provision of open space and pedestrian walkability environment, as the previous manufacturing industry influenced a vehicular prioritized road network unsuitable for the more commercial and service-based activities envisioned.

9.5.1 "Walkable" Kowloon East

Due to the historical significance of Kowloon East as an industrial manufacturing area during the late twentieth century, the urban design caters to a street network favouring heavy goods vehicles with narrow pavements and an abundance of loading/unloading areas along the roads. As a result of the future transformation

into an attractive Central Business District with commercial buildings, shopping malls and hotels, the urban design of the pedestrian and road network requires an overhaul to facilitate the increase in pedestrian flows and ensure Kowloon East becomes a future economic, commerce, leisure and tourism hub in Hong Kong.

Good walkability will be achieved by advocating improvements in the connectivity and quality of both the existing and planned pedestrian environment, face-lifting back alleys to incorporate them into the pedestrian network, enhanced greening and beautification and improving connections with expansions in the pedestrian footbridge and subway network. Improved walkability has potential health and environmental benefits, as people would get more daily exercise and walking is a zero carbon activity. The EKEO is currently undertaking feasibility studies on the Pedestrian Environment Improvement Scheme for both Kowloon Bay and Kwun Tong Business Areas. These studies aim to assess the existing pedestrian environment and road conditions and formulate improvement schemes and areas of focus that will enhance the accessibility and connectivity of the Kowloon Bay and Kwun Tong Business Areas to MTR stations and the waterfront. The EKEO has actively engaged the community by committing to three Public Engagement stages for each business area so as to ensure the views and concerns of the public that uses the area is appropriately considered.

Although improvement initiatives such as wider and greener pavements, revitalized back alleys and enhanced footbridge and subway connections do not specifically utilize information technologies, these improvements are considered as "smart" ways of thinking in planning and design which will foster economic benefits and improvements of quality of life. In the long term, effective improvement to the pedestrian environment and road conditions through smart urban design and planning can foster economic benefits through increased productivity, employee satisfaction, health and less congestion and time wasted.

9.5.2 Green CBD

The focus on becoming a green CBD has promise in transforming Kowloon East into an area that people will want to travel to and spend time at. The Kwun Tong Promenade along the harbour front will integrate art and creative spaces and connect to a landscaped pedestrian network. Green buildings will be promoted, connected through a comprehensive network of parks and gardens incorporated into the overall urban fabric.

9.5.3 Smart City

The utilization of smart technologies has benefits for improving efficiency, operation and management, and information exchange. Kowloon East will use

technology to enhance pedestrian and vehicular accessibility, manage the distract facilities, and disseminate information to the public in digital format. The sections below will further elaborate on KE's Smart City initiatives.

9.5.4 Kai Tak Fantasy

In addition to ensuring the sustainable planning and smart technology integration, the two last focus points, Kai Tak Fantasy and The Spirit of Creation, aim to foster a sense of place to entice visitors by "developing the former runway tip, the Kwun Tong Action Area, and the water body in between into a tourism, entertainment and leisure destination for all" [23]. The EKEO held an international design competition to develop a conceptual use of this area.

9.5.5 The Spirit of Creation

As the new CBD2 in Kowloon East rises from the bygone past of Kwun Tong's Industrial Area, efforts to preserve the past industrial culture and vibrancy in the urban fabric are being taken by extending the "Spirit of Creation" of the old Kowloon East into future developments in the area. The EKEO has commissioned a consultancy team to document and record this industrial culture and the stories of the old factory buildings and unique architectural features, so that recommendations can be made to incorporate the industrial history of the era into the urban design and place making strategy of the CBD2. From conversations with local industrialists and local factory workers, we are able to develop and understanding of the commitment, work ethic and adversity of the past 50 years, and translate that into the urban design of the area to "*ensure the rich industrial culture lives on as we enter the next chapter for Kowloon East*" [24].

9.6 Smart City Initiatives

As part of KE's master plan, it aims to pilot the use of technologies to determine the feasibility of developing a Smart City. Various technologies will be implemented into the existing urban infrastructure in Kwun Tong and Kowloon Bay, as well as the planned KTD.

The Smart City initiatives fall under three main categories:

- Smart data and technology
- Low carbon green community
- Walkability and mobility.

Making use of smart data and technology helps establish an information platform for communications and data sharing to improve city management, enhance efficiency, provide transport/traffic information and high-quality public services. This includes initiatives such as pedestrian traffic light sensors, time sensors for delivery trucks, real time electronic parking availability information with electric panels at major intersections and the provision of free Wi-Fi in public parks. This use of technology has benefits that extends to the goals being low carbon and green, and enhancing walkability and mobility. The traffic light sensors will be able to detect when pedestrians are waiting at crossings within a demarcated zone, and doing so will cause the pedestrian lights to change from red to green within seconds. Real time electronic parking availability information can inform drivers of nearby available spaces, preventing cars from aimlessly driving around searching for a parking space, which reduces the pollution generated by vehicles and can alleviate congestion on the roads.

To strive towards becoming a low carbon green community, the Government plans to adopt various environmentally friendly strategies. The Government will conduct a feasibility study on an Environmentally Friendly Linkage System (EFLS), implement a district cooling system within the KTD, encourage more green buildings (those with BEAM Plus NB Gold or above rating) and seek to reduce the need for conventional vehicular transportation and hence a reduction in carbon footprint. Furthermore, new commercial developments will be integrated with waste-handling systems, where generated waste can be automatically sorted with the press of a button, making old refuse stations on the ground level redundant, giving more space back to the public [25].

Facilitating a low carbon green community requires a carefully planned street network and transportation system, which is innovatively designed and integrated into the built environment. Enhancing the walking environment and connectivity of the district with transportation systems can have significant benefits in encouraging walking and public transit as viable and enjoyable alternative transportation options. The proposed EFLS is a 9-km 12-station monorail running on parallel tracks from Kowloon Bay Station, through the Kai Tak Development to Kwun Tong Station. The monorail design was chosen to facilitate efficient and reliable service for the sustainable development of the CBD, and to also act at as an iconic element of the districts branding and visual identity. This will greatly improve the mobility and connectivity of the district to allow pedestrians to seamlessly travel around Kowloon East and to the external MTR system [26].

As mobility and walkability are closely interlinked, KE will be enhancing its pedestrian street network in terms of both quality and quantity of connections. Improvements in pedestrian infrastructure are already underway in Kowloon East, by widening pedestrian crossings, installing new pedestrian signals at high-traffic intersections, and the use of pedestrian sensors, it will enhance the walkability of the area encouraging walking as an efficient, healthy and enjoyable activity. As of mid-2014, short-term traffic improvement works have been completed at 27 locations, and 41 signalized junctions have been reviewed, with signal timing adjustments where necessary [27]. The Back Alley Project in Kowloon East spearheading

a movement in Kowloon East to beautify and activate the back alleys between its industrial buildings, increasing connections and relieving foot traffic on main roads during peak hours [28].

Once completed, Kowloon East will become a testing ground for significant smart city technologies that could be applied to other areas of the city to improve the quality of life, efficiency and sustainability of Hong Kong and its people. The successes and failures of Kowloon East's smart city initiatives and overall integration to the urban fabric will provide important lessons for government officials, planners and urban designers, business technology leaders, as well as citizens themselves to how Hong Kong can effectively utilize information technologies and smart planning to enhance the city's productivity and economic competitiveness to maintain its position as a leading global city.

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Chapter 10
Way Forward and Conclusions

Sujata S. Govada, Widemar Spruijt and Timothy Rodgers

Abstract Conclusions are drawn from preceding chapters regarding the capacity of Hong Kong to become a Smart City. A lack of a holistic and comprehensive approach to tackling unsustainability within the city will restrict the ability of Hong Kong to become a truly Smart City in all six elements. Some Smart City initiatives are implemented in one area, but coordination is lacking to implement the measures city-wide. With smart thinking and a focus on People, Place and Planet with planning and design as important drivers and technology as an enabler smart and sustainable cities and communities will become a reality in both existing and new development areas. Positive experiences from the regeneration of Kowloon East could be used to the benefit of the development of Hong Kong as a Smart City, although lessons can also be drawn to further improve implementation of Smart City initiatives in Hong Kong.

Keywords Smart City framework · Kowloon east · EKEO · Way forward · Lessons

10.1   Way Forward for Hong Kong

This research has shown that, in theory, Hong Kong is ideally placed to fulfill objectives of a Smart City in terms of Planet: the built-form is generally extremely dense with little or no urban sprawl. As a result, a vast percentage of trips are taken by public transport, which minimizes overall carbon emissions resulting from transport. This potential for a smart and sustainable urban environment is, however, compromised by a lack of initiatives to create smart management systems for waste, green open space, water, air pollution and overall carbon emissions.

S.S. Govada (✉)
School of Architecture, Chinese University of Hong Kong, Hong Kong, China
e-mail: sujata@udpcltd.com

S.S. Govada · W. Spruijt · T. Rodgers
Institute for Sustainable Urbanisation, UDP International, Hong Kong, China

In terms of People, Hong Kong as a society offers many positive facets of urban life, from accessibility of information to the relative safe environment. More could be done, however, to offer a better quality of life with more affordable housing, better employment opportunities and a wider spectrum of civic culture. Public engagement in the planning process is improving, and people are getting more involved. However, participation in public life is limited as a result of limited voting rights and general discontent with high costs and a lack of optimistic future, especially for the younger generations, is being expressed with demonstrations such as Occupy Central.

In terms of Place, Hong Kong offers some unique and high-quality spaces and environments, thanks in part to Victoria Harbour, the mountain ridges like the Peak and Lion Rock and its abundant coastline, natural environment with varied geography. More effort, however, should be given to provision of more open space in the dense urban environment with more emphasis on the quality of public open spaces: their design, how they are used and how they are linked up and programmed for use.

There needs to be safeguards in place so that the planning and development process is streamlined, more efficient and results in effective decision making. This includes the public engagement processes should not be used to just check the boxes, and that they are also not used to delay and derail the process. People in all sectors of society including public, private, professional, academia, community work together do not lose sight of the common vision for Hong Kong to become a smart and sustainable city.

10.2   Lessons from Kowloon East

There are many positive aspects of the Kowloon East initiative that should be replicated in other districts. One of the key aspects is the cross-departmental nature of the government satellite office, Energizing Kowloon East Office (EKEO). By combining different but relevant disciplines into one team, proposed improvements can be implemented significantly quicker than if a proposal has to 'tick off all the boxes' at the various departments, invariably running into one or more road blocks along the way, which would require a redesign and a new consultation process.

A second positive aspect to replicate is that by focusing on 'easy wins' EKEO could quickly establish itself as a 'can-do' government office, creating goodwill among the public and enabling more complex projects.

In spite of these positives, there is a lack of a truly strategic overall plan for the study area. At the moment the Conceptual Master Plan, CBD2 4.0, is more a collection of different initiatives that were in the realm of possibilities than a comprehensive master plan [1].

The Kai Tak Office, in charge of the redevelopment plans for the old airport, functions separately from EKEO, and their approaches are not well aligned. A more coordinated effort using a common vision for Kowloon East following smart and

sustainable development principles would truly integrate the two areas with each other and into the wider city. For example, the proposed monorail (Environmentally Friendly Linkage System) may be too expensive as well as spatially disruptive and can be put on the back burner and more focus should be toward ground-level connectivity and perhaps also looking into an electric bus or tram system to begin with.

In addition, certain adverse conditions were not sufficiently challenged, for example the volume of motorized vehicles, the space requirements for motorized traffic and the proposals to build upper-level connections or the absence of residential use within Kwun Tong and Kowloon Bay is a concern. Instead, more mixed-use development should be encouraged together with well-integrated Transit Oriented Development.

Although there has been considerable effort toward public engagement, there is a lack of awareness among the general public of these efforts. Place making, place marketing and branding efforts should therefore be further enhanced so that the EKEO works collaboratively with the people to plan and realize a sustainable regeneration of Kowloon East.

Smart City initiatives in Kowloon East are just in the early stages, and the new Smart City framework developed should be used to ensure a smart and sustainable urban regeneration of Kowloon East area. Also as this research has demonstrated smart thinking with a focus on People, Place and Planet should be embraced and good planning and design should be the driver with technology as the enabler to facilitate the development of a smart and sustainable city in Kowloon East to become a model for other areas in Hong Kong, the region and the world.

10.3 Toward a Holistic and Integrated Approach

While there are quite a number of successful and beneficial Smart City initiatives being piloted and implemented around Hong Kong, a central management system and/or information system is lacking that would be able to easily monitor, control and publicize big data and information gathered through initiatives to reach the full potential for Hong Kong to become a Smart City. Smartphone applications have been developed for numerous government departments and organisations, and there currently exist over 100 government mobile applications ranging from transportation to recreational and leisure services, and from weather and environmental services to social welfare and health care [2].

It is encouraging that the government has taken the initiative to develop and release such a wide range of mobile applications for public use; however, the lack of seamless integration between mobile applications and online services hinders the potential convenience accrued by mobile users. Consolidating a large portion of the information and services into a few more comprehensive and user-friendly mobile applications would promote the idea of a 'one stop shop' for all public services relating to different government departments, and improve the user experience, as

all relevant and necessary information would be at their disposal within the same application. Similarly, the implementation of Smart City initiatives themselves should follow this integrated concept.

Too often Smart City initiatives are undertaken at both small and larger scales, but in a piecemeal fashion with no coordination and unification of information or services. This may indicate in essence Smart City progress; however, ultimately every Smart City indicator, initiative and project should be integrated and connected to a larger smart grid or city infrastructure that supports, monitors and manages the entire system. Smart City development must consider the best method of implementation given the situation and context, and not simply aim to incorporate as many technologies as possible, develop the most mobile applications or partner with the biggest technology companies.

Furthermore, as emphasized in Chap. 2, a more holistic approach to the Smart City concept is needed. A focus on more than the technology and data is essential in order to better comprehend the influences and impacts of the People, Place and Planet on the effective or ineffective advancement of the Smart City as a concept and a reality. Hong Kong scores well in regard to a number of indicators relating to the Smart City elements, from having a highly efficient transportation network, fair and affordable telecommunications services, mature and gradually diversifying economy, and environmental sustainability initiatives.

This research highlighted that Hong Kong is also relatively transparent in its organization, and a wealth of information is accessible in paper and online. The Government has initiated a number of good public policies, but it is clear that policies in some fields fall short of Smart City objectives. In addition, there is a disconnection between policies developed by different stand-alone Departments and Bureaus. Good policies are left on a shelf or are being ignored in the implementation phase of a project because there is not enough coordination between the Departments and Bureaus. A Smart City should have the structural ability to develop and implement cross-cutting policies and plans, and in this respect Hong Kong will need to become more effective.

A greater focus should be put on quality of life issues and quality of the environment with regard to, for example, poor air quality, waste management and walkability. More resources should be devoted to create a higher-quality public realm infrastructure to make the pedestrian and cycling experience in Hong Kong more enjoyable. There are improvements currently happening in certain areas that can be looked upon as a model for other areas within the city. More effort into research and development will take Hong Kong to the next level in the smart and sustainable city and will help other cities in the developed and the developing world to follow.

In addition, while Hong Kong champions operational efficiency and profitability in the realm of public transport and deserving of the classification of having Smart Mobility, the government could do more to curb the growth in private vehicles on the road and encourage more people onto sustainable zero-emission forms of transportation.

This lack of a holistic and comprehensive approach to tackling unsustainability within the city, and targeting smart initiatives in one area but ignoring a problem elsewhere, will restrict the ability of Hong Kong to become a truly Smart City in all six elements.

10.4   Concluding Remarks

Overall, the new Smart City Framework developed is applicable not only to Hong Kong but cities in the rest of the world. This framework could be used as a tool to assess cities, both in the developed and in the developing world so areas of strength and areas that need to be improved can be ascertained. This can become input to policy development but also help in the planning and design of existing and new areas. With smart thinking and a focus on People, Place and Planet with planning and design as important drivers and technology as an enabler, smart and sustainable cities and communities will become a reality in both existing and new development areas.

The Smart City framework can be further developed to include assessment and measuring tools, along with a rating system and key performance indicators so that cities can double check their progress over time and evaluate the outcome of their policies, planning and design and implementation efforts. Also the new framework can also be used to assess and compare various cities to see how they rank so that there is some healthy competition among cities, which will help cities to strive to do better.

Hong Kong does quite well in the areas of Smart Mobility, Smart Infrastructure and Smart Economy but needs to improve in areas of Smart Living, Smart Governance, and considerable effort should be devoted toward Smart Environment. Once it improves in these areas, and in addition to learning from its experience in developing Kowloon East, Hong Kong has the potential to become a truly smart and sustainable city, as well as a model for other cities to follow.

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Part IV
Germany-Stuttgart

Chapter 11
Morgenstadt—A German View of the City of the Future

Satyendra Singh

Abstract Cities which are considered as one of the largest future markets in the world continue to develop innovative technologies and intelligent concepts leading to sustainable development. Urbanization, climate change, growing online culture, ageing populations all call for an innovative solution. Researcher communities all over the world are constantly drafting various concepts and recommendations for smart cities which have solutions to such problems. Cities in Germany are making significant efforts to develop smart and innovative administrative, cultural, educational, and infrastructural practices through connected technologies. Fraunhofer Institute for Industrial Engineering (IAO) initiated the Innovation Network "Morgenstadt" which means City of the future. Morgenstadt serves as a neutral knowledge platform for the integration of various approaches to find solution to such complex dynamics. A consortium of twelve Fraunhofer Institutes spread across Germany contributing to their technical expertise for the joint processing of arguments for the "city of the future". The synthesis of above-mentioned aspects which deal with Urban manufacturing, visual communication and shared economy-based approach have a potential to lend the city a unique profile which is vitally important for the city's future economic development. These constitute the framework within which future economic profile of a city regions are determined.

11.1 Introduction

The world's increasing urbanization has the consequence that today more than half of all people live in cities and this number is expected to grow in future. City regions are constantly evolving themselves to deal with global megatrends such as climate change, resource scarcity and demographic change. Cities which are considered as one of the largest future markets in the world continue to develop innovative technologies and intelligent concepts leading to sustainable development.

S. Singh (✉)
Visiting Faculty, University of Applied Sciences, Stuttgart, Germany
e-mail: ssingh27@hotmail.com

The concept of sustainability, in this term, involves organizations that modify their actions as a result of participating in research, and individuals who, through the research process, gain knowledge and skills that are used in real world economic domains [1]. Urbanization, climate change, growing online culture, ageing populations or pressures on public finances, call for an innovative solution and researchers' communities all over the world are constantly drafting various concepts and recommendations for smart cities which has solutions to such problems.

In Germany, smart cities are largely perceived as "CO_2 neutral, energy and resource-efficient, climate-adapted cities of tomorrow". The leading scientific research organisation Fraunhofer Society is also propagating that a smart city is an "informed, networked, mobile, safe and sustainable city". Cities in Germany are making significant changes in turning to smart administrative, cultural, educational and infrastructural practices through the use of information and communication technologies. It is generally considered that these changes will have a positive impact upon all levels of society. Cities in Europe such as Southampton, Stockholm, Amsterdam, or Vienna are already marching ahead while cities in Germany like Stuttgart, Frankfurt, Berlin, and Munich have taken similar steps in this direction.

Aiming for the sustainable reconstruction of the cities to explore the best technologies and solutions in the world of tomorrow, the Fraunhofer Institute for Industrial Engineering (IAO) initiated the Innovation Network "Morgenstadt" which means future cities. Morgenstadt serves as a neutral knowledge platform for the integration of various approaches to find solution to such complex dynamics. The network which consists of partners from the industry and representatives of cities, emerging technologies and concepts for sustainable urban systems offers the ideal framework to analyse future trends of city development. The partners draw on existing "best practices" in the sectors of mobility, energy, communications, buildings, resources, security and governance, as well as on existing studies and strategies to analyze these on common opportunities and challenges. Current partners in the network include global companies such as Bosch, Fichtner, Daimler, EWE, Drees and Sommer, EnBW, TÜV Süd, Siemens and Volkswagen. A consortium of twelve Fraunhofer Institutes spread across Germany contributing its technical expertise for the joint processing of arguments for the city of the future. The long-term goal is the establishment of new concepts and innovations in the respective cities in the world.

The Chaps. 12–14 discuss three research project undertaken by IAO Fraunhofer Institute Stuttgart along with Stuttgart University and other European and private sector partners. The important contribution comes from the Triangulum project involving Manchester (UK), Eindhoven (Netherlands) and Stavanger (Norway), as well as the "follower cities" of Leipzig (Germany), Prague (Czech Republic) and Sabadell (Spain). The project emerged from the Fraunhofer-IAO Morgenstadt (city of tomorrow) initiative. Other projects deal with economic and innovation aspects on Smart cities. Stuttgart and its surrounding region have already set various examples of smart practices while ensuring the environment friendly and people-oriented mobility for everyone. The development of Stuttgart region over

time incorporated specific core competencies which result from integrated socio-economic interaction, evolution of firms, institutions and political actors.

The whole section "Morgenstadt—A German View of the City of the Future" is divided into four chapters. First, a general profile and the socio-economic profile of Stuttgart and its surrounding region are presented. This section then focuses more closely on governance structure of the Stuttgart region with a unique blend of its innovative potential. This section also emphasizes how industrial clusters, the institutional set-up within the region, training and education, regional R&D infrastructure to a large extent determines the economic and innovation profile of the city. The innovation applied in institutional and governance structure by Stuttgart region with its unique way of functioning and decision-making has also set an example for its all-round spatial and economic development.

The following chapter propagates the innovative concept of urban manufacturing i.e. coexistence of living and manufacturing zones in the backdrop of urbanization and growing demand of industrial real estate in Stuttgart Region. The term urban manufacturing means production of goods close to conglomerates of humans and their living areas. The project considers high technology with "ultra efficiency" as important factor for future competitiveness of a region. The idea is that companies with the concept of urban manufacturing can create production networks and share resources for optimized capacity balancing. The regional sourcing may help improving the product life cycle and resource cycles.

In Chap. 13, it is argued that smart technologies for cities require a fundamental shift in business model paradigms. A synthesis of business models is presented by combining a set of elements that require radically new forms of investing, building and operating urban solutions. A smart city value model is conceptualized with a unique shared economic approach which also considers challenges of market barriers along with organizational and leadership challenges. The section also touches the aspects of technology trends, key challenges of investing, building and operating smart solutions, opportunities and some details around the cores of transition in planning. The section concludes with a suggestion to conceive smart solutions as a structured and reproducible set of technologies, services, actors and benefits.

Chapter 14 emphasizes the significance of public participation in mega construction project for sustainable development. This is particularly relevant for the development and redevelopment of city centres and urban areas to improve residential conditions and public services. This can safeguard interests of both public as well as private stakeholders and the interests of citizens and community members. The section also explores importance of visual communications, visualization techniques targeted to different groups, and adaptation of these key visualization methods to ensure informal public participation. This whole idea is seen as minimizing the confrontation between different groups like one has witnessed in project Stuttgart 21.

The synthesis of above-mentioned aspects which deal with Urban manufacturing, visual communication and shared economy-based approach have a potential to lend the city a unique profile and are vitally important for city´s future economic

development. These constitute the framework within which future economic profile of a city region can be determined.

Stuttgart Region: General Profile The Stuttgart Region in south West Germany comprises the City of Stuttgart (the capital of state of Baden-Württemberg) and its five surrounding counties. Stuttgart region counts up roughly 2.7 million inhabitants while Stuttgart city has roughly 600,000 inhabitants. Stuttgart region includes a large core city and the smaller surrounding towns which share economic activities, essential public services as well as close cultural relations with Stuttgart. The area boasts a highly advanced industrial infrastructure and enjoys a reputation due to its economic strength, cutting-edge technology and exceptionally high quality of life. River Neckar passes through the city of Stuttgart.

Stuttgart is the 7th largest city in Germany with a strong economy, vibrant cultural life, low crime rate and excellent health and education facilities. The city often finds place in liveability rankings as well as mentions in economic and social innovation news. Various surveys on quality of life in German cities indicate that Stuttgart offers best quality of life with highest per capita income among German cities. Being home of Mercedes, Bosch and Porsche, it is considered to be the starting point of the worldwide automotive industry and is sometimes referred to as "The cradle of the automobile". The official spoken language is German, though city is home to a large migrant population where people from over 180 countries live in complete harmony. The region also has its own parliamentary assembly "Verband Region Stuttgart" (VRS), ensuring fast, effective decision-making on regional issues such as local public transport, regional planning and business development.

In recent years, Stuttgart Region has earned the reputation of being one of Europe's most successful economic centres. There is a healthy mix of leading multinational companies along with highly innovative and dynamic medium-sized enterprises. Companies from this region Würth, Kärcher, Festo, Stihl and Trumpf have made their name throughout the world for innovation and quality. The region boasts of highest density of scientific, academic and research organisations which along with strong economic landscape pave the way for innovation and development. The region finds second place at the national league for patent applications. Stuttgart Region Economic Development Corporation "Wirtschaftsförderung Region Stuttgart" (WRS) ensures companies located in the area enjoy the conditions required for innovation. WRS helps establish and maintain links between regional networks and industry clusters, and between business, the education system and the research community. WRS takes care that region's economic and structural strengths is maintained (Table 11.1).

Stuttgart with presence of world's largest high-tech auto industry is also known for its advanced implementation of ICT industry. The city offers supportive and conducive environment to develop innovative technologies which spread across mobility, energy, environment, automotive and building industry. Stuttgart's healthy innovation climate is fostering the development of futuristic environmentally friendly and sustainable technologies. The Stuttgart Region attracts numerous regional and international companies. It is also Germany's leading export region.

Table 11.1 Key economic data of Stuttgart Region

Key data: Stuttgart Region	
Population	2.7 million (170 countries)
Area	3654 km^2
Population density	724 per km^2
People in employment (economically active)	1.5 million
Gross Domestic Products	109.8 billion €
Registered companies	About 160,000
R&D expenses by the companies	7.5 % of GDP
Unemployment rate	Low: 4.2 % (01/2015)
Export rate of manufacturing industry	63.4 %
Productivity	72,991 €/employee
Per capita income	37,936 €

Source Reports by WRS, VRS and The Chamber of Commerce and Industry (IHK) Region Stuttgart

The region has high international competitiveness with more than 60 % of turnover in manufacturing is generated abroad. Compared to other economic locations, Stuttgart and the Stuttgart region are perfectly positioned, also relating to growth, employment, purchasing power and investment and the great diversity of innovative fields.

The high-tech industries are the key industries of the city of Stuttgart as well as that of the entire region. Numerous products which are manufactured here are identified with a long tradition, innovation, excellent quality and outstanding success. Many of the everyday conveniences we now take for granted were once invented in the Stuttgart Region. Some of invention include Coffee machine, Office copy machine, Spark plug, Air bag, Handle drill and TV Tower. Stuttgart's economy is well known for its competencies in the fields of mobility, aerospace, mechanical engineering, financial services, IT, media, health and tourism [2].

11.2 Stuttgart Region: Innovation Profile

The Stuttgart Region is arguably one of Europe's best innovation hubs with a strong industrial base in service and manufacturing segments. The technologies which have evolved over decades, today show a high level of integration comprising OEMs, suppliers and specialized service providers as well as educational and research institutions. Sectors like ICT, electrical engineering, creative industries or financial services play an important role too. Universities and research organisations enjoy an excellent reputation particularly with regard to engineering, automotive and natural sciences. Graduates quickly gain understanding of latest scientific developments and hands-on experience which they can easily transfer to the workplace. This arrangement of cooperation between universities, research

establishments and companies benefits all sides and the regional economy. The region has earned reputation for high-grade engineering, Machine tools, robots or laser technology development and production of a wide spectrum of innovative and highly specialized solutions and services.

The Stuttgart Region is also a hub of the over 10,000 creative industries which include publishing houses, advertising, marketing, animation, film and communication agencies as well as numerous design and global architectural firms. Global names in ICT sector, open source, virtual engineering and software development have established their centres in this region. Stuttgart Region is pursuing the ambitious goal to become one of Europe's most important locations for clean energy technologies which include renewable energy and efficiency technology. The region has clean energy cluster of nearly 300 companies ranging from small start-ups to global players.

The Stuttgart Region Economic Development Corporation (WRS) takes a comprehensive approach to economic development of region and places with a great emphasis on creating and maintaining corresponding networks between knowledge-driven businesses and the education and research community. WRS plays a crucial role to improve the competitiveness of established businesses through regional competence and innovation centres. WRS also supports programs to enhance the skills of local employees, and to support innovative start-ups. Young technology-led businesses mostly by start-ups are linked in the proximity at a number of technology parks and business incubation centres. They also get adequate support and advice from Regional competence and innovation centres on market entry and collaborative projects. This opens up new doors for opportunities for up-and-coming enterprises.

The Stuttgart Region has many leading universities and institutes dedicated to innovation. Enterprises here invest more on R&D than anywhere else in the country. This accounts to 10 % of total expenditure by German industry. This has placed Stuttgart in the top league of areas from where more number of patents has been applied. For Table 11.2 shows the number of patent registration in different region of Germany in 1995–2000 in which Stuttgart tops the list.

The economic development strategy aims at holding the leading position through innovation, diversification and orientation towards export. The city region applies instruments like support for skill development programs, promotion to Start-ups to achieve these goals. Stuttgart Region and WRS also obtain support from the European Union for innovative project concepts in their various fields of activity. The thematic focuses of the EU projects are within the fields of activity of the Verband Region Stuttgart (VRS) and Stuttgart Region Economic Development Corporation (WRS). It is ensured that that experience and knowledge be exchanged with other regions involved in the projects which are also evident in Triangulum project undertaken by IAO Stuttgart. Networks like METREX, ERRIN, POLIS, the network of European Metropolitan Areas and Regions are some of the examples of cooperation with other EU partners. Recently Horizon 2020 and INTERREG programs have been started keeping in mind the same objectives. The cooperation

Table 11.2 Patents from German economic centres

		Stuttgart	München	Düsseldorf	Rhein-Main	Mittefranken	Berlin	Köln	Braunschweig	Unterer Neckar	Starkenburg	Deutschland
Patentanmeldungan	1995	2539	1981	1632	1517	998	960	1028	391	682	745	29,690
	2000	3653	3091	1901	1680	1267	1179	1090	1057	816	812	40,374
Rangfolge	1995	1	2	3	4	6	7	5	24	9	8	–
	2000	1	2	3	4	5	6	7	8	9	10	–

Source City of Stuttgart

helps and facilitates benchmarking activities enhances the experience and benefits of knowledge transfer with other European partner regions.

With the changing face of industry, regional strategy of the region is restructured to enable the region to meet its economic challenges. The thrust areas identified are innovation, sustainable mobility and environment, skilled personnel, investors and marketing for the region. The idea is to make this region most competitive region of Europe with high quality social and educational infrastructure, where ideas are quickly turned into innovative processes, products and services without forgetting social and ecological responsibility. WRS utilizes its close network of public and private sector organisations representing the state government, county governments, local municipalities, the regions' universities and higher education institutions.

11.3   History

The first settlements of Stuttgart date back to the 1st century AD with the establishment of a Roman fort on the banks of the river Neckar. It was under the Roman Empire that Stuttgart became thriving and prosperous and elevated to status of a city in 1321 when it became the official royal residence. Stuttgart has had wine yards as far back as 3AD and its prosperity kept growing up till date. Stuttgart became the capital of Württemberg in 1918, and when Baden joined with Württemberg in 1952, the city was named the capital of Baden Württemberg. Gottlieb Daimler, who helped pioneer the motor car, and inventor Robert Bosch, who owns a huge engineering and Electronics Company, are some of the famous names who belong to this region (Fig. 11.1).

At the centre of Stuttgart lies its main square Schlossplatz which stands at the crossover point between the city's shopping area and Schlossgarten park. The city centre with castle, churches, museums witness the cultural relevance that Stuttgart has had in the course of the time. Königstraße, Stuttgart's most important shopping street which runs along the north western edge of Schlossplatz, claims to be the longest pedestrianized street in Germany. The centre of Stuttgart was almost completely destroyed by Allied air raids during World War II. The US military made Stuttgart the headquarters of its forces in Europe, a presence that helped the city reconstruct following major structural damage in World War II.

11.4   Geography and Administrative Boundaries

Stuttgart is located in the geographic centre of state of Baden-Württemberg (BW) in south west of Germany. BW is located 48.78 latitude/9.18 longitudes (at elevation 252 m above sea level) shares its border with by France and Switzerland. City of Stuttgart is divided into five "inner" and 18 "outer" municipalities. They are clockwise from the northeast, called: Fellbach, Kernen im Remstal (all Rems-Murr-Kreis),

Fig. 11.1 Stuttgart with its lush surrounding hillsides

Esslingen, Ostfildern, Neuhausen auf den Fildern, Filderstadt and Leinfelden-Echterdingen (all Esslingen district), Sindelfingen and Leonberg (Böblingen) and Gerlingen, Ditzingen, Korntal—Münchingen, Möglingen, Kornwestheim and Remseck (all the district of Ludwigsburg). The rich neighbourhoods in the East, West, North and South make it strategic when it comes to geographic linkages with Germany and other parts of Europe. The city covers an altitude difference of almost 350 m, which is unique among the large cities (Fig. 11.2).

The municipalities have a county council and a volunteer district director. Municipalities form administrative counties called "Landkreise" to ensure broad array of public services to every citizen within an acceptable time and distance. Municipalities enjoy autonomy to engage in economic development and spatial planning and are considered to be most important political level. The municipalities are divided further into districts. In BW the number of districts was increased to 152 districts from 1 July 2007 and January 1st of 2009.

Stuttgart is an important political centre in Germany and the seat of the State Parliament (Landtag) as well as all Baden-Württemberg state departments. In June 2009 for the first time since 1972, the Greens gained the most seats in a German city with more than 600,000 inhabitants, effectively changing the balance of power in the city council toppling CDU absolute majority shared with the Independent Party and the FDP. The main reason for the Greens' victory was disgruntlement with the controversial Stuttgart 21 rail project. The participation of citizens in
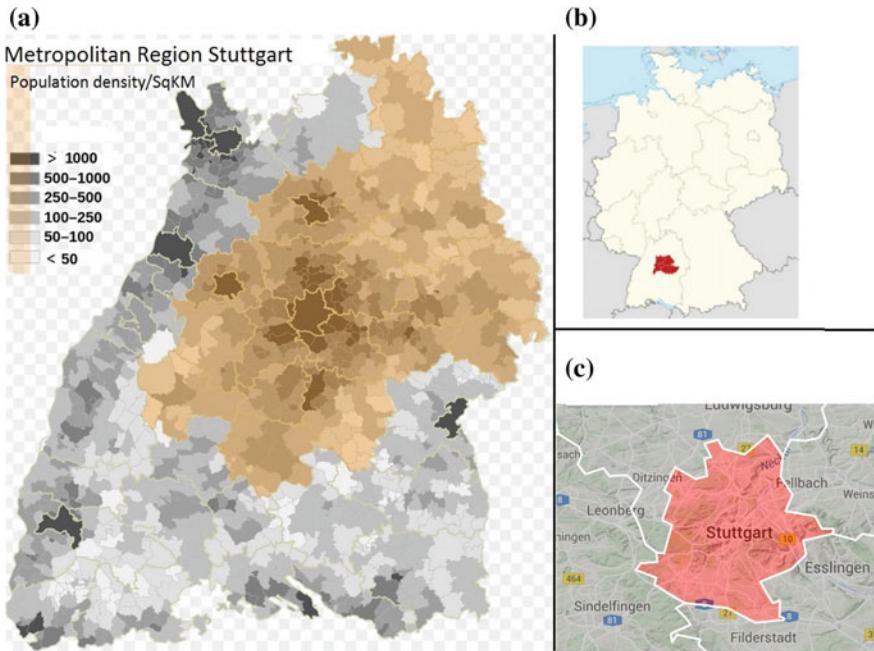
Fig. 11.2 a Municipalities of the Metropolitan City of Stuttgart; **b** Location of Metropolitan City of Stuttgart in Germany; **c** Location of Metropolitan City of Stuttgart in State of Baden-Württemberg

decision-making on big construction and infrastructure project was not ensured which resulted into disagreement and resentment and frequent protests against Stuttgart 21 project.

11.5 Demography

Stuttgart region has a population of around 2.7 million people coming originally from 169 countries. This represents a quarter of the population of Baden-Württemberg at just about one tenth of the area. The population density of the region is 731 people per square kilometre. Figure 11.3 shows the trend of population from 70s till 2009. There has been no significant change recorded after 2006.

Historically, the population of Stuttgart city was limited to 100,000 inhabitants till 1875 and a significant growth has been recorded in 1905 when city had almost 250,000 inhabitants. This number doubled in 1950 when it touched the figure of half million in 1950. The historical peak of the population reached 640,560 in 1962. In 2009, the population for Stuttgart was 592,900 which make it the sixth most populated city in Germany city is in the list of cities in Germany after Munich and

Fig. 11.3 Population growth of Stuttgart region
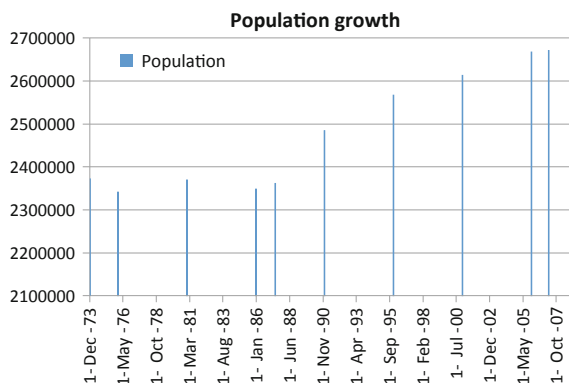
Frankfurt, the third largest city in southern Germany. Among the counties also Stuttgart tops the list with highest number of people followed by Ludwigsburg. Table 11.3 shows the population growth trend of Stuttgart region, which is increasing since 2011.

As is evident in many parts of the Germany, Stuttgart has also registered a slow population growth rate. It registered even negative growth rate of 1.95 from year 1990 to 2000 which was later picked up and has shown a growth rate of 1 %. Table 11.4 shows the population of Stuttgart in the last 3 decades. It can be seen from the table, that population growth is almost stabilized and stagnant. But, the economic growth is not stalled, and the city has shown considerable growth in the previous 20 years.

It is clear from the above figure that the average age of the population has been growing continuously in each of the decades. It is also indicated that the decline in the population is in the less than 15 year class and the increase in the more than

Table 11.3 Population growth of Stuttgart City

Population, foreign passport holders (December, 31)				
	Population			
	2011[a]	2012[a]	Increase/decrease %	Aliens in %
City of Stuttgart	591,015	597,939	+1.2	21.5
Böblingen (county)	364,458	367,208	+0.8	14.3
Esslingen (county)	504,961	508,577	+0.7	13.5
Göppingen (county)	247,194	247,835	+0.3	12.1
Ludwigsburg (county)	512,086	516,748	+0.9	14.4
Rems-Murr-county	407,150	408,827	+0.4	12.4
Stuttgart Region	**2,626,864**	**2,647,134**	**+0.8**	**15.3**
Baden-Württernberg	10,512,441	10,569,111	+0.5	11.4

[a]Based on census of 2011
Source City of Stuttgart

Table 11.4 Population growth of Stuttgart City

Inhabitants	1990	2000	2009
	598,698	586,978	592,900
(a) Fewer than 15 years	73,700	76,500	74,100
(b) Between 15 and 45 years	274,100	263,100	261,900
(c) Between 45 and 65 years	155,300	151,300	145,900
(d) 65 years and over	95,700	96,200	111,000
Average age	40.8	41.5	41.6
Population density (Inh./km^2)	2890	2830	2860

Fig. 11.4 Age structure of Stuttgart city
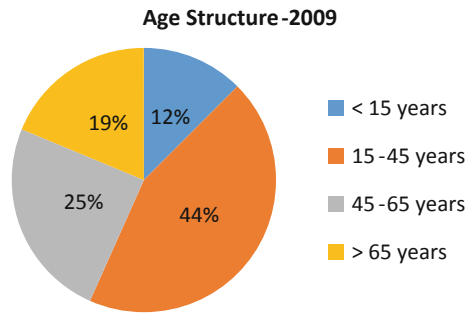
65 year class. The age structure is as recorded in year 2009 is represented in Fig. 11.4.

The mid-1950s marked the start of the immigration to Stuttgart. The city has got a large number of migrant populations as it ensures better employment prospects and better wages compared to the other cities of the country. Stuttgart has a substantial proportion of the population with immigrant background. The migrant population in 2011 census was second highest at 38.6 % after Frankfurt with 44.2 %. These were primarily male 'guest workers' from southern European countries mostly engaged in reconstruction of cities and town after massive destruction during WW II. By the end of 1970s, it was clear that these workers have started settling down with their families in Stuttgart. As part of the "Gastarbeiter" program many foreigners have also immigrated in search of work. The next major set of immigration was caused by the wars in Yugoslavia in the 1990s. Thus, 40 % of the city's population is of foreign background. In 2000, 22.8 % of the population did not hold German citizenship; in 2006 this had reduced to 21.7 %. The largest groups of foreign nationals were Turks (17 %), Greeks (11 %), Italians (11 %), Croats (10 %) [3] and Serbs followed by immigrants from Romania, Bosnia and Herzegovina, Portugal, Poland, France and Austria. This is represented in chart 2. 39 % of foreign nationals come from the European Union (mostly Italy, Greece and Poland). In recent years, Stuttgart's migrants had stronger economic reasons than political ones.

Fig. 11.5 Foreign migrants in Stuttgart (by percentage of migrant population)

Foreign Migrants in Stuttgart (by percentage)

- Turks
- Italians
- Greeks
- Croatians
- Serbs/Montenegrins
- Others
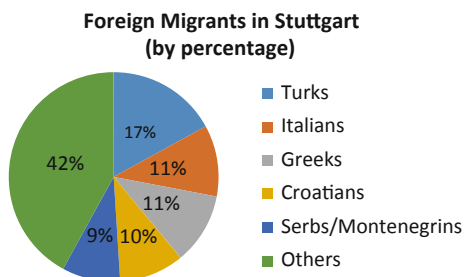
Fig. 11.6 Workforce structure

Workforce Structure

- Agriculture, Forestry and Fisheries
- Construction
- Manufacturing
- Wholesale and retail trade
- Financial intermediation and other services
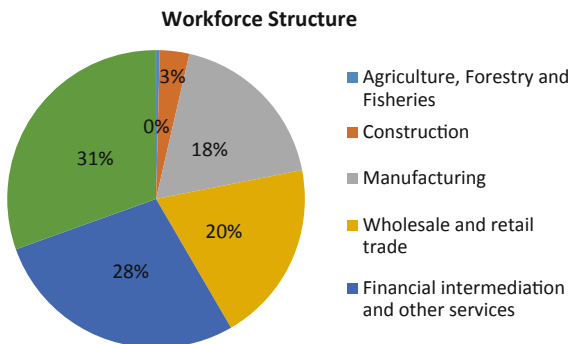
As per the estimations of The Chamber of Industry and Commerce in 2009, the Stuttgart region had a total of 1.4 million people in its active working population. As is seen in the population dividend on the basis of origin, majority of the workforce is still German with around 22 % being comprised primarily of a mixture of Turks, Italians, Greeks, Croatians, Serbs and Slovenians (Fig. 11.5).

Stuttgart's largest employment generator is the automotive sector. Around 50 % of its economic turnover comes from auto related industries. Manufacturing accounts for 40 % of employment in the city. Finance, Media and ICT have also got a key role in the play. 24 % of the work force is expected to be employed in hi-tech jobs. Stuttgart's highly skilled workforce comes from its well-established public education system (Fig. 11.6).

The city has a number of universities, technical colleges and other academies such as the University of Stuttgart, University of Hohenheim, State University of Music and Performing Arts and the University of Applied Arts. The Initiative Neue Soziale Marktwirtschaft (INSM) estimated in 2009 that 21 % of the work force had gained a degree from a university or university of applied sciences. It is to be noted that Stuttgart has consistently kept the lowest levels of unemployment compared to other German regions.

When compared to the other major cities in Germany, the percentage of people engaged in high-tech industries is much higher in Stuttgart. Please refer Fig. 11.7 for comparison between various cities on percentage of people engaged in
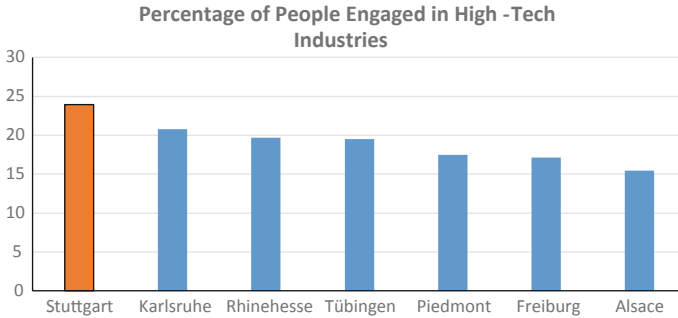
Fig. 11.7 Percentage people engaged in high-tech industries

High-tech industries. In 2007 Eurostat ranked Stuttgart number one in terms of number of people employed in high-tech industries in Europe. This is due to the presence of many leading auto manufacturing units and IT firms in the region.

11.6 Governance

The idea of "Stuttgart region" started in early 1990s when the term was coined while reorientating the spatial planning policy of Germany. Selected key regions of Germany namely Stuttgart, Rhine-Main, Hamburg and Berlin were considered as motors of socio-economic development in the process of European integration. The Stuttgart Metropolitan region and its association with the Stuttgart Region was typical example of the new institutional and governance structures. The structure was created to complement and improve traditional forms of politico-spatial organisations in Germany. The idea of "Verband Region Stuttgart"(VRS) was introduced in order to increase the effectiveness of administration and mobilize regional potentials. As a result, a new innovative governance structure emerged and institutionalization of Stuttgart Region was conceived which added positive development trends in this region.

The task of economic development which was made obligatory for VRS till economic development agency WRS was founded which also included responsibility for promotion of location, attractiveness, foreign trade, promotion of innovation, support for environmental technology, computer services, Internet and establishing a regional job training agency. The VRS is still responsible for economic development of the region by interlinking it with spatial planning and economic policies. Attention was also paid to support job creating sectors and job training agencies for skill development. Behind all the projects of the VRS and WRS the key idea is to create a synergy among leadership, project partners and teams to trigger innovation. The aim is for actors to acquire the competence to develop and realize projects and to develop the capacity for cooperation and networking [4].

Fig. 11.8 Building and adjacent open area change over years

Building and adjacent open area change over years (in Sq.Km)
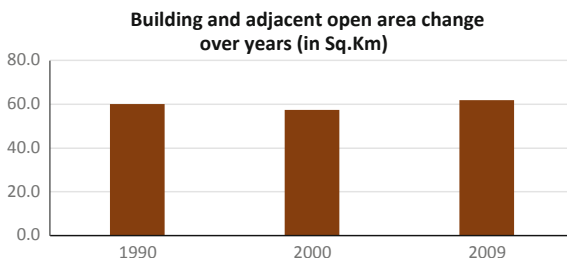
Fig. 11.9 Change in area under trade and services (km^2)

Trade and services (km²)
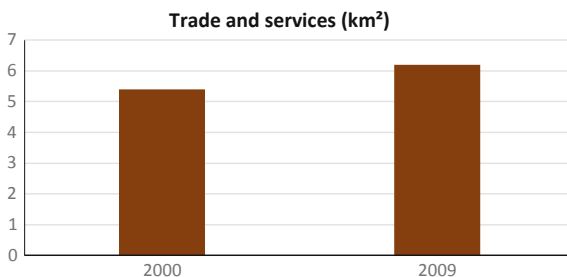
The development of Stuttgart region is characterized by process of suburbanisation of economic growth, population and industries. In the process administrative boundaries were increased in 70's which added more number of inhabitants to the region. This process has also affected adjoining municipalities which were benefitted from suburbanization process. This has also made positive changes in the socio-economic fabric of the city which has also affected employment scenario of the region. The inclusion of efficient mobility infrastructure in the region has also improved the economic situations.

The whole development has increased land utilisation of the region which has affected ecological balance of the region. Figure 11.8 shows the change in built-up and open area from 1990 to 2009. As a result, the core city areas have seen increased population of economically weaker classes while prosperous households started moving in the urban fringe to find natural surroundings. The changes in major land uses over the years are shown in the graphs below. Figure 11.9 depicts the change in area used under trade and services which is increased in last 15 years.

Attempts were made to streamline the land use planning of commercial/ industrial areas, residential area along with mobility and key infrastructure of the region. Inter-local industrial areas (Gewerbegebiete) were established in the region to create positive economic effect. At the same time, local municipalities and/or administrative districts formulated policies by offering attractive land outside city centres and quite often close to adjoining municipalities or administrative districts. An innovative concept presented in the following chapter is the extension of similar thought terms as urban manufacturing i.e. coexistence of living and manufacturing zones. The idea is that companies with the concept of urban manufacturing can

optimize production networks and share resources for optimized capacity balancing.

As a result, the Stuttgart region which was socially and economically integrated by 2000 has become the largest contributor on gross value addition in the state of Baden-Württemberg. As many as 27.6 % of all jobs in traditional industries (e.g. electrical engineering, clothing, textile and furniture industry) in Baden-Württemberg were located in the metropolitan region. Typically, service industries dominate the inner city while Production and R&D activities are predominantly located in the urban fringe.

New jobs were created in the region mostly in tertiary sector. While occupying only 10 % of the total area of Baden-Württemberg, in 1995 the Stuttgart region accommodated 25 % of the population and 28 % of the jobs, in 1996, 36.3 % of all jobs in financial services, 35.7 % of those in producer services and 34.1 % of those in knowledge intensive industries (e.g. mechanical engineering, computers and automobile industry) [5].

The metropolitan region has also experienced an economic downturn in 90s which affected key industries and increased unemployment. Due to this, new objectives were formulated for "Stuttgart metropolitan region" while considering it a European region Stuttgart' keeping in mind the competitiveness of this region. Tasks related to transport planning, waste disposal, economic development, job training, locational marketing and marketing of regional tourism management of services in the region were given due importance (Fig. 11.10).

Project 'Stuttgart 21' which was originally conceived by VRS together with the federal state Baden-Württemberg and the city of Stuttgart is of key importance.

Fig. 11.10 Stuttgart Region

The VRS mediated between the various stakeholders, particularly the affected municipalities. In the EUR 2.5 billion project to remodel the main railway station ('Stuttgart 21). The policy and decision-making style adopted by Stuttgart metropolitan region indicates a shift away from conventional decision-making. This development was focusing on social and economic development; improve tie-ups between a broad array of actors, dissemination of knowledge, mutual learning, promoting inter-organisational relation and foster partnerships between official and non-government organisations in the management of economic, political and social relations. However, in case of Stuttgart 21, it was difficult in a complex system to convince each stakeholder for the common objectives which seem not mutually decided. After many delays related to legal, financial, administrative and other factors the project has seen mass opposition due to concerns like damage to green spaces, soaring costs and regional identity of the Stuttgart. The discussion started about importance of early public participation and communication for such construction projects. The study done by Fraunhofer emphasizes the significance of public participation in mega construction project for sustainable development which is presented in the last chapter of this section. This whole concept of early participation is seen as minimizing the mass opposition like one has witnessed in project Stuttgart 21.

11.7 Culture

Stuttgart is considered as the cultural centre of not only the State of Baden-Württemberg, but also whole of Germany. Stuttgart is also the home of the world-famous ballet and there are museums and art galleries as well as academies of music and art. Stuttgart gets top rankings in number of polls which are undertaken among European cities. Stuttgart's cultural flagships include the city's art museums and its renowned orchestras, its music festivals in a variety of genres and its architectural highlights, as well as the State Theatres with the world-famous Stuttgart Ballet, the award-winning Stuttgart Opera and innovative theatre productions [6]. This wealth of culture has a significant influence on the success of the conference and congress sector, presenting an endless range of possibilities for exceptional supporting programmes and incentives.

11.8 Mobility

The Stuttgart region has well-developed mobility network connecting to all key location of Germany and Europe. Stuttgarter Straßenbahnen AG (SSB) operates the bus and light rail system in Stuttgart called "Stadtbahn" which reaches the neighbouring towns of Remseck am Neckar, Fellbach, Ostfildern, Leinfelden-Echterdingen and Gerlingen. The Stadtbahn is a part of the regional transport cooperative, the Transit and Tariff Association Stuttgart (VVS), which coordinates

Fig. 11.11 Stuttgart Main Station

tickets and fares among all transport operators in the metropolitan area. The network of The Stuttgart Stadtbahn is the successor system of a tram network (Straßenbahnen) that characterized the urban traffic in Stuttgart for decades. The motorway junction Stuttgart cross connects the motorways 8 (Saarland—Stuttgart—Munich—Salzburg, European route E52), 81 (Würzburg—Stuttgart—Singen (Hohentwiel); European route E41) and only a few kilometres long A831.

The main train station called Hauptbahnhof is located in the close proximity of Stuttgart's shopping district Königstraße and the Schlossgarten. The project Stuttgart 21 which was conceived in 1994 to improve the linkages with other cities and countries streamline regional and local train traffic in the Stuttgart region has also been considered as catalyst to boost the economic prospects of country and region. In the train station's tower, one can find the exhibition Stuttgart 21, which is a project of the City of Stuttgart that consists of a complex reconstruction of the train station into an underground through station. There has been difference in opinion regarding the planning and idea of project Stuttgart 21 which also has seen widespread opposition (Fig. 11.11).

Stuttgart is also a part of EU-part-funded Trans-European Networks (TEN) project which connects Stuttgart to East west transport corridor Paris—Vienna—Bratislava. It is envisaged that after completion of project Stuttgart 21, a well-developed area would be available for services, trade, culture and high quality of living. There are plans to link and develop green belts connecting green spots namely Schloßgarten, the Rosensteinpark and the Killesberg. The total development area consists of 100 ha and is divided north easterly of the train station in three part areas with different characters.

Stuttgart has set an ambitious goal when it comes to mobility on bicycle, cycle network and new services that make cycling more attractive. At present, the cyclists make up 20 per cent of all traffic on available 180 km cycle tracks. There are online route planning facilities, Bike and Ride offers, bicycles or bicycle service stations at
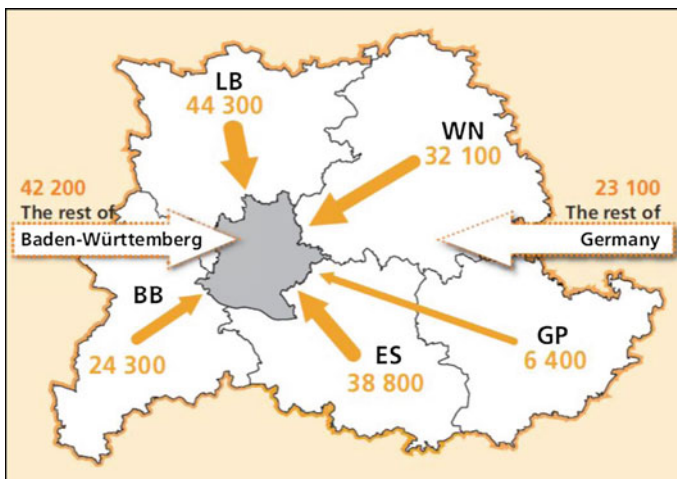
Fig. 11.12 Mobility data showing daily commuters to Stuttgart. *LB* District Ludwigsburg; *WN* Rems-Murr-District; *GP* District Göppingen; *ES* District Esslingen; *BB* District Böblingen. *Source* Economic Data on Stuttgart-2010

railway stations make the public transport for cyclists attractive. An extensive call-a-bike network is in the inner city districts and Bad Cannstatt is also made available. The city offers a fleet of rental bikes, in a scale that is unique in Germany, with electric support in Stuttgart.

The Stuttgart Region has a highly developed concentration of automotive manufacturers, engineering service providers, component suppliers and research facilities. The region has earned a reputation to use fuel cell technology, electro mobility and IT for cars and virtual engineering. The Federal Ministry of Transport has granted the Stuttgart Region the status Electric Mobility Pilot Region (Fig. 11.12).

The map shows daily commuters from surrounding districts of Ludwigsburg, Rems-Murr, Göppingen, Esslingen and Böblingen to Stuttgart region. This idea is to represent how Stuttgart is integrated to the surrounding counties of administration. The commuters from other regions of Baden-Württemberg and Germany to Stuttgart are also shown. From this, it is clear that the interrelation of Stuttgart with Ludwigsburg and Esslingen is more when compared to the other regions. The number of commuters from other parts of Baden-Württemberg is much more than that from other parts of Germany.

11.9 Economy

In 2009, the Chamber of Industry and Commerce (IHK) estimated the Stuttgart regional GDP at €101.336 billion, with an estimated per capita income of €33,995 per inhabitant. The city is also one of Germany's leading financial centres, home to Germany's second most important stock exchange.

Table 11.5 Economic potential of Stuttgart

Category	1991	2000	2008
Gross domestic product (GDP) (EUR bn)	25.4	28.6	34.4
Per person in employment (EUR)	52,800	61,900	73,000
Gross value added (EUR bn)	23.7	25.8	30.9
Per person in employment (EUR)	50,600	55,700	65,500

The region is also renowned in terms of its Research and Development expertise, home to the highest density of universities and institutes and research facilities. Stuttgart has shown a steady growth in terms of GDP from 1991. This is despite the fact that the population has not increased on a par with this growth. This implies that the income per person in employment have increased which is evident from Table 11.5.

11.10   Steps Towards the Smart City

The evolution of the smart city will involve key building blocks i.e. smart people, smart economy, smart mobility, smart living and smart governance. While no city can truly claim is to be a compliant of all the building blocks, Stuttgart city region complies with almost all key building blocks of Smart City System and it would take a complex set of collaborations to study the interlinking of these building blocks. Taking example of Smart Mobility in Stuttgart Region, Stuttgart Service Card, which links mobility services for public transport, car and bike sharing has been widely accepted which also provides access to libraries and public swimming pools, as well as the provision of a payment and bonus function using just a single card. Additional benefits for the citizens are improved quality of information and time savings through central service processes via the B2C portal.

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Chapter 12
Economic Impact of Ultraefficient Urban Manufacturing

Satyendra Singh, Michael Hertwig and Joachim Lentes

Abstract Cities are adopting urban manufacturing practices by producing the goods close to conglomerates of humans and their living areas. Production takes place in city areas with optimize production processes. The burden on resources is minimised by creating production networks and optimizing capacity balancing. This practice is seen as reducing burden on resources, boosting innovation and offering a better quality of life. Ultraefficiency concept is introduced to achieve sustainability in efficiency and make processes economically better. Some cases taken from Stuttgart region provide further insight to implementation of this concept and the way the simulation and its long term evaluation is planned.

Keywords Urban manufacturing · Ultraefficiency · Productivity · Sustainability · Economy

The contribution of Stuttgart region in GDP of Germany is 3.7 %. The economy is largely service oriented while manufacturing contributes to almost one third of total employment. The contribution of agriculture to GDP is meager 0.5 %. During the past few years, employment in manufacturing as a share of total employment has been falling. The knowledge and experience from Manufacturing sector is crucial to develop the service sector. The structure of the local economy is embossed by two clusters—the automotive cluster and the manufacturing technology cluster [1].

Despite this falling trend in manufacturing, the demand to create industrial real estate is still growing as manufacturer find it hard to develop business network, handle transportation and get involved in R&D from remote locations. Recent reports indicate high technology as an important factor for future competitiveness of the region. Stuttgart region boasts of very high investment in research and

S. Singh (✉)
Stuttgart University of Applied Sciences, Stuttgart, Germany
e-mail: ssingh27@hotmail.com

M. Hertwig · J. Lentes
Fraunhofer Institute of Industrial Engineering (IAO), Stuttgart, Germany
e-mail: Joachim.lentes@iao.fraunhofer.de

		importance	satisfaction
	high	1	1
	low	4	4
strength	supply security of energy supply	1,8	1,71
	Accessibility of sales markets/ customer distance	1,8	1,77
	customer loyality	1,8	1,78
	image of region Stuttgart	2	1,8
	Accessibility of matching education possibilities	2	1,99
neutral	general accessability	1,9	2,11
	high speed internet	1,4	2,15
	performance of connection to long-distance travel routes	1,6	2,16
	attractivity of locations to experts and managers	1,7	2,16
	interests of companies	1,7	2,26
	time to react	1,9	2,3
	quality of service	1,9	2,33
weaknesses	availability of experts and managers	1,6	2,43
	performance of inner-city traffic	1,9	2,44
	time for proceding proposals and requests	1,9	2,44
	reasoning of decisions	1,9	2,45
	cost of work	1,5	2,51
	availability of optimal qualified experts	1,5	2,52
	costs for industrial real estates, offices and shops	1,9	2,52
	costs for water, waste water, waste	1,8	2,74
	business tax and real estate tax	1,7	2,79
	reduction of administrative burden	1,8	2,82
	energy costs	1,6	2,86

Fig. 12.1 Evaluation of strength and weaknesses [3]

development (7.4 % of the GDP) which is significantly higher than other regions in Germany and Europe [2].

The urbanization is already very high in most of the European regions. The Stuttgart region with 2.7 million inhabitants represents 3.3 % of German population. Due to the changes in built-up areas, the southwest of Stuttgart region now has one quarter of the people in 10 % of the area. There has been a constant influx in the Stuttgart region due to better employment prospects. There has been a constant increase of people migrating to Stuttgart region, which has seen increase of over 1 % in last decade. The most evident reason for this inward migration is the facility to have best educational locations with universities and research institutes, reasonably higher salary in jobs in manufacturing and technology industries and the image of the region and some of its companies [3]. There are multiple reason for inward migration as shown in Fig. 12.1.

As stated in previous section, more demand for land for living and economical activities lead to conflicts in land use. There are less possibilities of greenfield development in Stuttgart. The attractiveness of living in Stuttgart and working close by will result in close coexistence of living and manufacturing zones. The concepts of urban manufacturing are one way for solving the problem of conflicts between stakeholders. The production companies will change the manufacturing towards city-compatible processes and approaches. The importance of resource efficiency and energy efficiency will increase [4]. The environmental pollution need to be reduced. The neighbours have to accept the industrial manufacturing close to their living place. However, due to increased efficiency and productivity the Urban Manufacturing option can reduce the burden on resources.

12.1 What Is Urban Manufacturing?

The idea of urban manufacturing is small manufacturing units which are close to the customer and possibly the supplier. The technological development makes it possible to produce with little to no emission and waste. Based on that, a production close to living areas is possible. The parts which may be standard parts are still produced in facilities with greater distance from the city. The term urban manufacturing means production of goods close to conglomerates of humans and their living areas. The production process roughly consists of engineering, manufacturing and assembly. For urban manufacturing, either manufacturing or assembly happens close to the customer and the workers. Urban manufacturing is a different concept with highly optimized mass production facilities. Due to high costs of land and residential land use, cities offer only a limited space to allow manufacturing. Additionally, in traditional grown cities the space which belongs together is limited as well, because the development of space depends on type of building, owner and profitability of current use.

Urban manufacturing offers plenty of advantages to its surrounding because the quality of living is improved. Additionally, the amount of traffic and energy supply will be optimized. On the one hand new jobs are created, which reduces problems in inner city. On the other hand the increasing purchasing power and high living standard offer need-orientated even dual-based education offerings. These advantages lead to high willingness of citizen to live in this attractive place. This approach helps to reduce traffic for commuting of employees and transportation of parts. Additionally, different companies with the concept of urban manufacturing can create production networks and share resources for optimized capacity balancing. The regional sourcing may help in improving the product life cycle and resource cycle.

12.2 General Approach to Urban Manufacturing

Urban manufacturing approaches may be characterized amongst others by the criteria if the location in an urban surrounding was explicitly chosen or happened by chance based on a historical development. Historical urban manufacturing happens in case the company or production site was formed in the fringe areas of a city. Gradually, the housing develops in the vicinity. There are different characteristics and participative characters developed and visible in such a diverse setting.

If the characteristics of the location are not taken into account, the company's setting is considered **neutral**. In case it complies with low-emission and resource-efficient production, it is considered which can **internal adjusted and optimized** production can create competitive advantages by efficient process technology. The company is **communicative** if it is open to share information with citizen, employee and companies. The company is **contributing** if the company

opens its restaurant or kindergarten for public use. The company increases the communication with the surrounding, e.g. for planning a new construction to collect agrees and disagrees of neighbours.

A newly constructed production site in the urban area can be additionally characterized by its choice of location. The company used the choice to profit from potentials of the city and for exploitation of new sales opportunities. Companies in the urban areas can be classified by their business model and level of maturity. With level of maturity in mind, it is possible that an existing company can create an urban manufacturing facility or a new foundation of an urban manufacturing company. The advantage of such urban-based establishment includes availability of skilled and qualified employees, realization of knowledge-based products and processes together with profiting of the positive image of the city. In particular, the creative potential of cities can accelerate innovation and new business models. Some new business models in this context may be a part of »sharing economy [5]«. The classification can also be done based on type of land use and degree of utilization. As shown in Fig. 12.2 four divisions are possible: classical factory, vertical productive area utilization, vertical mixed utilization and area measured mixed utilization.

Urban manufacturing can start with a classical factory design which is situated in urban surroundings. Processes and transportation need to be developed and adapted based on the given requirements. The implementation of the facility in the surrounding needs to be addressed in specific manner. Vertical mixed land use is attractive for effective utilization when resources are limited. Hereby, the building can be divided as follows: part manufacturing and sales can placed on ground floor level, the second floor can be used as assembly and R&D and offices can be above. Additional floors which are currently not in use can be flats, shops or cultural areas and restaurants. With this approach, a vertical mixed land use can be realized. The

Fig. 12.2 Characteristics of urban manufacturing by land use and integration
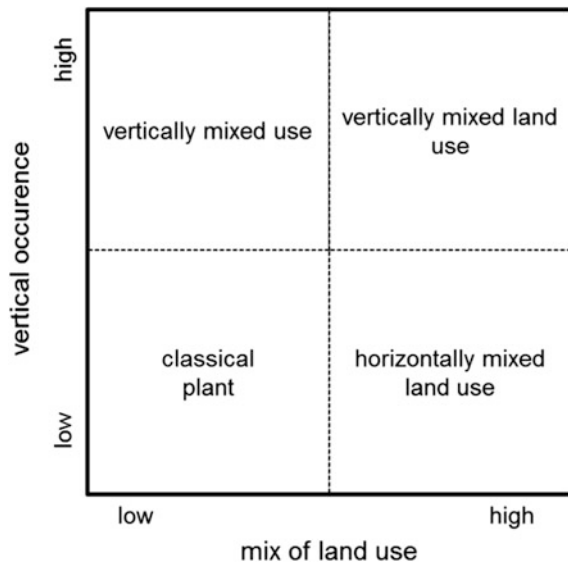
horizontal mixed land use consists of the same idea but horizontal mixture. This can be utilized for old army spaces, huge industrial areas with no further use by a big company. On the area, all kind of utilization is possible with regard to the requirements of each partner and neighbour.

12.3   Advantages of Urban Manufacturing Approach

The advantages of the urban manufacturing concept can be divided into three categories: acquisition-based, production-based and sales-based.

(a) **Acquisition-orientated** potentials of the production in urban areas can be exploited as it makes acquisition of high skilled employees, suppliers and service provider from the close vicinity. Usually, urban areas have a higher density of educated and skilled personal in proximity. This mutual communication and cooperation reduce the efforts. This results in enhanced efficiency and innovation, in case of technological cooperation as seen in some of the pockets in Stuttgart.

(b) **Production-orientated** advantage considers the shortest travel and transit time for employees coupled with option of flexibility of working schedules. This flexibility is not only positive for the employees, but also it improves productivity as well. In current projects like »CapaFlexy« [6], the research is revolving around how to create flexibility of capacity in a manufacturing company by use of technical approaches like »Industry 4.0«.

(c) **Sales oriented advantages** can be harnessed by evaluating the customer's customer base in close vicinity. The optimization of supply chain routes improves the transportation chains. Transportation with high energy consumption and emissions is to be avoided. These positive effects are proved by a study [7].

12.4   Selected Cases from Industrial Practice

New concepts of utilization can be done on newly emerging uncultivated land which is close to the city centre. This was the way how Greenpoint Manufacturing and Design Center (GMDC) was established in the middle of Brooklyn. Over 100 small to mid-sized companies are located here and created over 500 jobs [8]. The companies in the GMDC are next to craftsman, craftspeople, companies of creative sector and smaller manufacturing companies. They have all one in common—customer individualized products with high requirements in design and arts. The different companies profit from the wide variety of competencies which established close together and complements each other along the value chain. An informal knowledge pool was created, which has huge influence on the innovative capacity of the companies. The companies in GMDC are usually newly founded micro-companies and start-ups with less than 10 employees. The New Lab in Brooklyn is another example which is more concentrating on manufacturing [9].

Fig. 12.3 Examples for urban manufacturing—Volkswagen factory in Dresden (*left*) [Volkswagen 2014-2] and Wittenstein factory in Fellbach (*right*) (Wittenstein 2014)

A high demand on customer individualized products and the high innovative capacity in urban areas even offer companies of the start-up scene new potentials. Good examples are American Apparel, Rickshaw and many more. American Apparel is a textile company with more than 10000 employees. Most of them work in the headquarters in the centre of Los Angeles. In its building, all relevant business functions (marketing, design, development, manufacturing, sales and controlling) are localized together [10]. Rickshaw, a bag manufacturer, produces design-orientated bag with a customer focus in the city centre [11]. Rickshaw calls the urban surrounding with its creative capacity, the base of its business.

Traditional companies in Germany which are profit of urban manufacturing are Volkswagen AG and Wittenstein bastian GmbH (Fig. 12.3). Wittenstein Bastian GmbH built a new construction in an urban area [12]. The factory is located directly next to the conglomeration of passive houses and uses all advantages of urban manufacturing [13]. They have access to educated employees and the employees have short commuting way, because the factory is close to public transport. Volkswagen AG decided Dresden to be the location for its production site of the »Phaeton«. Important aspects for this decision were driven by the social responsibility [14] of the company and the image of the city of Dresden [15]. To create an excellent match for assembly site with the location, all the disadvantages have been accepted. The disadvantage was to build a logistics centre outside the city and to install a good transporting tram, the CarGoTram, which uses the public tram rails.

12.5 Ultraefficient Urban Manufacturing

Ultraefficiency is the combined improvement of efficiency through effectiveness and optimization of associated processes. Optimization processes have a long tradition in companies. After implementing a new process, machinery or production method, technicians and engineers have the task to optimize the associated processes. The quality at manufacturing stage, organizational process or other process

flows is enhanced. The goal is to reach the stage of higher efficiency and make processes economically better. In a company, all manufacturing stages, technical and organizational processes, as well as the employed worker are connected. Therefore, all parameters which may be used for optimization have interdependencies. This leads to the challenge that optimizing one parameter results in degradation of others. A long-term improvement of all influence parameters is only possible with the idea of ultraefficiency. The term »ultraefficiency« was coined by Bauernhansl in a presentation during a conference of sustainable production [16]. This idea was developed further through research and its implication on production chain of companies. A research project was started to explore the idea through companies.

The concept of ultraefficiency is the idea to do long-term optimization. The ultraefficiency optimization includes various improvement actions. An optimal mix for a long-term increase of efficiency and effectivity has to be found. For that all interdependencies are modelled. All possible improvement actions are evaluated to find the optimized mix. The scheduling of implementation of all actions is taken into account, too. This gives the company the possibility to profit from the action as soon as possible. For every improvement action, a model has to be designed. In the model, all dependencies and influences are respected. This is necessary to know what effect the action will have on the model which represents the company.

The scope of view is defined by the concept as shown in Fig. 12.4. The factory incorporates all value-adding processes. The factory has input factors such as material, energy, personnel and assets. The outcome is the product. Additional outcomes are waste, emissions and dissipation. This outcome needs to be reduced even to zero to reach an ultraefficient factory. The factory processes are supported by planning and IT infrastructures and procurements. The reduction of unwanted outcomes can be realized by the actions of reusing and recycling.

A holistic view on influencing factors can be created only by modelling all connections. If all interdependencies are known and can be described in quantitative
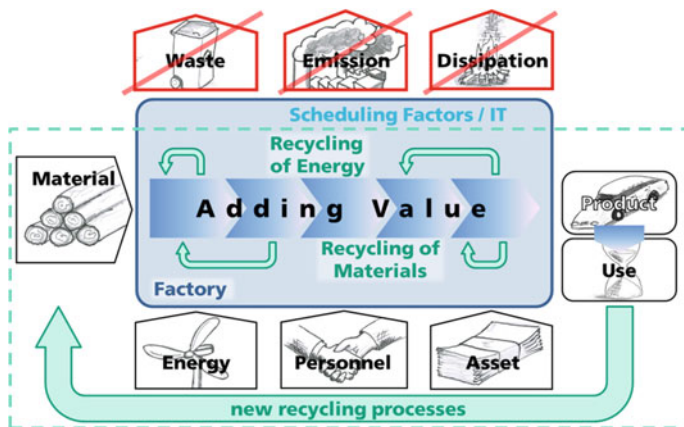
Fig. 12.4 Concept and scope of ultraefficient factories

manner, consequences resulted by the changes of influence parameters can be evaluated.

12.6 Interdependencies of Factories and Their Surroundings

Factory is a part of an ecosystem which consists of energy supply, material supply, human resource supply and legal framework. The outcome of a factory can be differentiated into product and emissions and waste and influence on ambience. In an idealistic world, the idea would be to optimize every factor to an optimum. However, the interdependencies make an improvement of all factors impossible. Reasons for that can be found in every single improvement action because it has more than one degree of influence. Every action influences different parameters on different level of detail. An improvement on one important factor results very often in a degradation of two or more other factors.

The acquisition of a new technology which results in a higher productivity, usually needs new know-how by employees and may reduce the number of needed workforce. The new technology also needs more energy to utilize the required performance. On the new machinery, bigger parts can be machined, so the employee working at the machine has no need to lift heavier raw materials which may result in bad body conditions. The new machine has a shorter cycle time; based on that, all processes need to be reworked to balance all processes. This might result in higher load for the machines, so they need maintenance more often. This shall just show an example for the dependencies [17].

12.7 Path Towards Ultraefficient Manufacturing

The initial state is before any improvement actions are planned. The current status of the company needs to be measured (Fig. 12.5). All data will be recorded in the system dynamic model. This is the base to evaluate all actions. All actions can be evaluated towards their impact on the model. The impact can be evaluated for each single action or with more respect to reality that how the impact of each action is developing with all interdependencies. With this evaluation process, actions which are realized over time can be checked towards their interplay. This helps to find the best combination of all actions and the right schedule. In case the data for the model is reloaded periodically, the improvement can be tracked and a long-term evaluation is possible. Additionally, a reaction towards new technology and changes in requirements can be implemented. This leads to consistent optimization which is always manageable even for small to mid-sized companies.
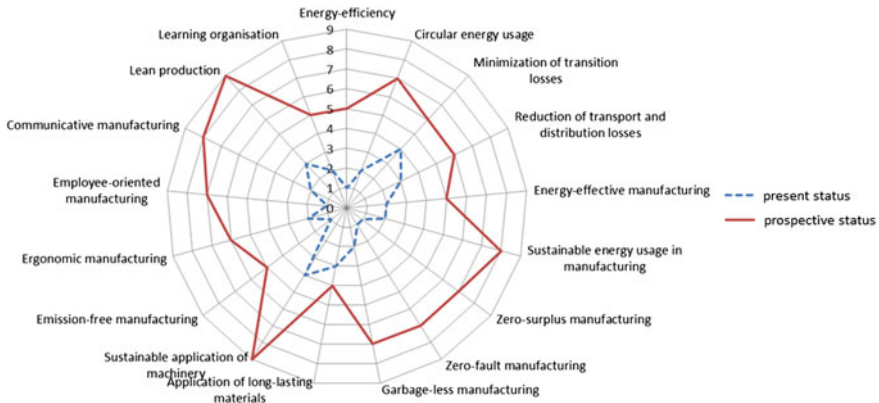
Fig. 12.5 Measured values for long-term optimization. System dynamic model

12.8 Tool Support

Part of the outcome of the project is three tools for company's employees to improve their company towards ultraefficiency. These tools support in finding better activities and initiatives than to find the best one. The reason for that is that every company is incomparable. Based on that, every company needs to be treated individually.

12.8.1 Ultra-F-Check Basic

The »ultra-F-check basic« is a primal tool to give employees the possibility to evaluate their company in a first step. This web-based tool consists of a questionnaire. All answers in the questionnaire are connected to a calculation algorithm, which is based on scientific research results, of the project and other independent researchers. As a result, the user gets a spider chart where they can see the degree of ultraefficiency of their company based on the inscribed answers in the questionnaire. Additionally, an average of companies with same size and of same industrial sector will be shown to allow a comparison with other stakeholders.

12.8.2 Ultra-F-Check

If the basic check offered some potential for improvement, a first consulting meeting may be arranged. In this meeting, specialists will have a detailed questionnaire which works as a base for detailed complete data documentation. These data allow a

company-specific evaluation of the current status of ultraefficiency. The ultraefficiency specialists who have close contact to experts in each topic or sphere of activity. This background is necessary to evaluate the data in realistic manner and towards state-of-the-art scientific ideas. The result of the »Ultra-F-check« is detailed and reliable potential analysis which is the base for evaluation of all improvement ideas, the company's expert think off. This kind of analysis can be used for evaluation of implementation of improvement activities after they are in progress. Therefore, the developed tool may work as continuous evaluation tools, too.

12.8.3 Ultra-F-Check Professional

The base for the evaluation of ecosystem production and surrounding is a complex model of interdependencies (Fig. 12.6). By using the methods of system dynamics, we are able to calculate results which are based on changes of single parameters. With this powerful tool, it is possible to compare different activities amongst their resulting influences on the complex system.

The base model is a result of the project and work, somehow as base for »ultra-F-check basic« and »ultra-F-check«. For really reliable evaluation which even respects company specifics, the model needs to be adapted to the company. Modelling of a specific company needs to question some parts of the model and to create a working one. Based on that, the expert analysis of company needs to be
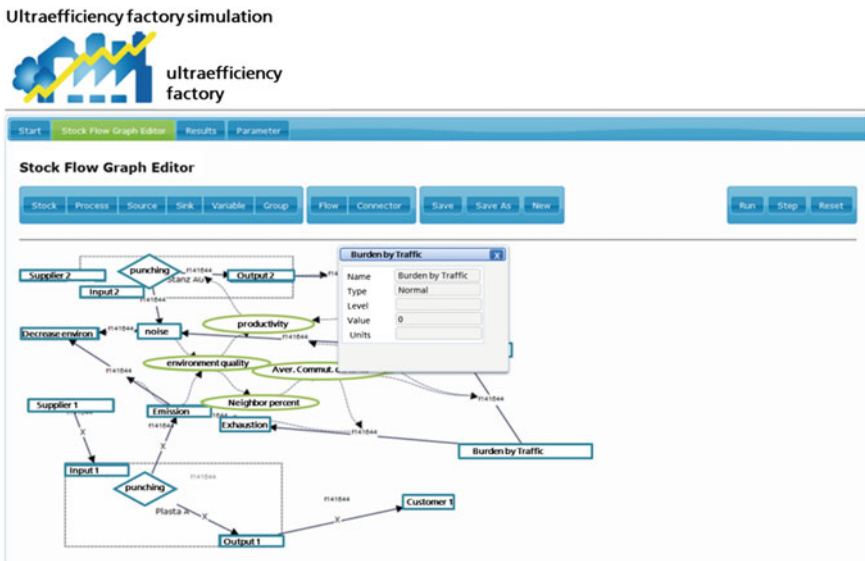
Fig. 12.6 Part of system dynamic model for holistic evaluation

done more precisely and take more effort than a consulting meeting. However, this individual model can be used for years by the company as long as all changes are implemented into the model.

12.9 Case Studies: Baden-Württemberg

The approach developed in the project is still new. After introducing the idea of verifying all influences with their interdependencies (Fig. 12.7).

1. Wittenstein bastian GmbH: Stuttgart Region

Wittenstein bastian is a small to mid-sized company which belongs to the Wittenstein Group with headquarters in Igersheim. Wittenstein bastian offers all parts for high performance gear systems. The application consists of automotive, machining, offshore and other industries with high requirement towards gear systems. Wittenstein bastian is situated in Fellbach close to Stuttgart. Wittenstein bastian is an innovative company with the idea of being the best. The turnover of 13.25 million Euros is generated with 95 employees [18]. To keep on being the best, Wittenstein bastian employs engineers to develop gearing system for tomorrow's use, like integrated cyber-physical systems and wireless technology to read sensor data [19]. In research of use of new technological solution, Wittenstein bastian is a reliable partner. This can be seen in the public funded project »CyProS—cyber-physical production systems« where an increase in productivity and flexibility by utilization of intelligent systems in the factory shall be created by development of new system architecture for industrial use [20].

Wittenstein bastian has developed ideas about futuristic topics already. When a new facility was necessary because the renting contract in the old facility ended, the potential properties have been evaluated by comprehensive factors. The ideas of urban manufacturing came into account. By evaluating, the company's management identified a building close to living area as optimal solution. To realize the

Fig. 12.7 Location of Cases based on Baden-Wuerttemberg compared to Stuttgart and its capital

idea of economic urban manufacturing, the building has areas for loading and unloading in isolated areas that the loud emission does not disturb the surroundings. Machinery inside is isolated to keep noise emission to the surrounding as minimal as possible. The shop floor in the factory is clean, and to show its cleanliness, it is even white. It seems to be more like a hospital operation room than a manufacturing facility. Additionally, the new concepts of zero-energy buildings allow reducing the energy consumption and emissions. The realization of the new approach of economical sustainability and ecological compatibility resulted in additional expenses of 2.5 million Euros for the construction of the new building. Most of the additional were spent based on the new technology in building equipment and appliances as well as more difficult construction work. With the new building, the company calculated a reduction of energy costs by 45 % to prior facility and a reduction of 72 % compared to a new construction with conventional technology (Fig. 12.8). The location of the new facility increased the attractiveness as employer for highly educated engineers. Reasons are the short distance to a station of the speed rail way, innovative products, and the new understanding for working environments which influenced the creation of offices, meeting room and clean and noiseless production. The building itself is realized under conditions of sustainable construction which intend that the materials and the building ecology are optimized, consuming less energy, fitting into surrounding and allowing a flexible use throughout its life cycle.

2. **ebm-papst GmbH**

The mid-sized company ebm-papst has its origin in Mulfingen, Baden-Württemberg, where still today the headquarters is situated. The company creates solutions for moved air which summarizes all kind of ventilation and cooling systems where wind has a major influence. Customers can be found in all kind of fields where cooling or heating of air and with air is a topic. The 1963 founded company is
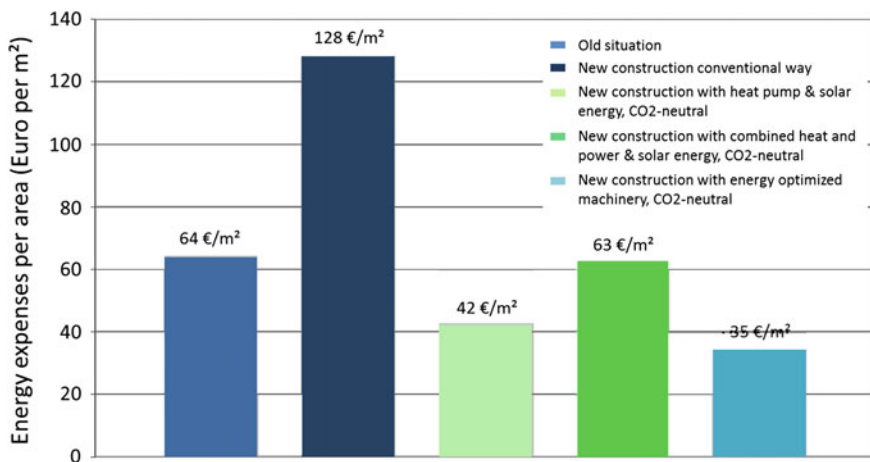
Fig. 12.8 Energy cost calculation of different energy concepts

managed by Rainer Hundsdörfer who is currently also the chairman of Verein deutscher Maschinen- und Anlagenbauer (VDMA) in Baden-Württemberg [21]. The company employs ca. 3000 people and generates an annual turnover of 480 million Euros [22].

Air ventilation is very energy consuming. Therefore, the company started already almost 50 years ago with efficiency and effective programs. Some years ago, ebm-papst introduced a new label »GreenTech« which also helps their customers with the sales of their product because the label can be added to products with efficient air ventilation systems inside [23]. This mindset is already implemented in youngest employees. Trainees participate in energy saving trainings and resource reduction seminars in the company (Fig. 12.9). They get educated as »energy scouts« to use their knowledge at home and in their private environments. Furthermore, the company offers a bus shuttle service for employees. With the shuttle, the company reduces the CO_2 emissions by 95 % in comparison with commuting of the employees every day (Fig. 12.10). The introduction of the commuter shuttle was also motivated by a potential increase of employee satisfaction. The employees did not acquire a car only for commuting. There was no need to find a parking lot close to the workplace. Additionally, the workers were more punctual and worked more effective. The other aspect of acting responsible is the local sourcing of materials, pre-assembled parts, auxiliary supplies and other consumables supplies for the final product. The local sourcing reduces the emission

Fig. 12.9   »Energy scouts« at work
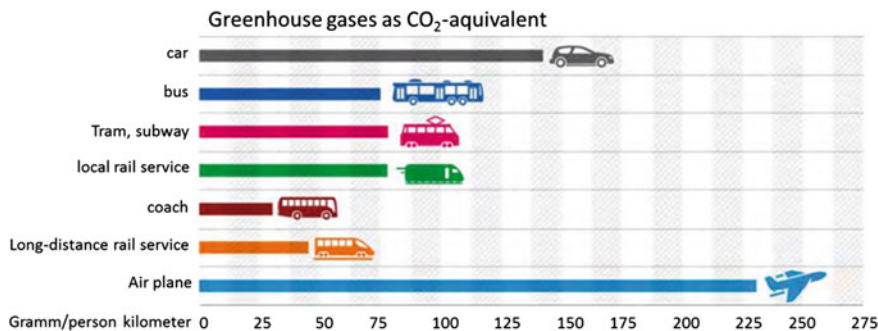
Fig. 12.10   Greenhouse gases of transport systems as CO_2 equivalent [25]

by transportation and increases the flexibility in reaction towards quality and quantity changes. The contracting with local suppliers is also not short-term related which results in trust for all parties—a reliable partnership for all sides.

When it was necessary to build a new production facility, ebm-papst built a »low-energy factory«. This was realized by use of heat pumps, sprinkler system as heat reservoir, solar energy and waste heat recovery. The idea was not to save cost with construction but to avoid costs of consumption in the future. The company foresees to avoid cost of up to 335,000 Euro per year with additional expenses of 100,000 Euros during the construction process [24]. The production site was planned to fulfil all criteria for a lean production. With the consequent realization of the lean principles, the company increased the material flow and number of produced parts, reduced risks of accidents because of less transportation systems in the production and even separated time-critical processes from non-critical.

3. Rieger Metallveredlung GmbH

The small to mid-sized enterprise Rieger Metallveredlung is a family-owned company situated in Steinheim am Albuch. The company is specialized in high-quality surface refinement of metal parts. Customers are usually from the sectors of automotive industries, machine manufacturer and prototyping companies. The variety of possible surface finishing consists of chromium, copper, tin, anodizing and nickel. Rieger Metallveredlung has 39 employees [26].

The owner of the company is keen to implement future-oriented concepts. He was always interested in new technologies and innovation and how they may help to improve his company. Based on that, he realized some actions to optimize processes. The project gave him the first time the possibility to verify all implemented action from an objective point of view. With this clear view, he saw the degree of maturity was not high. Additionally, the analysis of all processes resulted in an overview of potentials in specific processes and on different spheres of activity. An analysis of cost was done with the basis questionnaire to detect primary potentials (Fig. 12.11). The first analysis showed a highest amount in personnel cost (~ 50 %) and high cost for energy (~ 20 %) and emission elimination (~ 15 %).

At process level, analysis was done to find out the costs at each process (Fig. 12.12). This allows evaluating the activities and their impact on total costing.

Based on the cost analysis, an activity evaluation was done based on the potential investment costs. Activities on all areas, in this case machines and workplaces, have been evaluated towards its potential to save or reduce costs. Collection of all data in a diagram (see Fig. 12.13) allows a compared evaluation of all optimization potentials. Hereby, the activities on waste water will reduce cost for emission elimination and furthermore material costs. By implementing a better recycling process for water, less water as resource is needed and cost for water treatment by the public system can be reduced because waste water will be reduced in total.
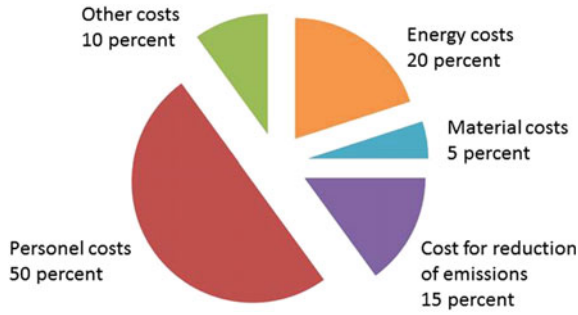
Fig. 12.11 First cost analysis for overview and evaluation of potentials
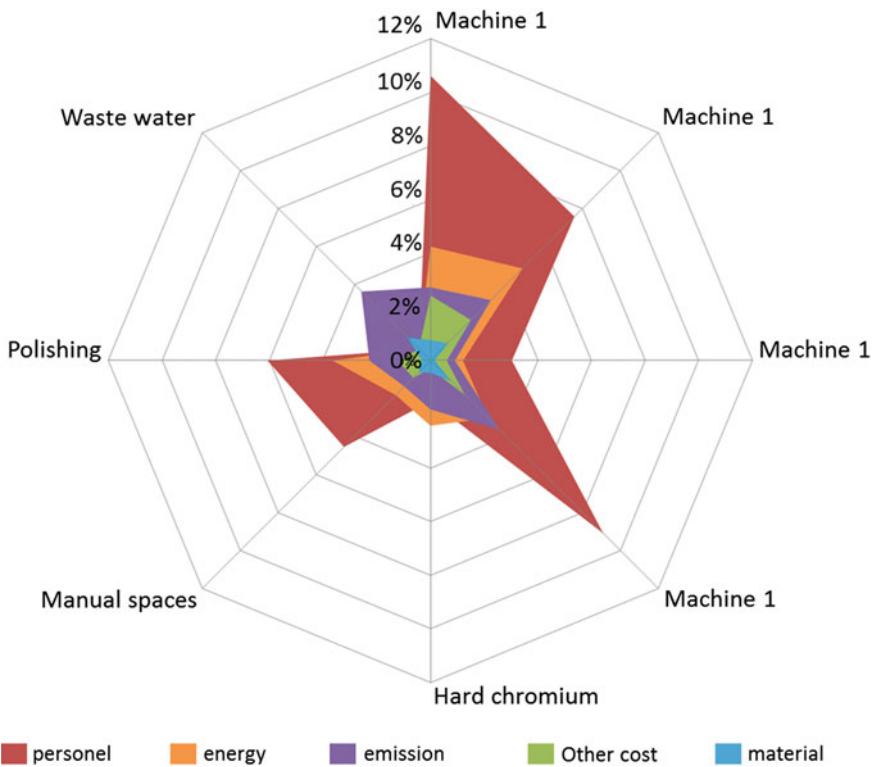
Fig. 12.12 Cost potentials detected by the ultraefficiency approach

4. **Würth Elektronik GmbH & Co.KG**

The Würth Elektronik company group is an independent company of the Würth Group. Its headquarters is situated in Niedernhall, Baden-Württemberg. The main products of Würth Elektronik are printed circuit boards, electronic and
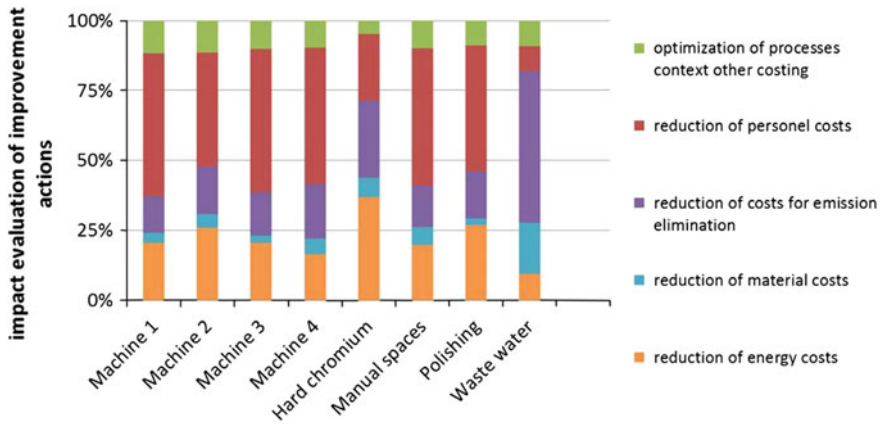
Fig. 12.13 Evaluation of impact for activities towards ultraefficiency at each production area

electro-mechanic part and electronic systems. Customers are usually from the sectors of industrial electronics, telecommunication, automotive and aeronautics industries, medical technology and renewable energy. With more than 7400 employees, Würth Elektronik generates 527 million Euros turnover [27]. Next to headquarters with production facilities, it has 15 locations for production, R&D and sales all over the world.

In the night of 27th December 2014, the production facility for PCB manufacturing was partly destroyed by fire [28]. The destroyed building accommodated the processes such as drilling, multilayer and interlayer connection, solder resist and shortly after the fire, a reconstruction was decided.

The approach of ultraefficiency was used as help to evaluate the technology, the production to rebuild. First was the evaluation of the burned down production based on existing data. This was the base for comparing new technology and the potential change of organizational processes. All potential technological solutions were modelled with the interdependency analysis to see the quantities change. The evaluation process by using the ultraefficiency approach happened on different level of detail. The considered levels of detail are every single process stage, the complete production process with all single process stages and finally the production site and its surrounding. The spheres of activity which were defined during the evaluation process are energy, material, emission and process improvement.

With the comparison of burned down and restoring production, 103 activities (32 activities for energy reduction, 19 activities for reduction of material use, 31 activities for emission reduction and 21 process improvements) [29] have been identified.

The etching process is one possible example for a holistic optimization. By implementing a MECER-Mixer Settler, optimization at different axes was possible. The new technology was the base for recycling of etching solution and dissipated copper. The etching solution last longer till it needs to be replaced. The dissipated
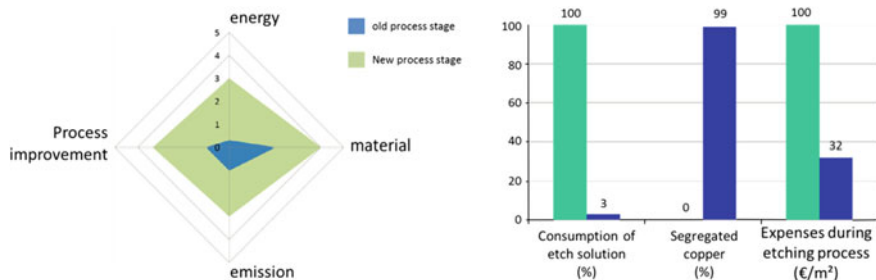
Fig. 12.14 Results of analysis with ultraefficiency tools

copper sticks on electrodes and can be sold directly as pure copper. Therefore, the implementation of the new technology reduced the amount of hazardous waste by 825 m^3 per year. This resulted in a CO_2 reduction of 40,000 kg/year because of reduced transportation. By the investment of the additional process, machinery pays itself off by the saving by reduced need of etching solution (Fig. 12.14). After one and a half year, the amortisation is completed.

5. C&C Bark Metalldruckguss und Formenbau GmbH

Founded in 1924, C&C Bark Metalldruckguss und Formenbau is still a family-owned small to mid-sized company. The swabian company is owned by two Bark brothers. Situated in Schömberg, the company tenders variety of performances which consist of consulting of feasibility, mould making, die-cast components of magnesium and other metals, CNC machining and surface finishing. Customers are mainly ancillary industry for automotive, process, machine constructors and special machinery industries. C&C Bark Metalldruckguss und Formenbau has 80 employees. The annual turnover of the company adds up to more than 10 million Euros [30].

The cost analyses of the current technology at C&C Bark Metalldruckguss und Formenbau have a potential of 40 % by activities to improve the efficiency and effectiveness. Conventional activities do not allow an improvement of the existing potential. The management of C&C Bark Metalldruckguss und Formenbau realized that a holistic approach is necessary for a long-term optimization. The executed analysis with the tools of the project ultrefficiency showed a high potential in the cast processes (Fig. 12.15). Assured by the results of the analysis, the management evaluated different technologies to evaluate all potentials especially in process organization. Three technologies have been evaluated: cold-chamber die casting (current technology), warm-chamber die casting and warm-chamber frech gating system. Each technology has different specifications. With the new technology, »warm-chamber frech gating« is material reduction of 60 % to the current technology by changing the gate system (Fig. 12.16).

Furthermore, the cycle time could be reduced to 75 % of the current cycle time [31].

Additionally, the energy sources are in the discussion. An organizational question the company management is discussing can be summarized in economic
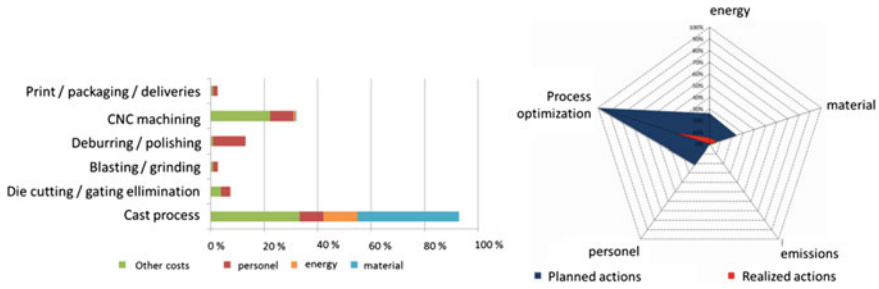
Fig. 12.15 Evaluation of company concerning process specifics and spheres of activity

Fig. 12.16 Difference in processes allows different gating systems

use of sustainable energy. The idea of predictive management is the topic. Still it is not clear what information is needed to what time to optimize the request of energy. A solution might be an active and intelligent use of data from different sources (Fig. 12.16). In particular for long-term related processes, the question is how to control such a production if the use of renewable and sustainable sources for energy supply has to be increased.

The company won with this approach a prize which is endowed by the Ministry of the Environment, Climate Protection and the Energy Sector of Baden-Württemberg. The prize was given to 100 companies which had a sustainable approach to increase the resource efficiency [32] (Fig. 12.17).
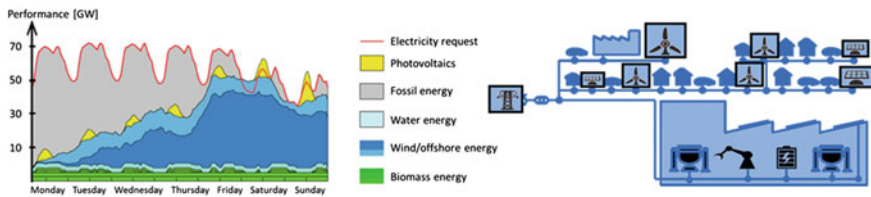
Fig. 12.17 Energy request and supply (*left*) and complex energy network which need to be managed (*right*) (Bark 2015)

12.9.1   Summary and Outlook

Ultraefficient factories will be the future for sustainable and compatible production in urban environments. The concept of urban manufacturing is not new. However, the companies did not have a tool or methodology to combine sustainability and compatibility with effectiveness and efficiency. The new approach of holistic evaluation of improvement methods will allow companies: the long-term planning and implementation of optimization with respect to different topics. The first time activities which can be evaluated easily or not can be simulated and their impact on the performance of the company can be measured.

This toolset is especially for small to mid-sized companies and it is very interesting. Reasons are the limited capacity regarding the employees and the quick responses towards impact of new ideas. Currently, the companies focused on the evaluation of the existing status. This allows them to check their already done activities. Additionally, they get an impression where they have a high potential of improvement.

Based on the short time the new approach is existing, no long-term evaluation is existing. Together with the stated companies a long-term evaluation is planned. On the one hand, the idea is to get a picture about dependencies and how they might change over time. On the other hand, the company data help to improve the model and the results of simulation. This leads to better statements towards activities of improvement about their effectiveness to create a long-term benefit for the company.

The long-lasting accompanying of the companies will increase the robustness of simulation model. Furthermore, the experience with the model will make modelling much easier. After the approach of ultraefficiency is implemented at some companies, more and more companies will join which will offer the possibility to model specific characteristics for certain industries. This will increase the robustness additionally.

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Chapter 13
Holistic Value Model for Smart Cities

Alanus von Radecki and Satyendra Singh

Abstract Smart technologies for cities require a fundamental shift in business model paradigms. Smart city solutions aim to link multiple technologies and multiple public and private stakeholders by an ICT-based connector. Digitalization and the Internet of Things (loT) practices require a new organizational and economic model for connected clean and efficient technologies. Companies and cities thus need to start thinking beyond efficiency and policy based models and understand themselves as part of a larger value model that delivers value-added services to cities and citizens. The smart city value model is thus a new economic approach to link the value creation of integrated socio-technical systems to a set of different beneficiaries and types of benefits, which builds on the conceptual work of positive externalities and external benefits. It is intrinsically linked to smart cities and districts places where the positive effects of a connected solution reach many different beneficiaries and are able to create different kinds of value through the interaction of many systems and people. The lighthouse project Triangulum thus serves as a test case to develop a modular framework that helps to systematise the factors that lead to a successful design and implementation of smart districts and prove the distributed benefits of smart and sustainable technologies in cities. This framework shall consist of a range of "smart city modules" that can be described as system solutions for smart cities. They represent core technologies that are organised around a business model and pursue a specific goal for cities and citizens. A set of smart city indicators will help distinguish between individual local factors and generic smart city success factors. Connected solutions can be broken down into some core categories leading to a finite number of connected solutions with specific characteristics.

Keywords Smart city solutions · Economic model · Business model · Value model · Triangulum · Lighthouse cities · Morgenstadt · Smart technologies

A. von Radecki
Fraunhofer Institute for Industrial Engineering (IAO), Stuttgart, Germany
e-mail: alanus.radecki@iao.fraunhofer.de

S. Singh (✉)
Stuttgart University of Applied Sciences, Stuttgart, Germany
e-mail: ssingh27@hotmail.com

13.1   Background

Various concepts of smart cities are emerging all over the world. In order to boost the creation of smart cities across the EU, there is a need to clearly defined "smart city model", which can be implemented in cities across Europe. Many cities across Europe have started to successfully implement first pilot projects for smart cities and smart districts. The project Triangulum supported by European Commission is one of three Horizon 2020 lighthouse projects for Smart Cities and Communities. This is the lead project for the Smart Cities and Communities initiative lead by Fraunhofer Institute for Industrial Engineering (IAO). Triangulum will lead the way towards a smart and sustainable development in European cities. The project emerged from the "Morgenstadt" (City of Future) initiative.

Triangulum will transform designated urban districts into smart quarters within the "lighthouse cities" Manchester (UK), Eindhoven (Netherlands) and Stavanger (Norway). They will be complemented by our follower cities Prague, Leipzig and Sabadell. A smart city value model is conceptualised with unique shared economic approach under the scope of Triangulum project, which also considers challenges of market barriers, organisational and leadership challenges. The module developed will be based around low-energy districts, integrated infrastructures and sustainable urban mobility designed to deliver a range of cross-cutting outcomes across different sectors and stakeholders. The Triangulum goals target a series of direct impacts around reduced energy consumption of buildings, increased use of renewable energies, increased utilisation of electric vehicles, deployment of intelligent energy management technologies and the deployment of an adaptive and dynamic ICT data hub.

The Triangulum project will investigate how a systems innovation approach can drive dynamic smart city development. This careful selection of cities will further demonstrate successful replication across a wide range of typical urban areas in Europe. Each city under the programme has developed its own individual approach reflecting specific local circumstances and has already moved ahead towards the transition of becoming a smart city. This will provide the basis to how it could be improved to facilitate wider replication. The design and implementation of innovative business models and the activation of citizens as co-creators are core cross-cutting elements to base the technologies in real-world city environments and facilitate replication.

13.2   Introduction

Concepts and technologies for planning and realising sustainable urban systems not only offer solutions to the many challenges of an urbanising world, but also bear the potential to unlock significant future markets [1–3]. Yet most cities are struggling with the process of transformation, and businesses have so far not been able to harness the full potential of the sustainable city as a future market.

This is partly due to a range of new challenges that cities, citizens and companies face when trying to respond to the challenges of a smart city. Along with the design of urban system solutions, cities, citizens and companies need to find new ways of collaboration and mutual engagement. Cities increasingly have to deal with complex systems that are cross-sectoral and dynamic. They aim at meeting goals that cannot be directly tied to specific technologies, but are highly ambitious and require collaboration across all departments and sectors (e.g. achieving carbon neutrality, reduction in individual mobility and increasing resilience) [4, 5]. Until now, no standard approach exists for companies to address cities as customers by tailoring their products to cities' needs in an efficient way without encountering major risks. The result is a range of corporate sale strategies for single products that are unable to cover the complex demand a city faces when attempting to implement more sustainable approaches to development.

Smart city solutions are characterised through a range of factors that make it impossible to use conventional business models and well-tested technology approaches. Developing smart cities in fact means that local governments and city administrations need to become innovators, just like companies need to discover their corporate share in urban governance. The following list of challenges for developing, implementing and operating smart districts and smart cities is based on a range of surveys, personal interviews, group discussions and personal experiences as co-ordinator of large multi-stakeholder smart city consortia [6–9]. It is not deemed to be exhaustive but should give a good overview over the current state of smart city challenges in cities and corporations across Europe. The main challenges are structured into three larger categories:

(a) Challenges through market barriers
(b) Organisational challenges
(c) Leadership challenges

13.3 Challenges Through Market Barriers

- Integration of innovative technologies has often not been tested and standards are missing. This lacking precedence means high risk of investment and unsecure ROI, leading to a situation, where conventional investment schemes fail and risks are taken neither by investors nor by the city.
- **Cash-flow models are not clear yet**—especially in complex stakeholder constellations, which are characteristic for smart and distributed solutions. In addition, different national landscapes for incentivising technologies like renewable energies (feed in tariffs) or electric vehicles prevent consortia from developing one-size-fits-all solutions.
- **Business models fail** in the face of complex urban system solutions. This is due to two main reasons: (a) sustainable technologies often have their largest gains within external costs (reduction in emissions, pollutions, noise, resource

consumption, etc.). If they are not factored into the business model, e.g. via government incentives, Pigouvian taxes or cap-and-trade systems, they are unable to compete against conventional solutions, unless the service model is strikingly better and the achieved benefits are noticeably higher. However, (b) as complexity of solutions rises, more stakeholders are needed to develop, implement, operate and maintain smart city solutions, which reduces the likelihood of an even distribution of benefits across all stakeholders, leading to unbalanced cost–benefit models and therefore to uneven investment incentives.

- **Standards** and **interoperability of systems** are lacking. There is little security of planning and transaction costs for smart city consortia are high, since they are not able to refer to existing architectures, communication protocols and standards.
- Many companies have not realised that own smart city products and business solutions need to be **embedded within larger systems**. New forms of collaboration, open innovation and co-creation need to be learned by these companies.

13.4 Organisational Challenges

- Most companies still think in products not in holistic solutions to larger needs and problems. They have a classic sales perspective that is output driven not demand oriented. However, in order to address cities as customers, companies must re-invent their sale strategies. No single products but system solutions to existing problems and needs are what cities want. The better a company can prove how their solutions contribute to the goals of the city; the higher it will be ranked as development partner. This, however, requires a deeper understanding of the city and its aims and problems (which are often individual). Instead of focusing on selling ones product portfolio, business-to-city (B2C) business means to constantly realign and reinvent ones solutions portfolio with cities' needs and demands. **Ecosystems of businesses, technologies and services** become more important, but companies are hesitant to truly open up to new partners.
- Virtually no company sees itself as **systems integrator** of smart city technologies and services. Neither do city administrations, nor municipal service providers. Thus, there is a vacuum when it comes to designing, coordinating and leading integrated smart city projects.
- Equally, most companies that aim to address the smart city market are not prepared to become **system operators**. Since the actual benefits of smart city solutions for users, local economies and the environment consist in increasing the share of using connected systems and lowering the share of owning individual products, the operational model (and with this also organisational structures like sales, marketing and corporate responsibility) change drastically. The operators of smart city systems and the corresponding networks of companies and municipal representations have not yet been identified or developed.

- Far too often city administrations **still think and act in silos**. They are structured in silos and give actors a hard time who want to push for integrated projects and solutions since cross-coordination between departments often needs to be built from scratch. The **smart city integrator** who is missing at corporate level is also missing within local governments.

  What makes it even harder—there is no standard for organising municipalities. This results in a broad variety of departments and offices across cities. Departments and offices are named differently and have different responsibilities in virtually every city. According to the administration's structure, the responsible managers for traffic, smart city, urban development, economic development, sustainability, etc. are found in different departments. This causes barriers, e.g. when industrial partners need not only identify these managers across the city administration, but also get in touch with a number of them to reach one goal. The organisational pathway to deliver smart cities at local government level thus needs to consist in local organisational innovation and change management processes rather than being able to adopt a blueprint for smart city organisation. Leading cities have developed a set of different strategies for dealing with complex cross-cutting issues and to escape the silo-dilemma. Some cities install cross-sectoral departments (New York City), some create special staff units (Ludwigsburg), others install rather informal interdepartmental work groups (Freiburg), again others outsource the responsibility to semi-autonomous project companies (Vienna), etc. Iveroth impressively delineates the complex institutional interactions that are needed for developing a systems integration approach in Stockholm [10]. Depending on the city's approach to deal with cross-cutting issues, elements like smart districts, innovation leadership, sustainability and resilience are emphasised and addressed differently. Creating a cross-sectoral structure that is able to bridge the silo-organisation of city administrations is one of the most important success factors for pushing for the delivery of smart districts.

13.5 Leadership Challenges

- **Political leadership is missing**. Building smart districts means long-term investment, and it requires the will to test something new. Many city leaders today are afraid of overstraining their citizens with new and innovative approaches that actually cost money and have not been thoroughly tested somewhere else before—especially if this means to push for an organisational shift within municipalities or to bet on an unclear return on investment. We are therefore seeing multiple challenges at the political leadership level of cities that make it difficult to have mayors buy into smart city developments. Yet, if the top-level decision-makers do not buy-in, there is little chance to push for a successful development of smart districts on the ground.

- Often no **real partnership** between cities and companies exists, since in some cases procurement regulations prevent close partnerships and in other cases the ways of thinking and acting are very different. When understanding a company and the city as part of a larger value model, city administrations and municipal stakeholders automatically start to become partners instead of customers. This shift in perception is of high importance since it means that urban solutions are co-created and fitted to the actual market, allowing for a rapid market uptake and providing support from the political and administrative realm. Full deployment of the triple helix model means that there is a continuum between politics, administration and private sector, linking these players as partners with equal importance but different roles within the value model of a city.

- Cities need support in **creating sustainable value**. But opposed to business understanding, value for cities is not confined to business value—it also refers to a sustainable development, a healthy environment, socially viable solutions and long-term stability of infrastructure and economy. In economic terms, large parts of the benefits of smart and sustainable urban technologies are achieved by reducing external effects and by creating socio-technical capital. This leads to difficult cash-flow models and unsecure investments. To actually identify the value of smart solutions and smart districts, companies and cities need to start thinking in **holistic value models** that reflect the complex benefits for environment, society, economy and a resilient city.

  Companies and cities thus need to start thinking beyond business models and mere social welfare and understand themselves as part of a larger value model that delivers value-added services to cities and citizens, creating value that reaches far beyond a monetary return on investment. In a second step, smart city value models need to be transferred into business cases for corporate players. Today, however, many corporate players fail to address the real value of smart cities, since they start with their business model right away.

13.6   The Need for a Smart City Value Model

As we have seen, many cities across Europe have started to successfully implement first pilot projects for smart cities and smart districts. Wherever these projects do not rely on a well-established efficiency model or are supported by a strong regulatory framework or government incentives, the implemented solutions still fail to build on viable business models that would allow for an easy replication under market conditions.

Through EU funding, a range of barriers has been overcome within the Smart Cities and Communities Lighthouse projects (Triangulum, GrowSmarter, RemoUrban [11]), leading to a successful implementation of a broad range of smart city technologies in these cities. In the absence of a viable business model, EU funding closes the investment gap. However, the funding is directed towards a

Fig. 13.1 Efficiency model

technology-based and data-driven development of smart district demonstrators. Little emphasis is put on governance structures, processes, business model innovation and integrated action planning to support the actual delivery of results. This shows that the EU Commission actually treats smart city solutions in an equal manner like conventional innovations. It reveals the implicit EC hypothesis that a successful proof of concept is sufficient to spur private investments into smart city solutions. It, however, neglects that smart urban solutions represent a fundamentally new approach of developing, implementing and operating cities and thus also need a fundamental paradigm shift with regard to business model innovation in complex public–private stakeholder environments. Up until today, we are basing our investments into clean technologies on two models—the efficiency model and the policy model:

The efficiency model is largely distributed and applied with clean technologies. Efficient devices like efficient motors, CHP power stations, LED lights, AAA + electronic devices, water-saving shower heads, isolated houses or the use of heat pumps are examples for efficiency technologies. The main innovation of the efficiency model lies within one single piece of technology or one clearly defined product. This makes market uptake rather easy [12]. In the case of the efficiency models, the reduction in external effects goes in line with the increase in efficiency, as shown in Fig. 13.1.

As shown in Fig. 13.2, the **technological innovation** itself is able to reduce external costs and to increase the socially efficient allocation (Q1) through a free market allocation of money and technology (Q) at the same time. The gap between social costs and private costs of the solution (Fig. 13.2 assumes a gap of 5 m € for a conventional technology) is being strongly reduced through efficient and clean technologies.

The **policy model** is strongly used in creating renewable energies and energy markets, or for overcoming lock-in structures of established socio-technical systems. We encounter it wherever governments seek to support politically desired technologies, and there is a financial gap between the efficiency model and a profitable business model [14–16]. The investor then invests into the clean technology and receives an additional bonus (in terms of granted return on invest or investment support) that allows for a profitable return on invest. Examples for this
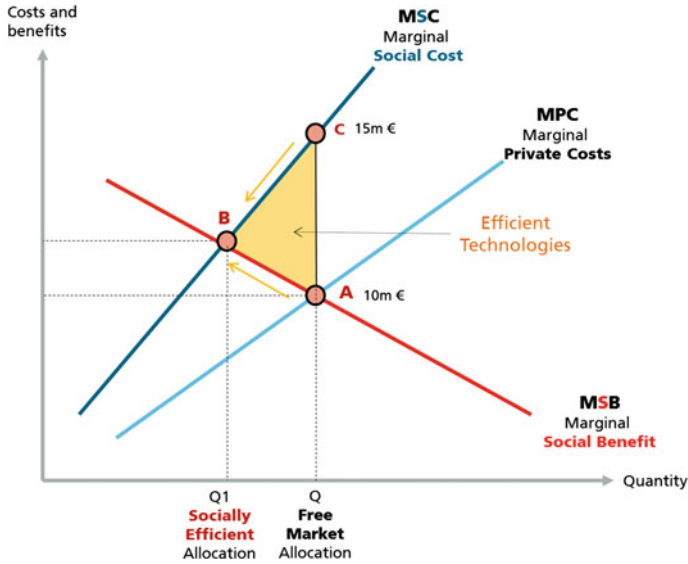
Fig. 13.2 Cornes et al. [13] External cost model and the effect of efficient technologies. This model is based on the standard economic model of externalities as described by Cornes und Sandler (1996)
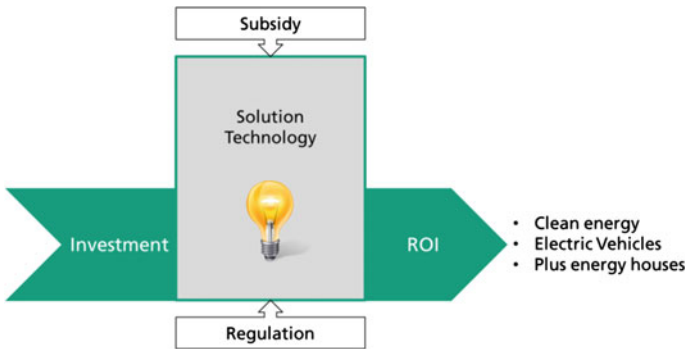
Fig. 13.3 Policy model

are feed in tariffs for solar and wind energy, subsidies for electric vehicles or market regulations like **taxes**, **fees** (e.g. for polluting cars) **caps** (e.g. emissions trading schemes) or **bans** (e.g. for FCKW), as shown in Fig. 13.3.

In the case of the policy model, the technology itself is not able to achieve a profitable return on invest under given market conditions. Therefore, the government closes the gap for the investor with a subsidy or adopts a regulation that makes investments into the desired technologies—or systems—more profitable than investing into conventional alternatives.
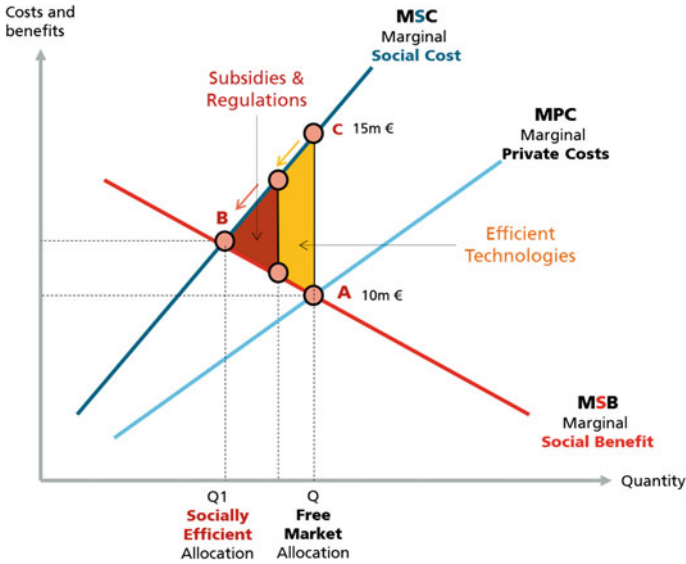
Fig. 13.4 External costs and the effect of subsidies and regulations

Figure 13.4 shows how subsidies and regulations help move the marginal private costs more towards the marginal social costs and therefore increase the social benefit.

Up until now, these models, the **efficiency model** and the **policy model**, are the only economic models for incentivising investments into clean technologies and for developing the markets of clean tech. Smart city solutions draw on both these models. However, smart city solutions are inherently different to the incumbent solutions, since they aim to link multiple technologies and multiple stakeholders from public and private by an ICT-based connector. With digitalisation and the Internet of Things (IoT), a new organisational and economic model for connected clean and efficient technologies needs to be developed, and it will be substantially different from the two incumbent approaches towards financing clean technologies—the efficiency model and the policy model.

Intelligent solutions that connect a range of technologies for a larger benefit not only have the potential to drastically increase efficiency, but also produce a range of **additional benefits** for many different actors. An **electric car-sharing** solution, for example, reduces noise in cities, frees up urban space, reduces emissions and increases personal mobility for everyone. A **hybrid district energy grid** reduces fossil fuel consumption, maximises clean energy use, achieves cost-effective production use and storage of energy through intelligent balancing schemes and increases the liveability for city dwellers that have electricity and heat at their demand at any time.

What is substantially different in this model is the interlinked and connected nature of the system solutions that are able to achieve these effects. It is not one
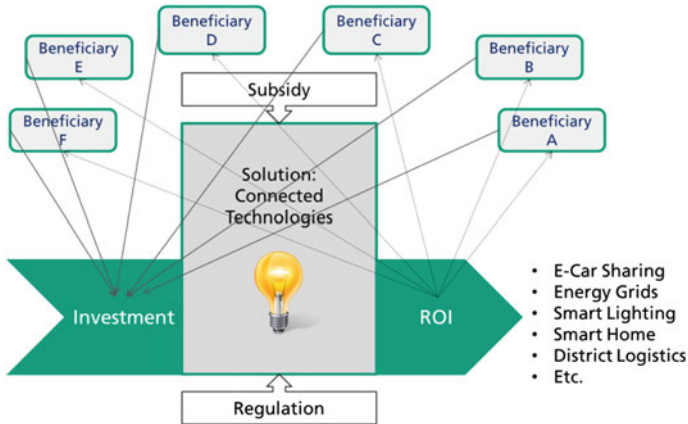
Fig. 13.5 Smart city value model

single technology, but rather a set of socio-technical systems that need to interact in an intelligent way, in order to deliver a broad set of benefits to an individual network of beneficiaries. The sustainability potential of these solutions cannot be harnessed through conventional business models and regulations or subsidies. New approaches are needed today to prove the potential of smart and connected solutions and to develop collective investment schemes that relate individual benefits with joint investments. The reason for this is the new interconnected nature of smart city solutions. Multiple stakeholders from the public (municipalities, municipal enterprises, state-owned agencies, etc.) and the private realm need to collaborate in a close way, sharing data, costs, benefits and responsibilities in a complex way. Neither of these organisations is set to do so in an easy manner, as shown in Fig. 13.5.

Connected smart city solutions thus have the potential to not only reduce external costs of technology but on top of this, to maximise value creation and welfare in districts and cities. Through this, they theoretically eliminate the need for a range of state subsidies on clean technologies that are part of the systems solution, freeing public money for other purposes (e.g. infrastructure investment or social development programmes). Through activating the additional benefits of a smart solution, an urban value can be created that combines high social benefits with low marginal social costs.

This potential, however, cannot be harnessed through conventional business models and regulations or subsidies. As subsidies and regulations were needed from the 1970s on to enforce market shifts towards clean technologies, new approaches are needed today to prove the potential of smart and connected solutions and to develop collective investment schemes that relate individual benefits with joint investments. Costs for smart solutions need to be shared by all stakeholders that receive a significant benefit from the solution. **Crowd investment schemes with public and private stakeholders are thus the financial equivalent to socio-technical system solutions for cities**. They, however, will only successfully
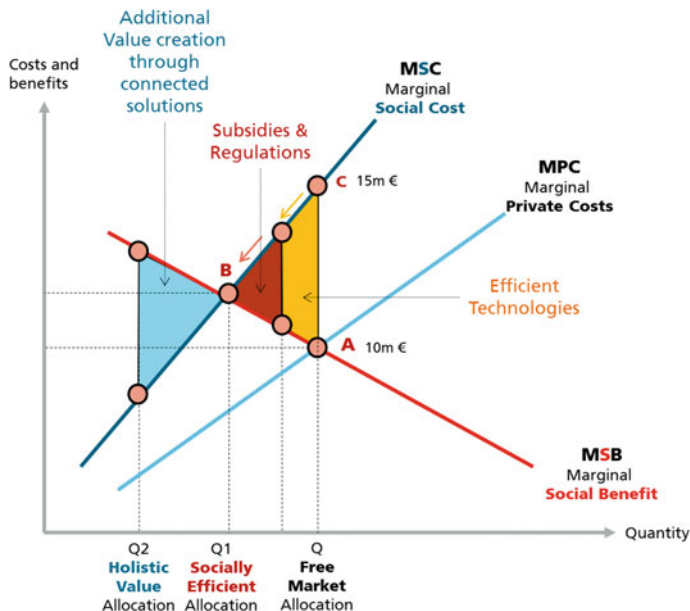
Fig. 13.6 External costs and holistic value creation through connected solutions

occur, if the benefits of a specific solution and under specific circumstances can be proven to actually occur. In other words: **prospected benefits of smart city solutions need to be proven under reproducible circumstances in order to convince future beneficiaries to become smart city investors!**

Figure 13.6 shows how through a holistic value approach positive externalities derive from connected solutions in cities. Similar concepts have already been described by authors such as McEachern for the case of education [17], Römer for the case of smart metres [18] or Krugman for the case of preserved farmland [19] and technology spillovers (ibid, p. 468).

The **smart city value model** is thus a new economic approach to link the value creation of integrated socio-technical systems to a set of different beneficiaries and types of benefits, which builds on the conceptual work of positive externalities and external benefits. It is **intrinsically linked to smart cities and districts**—places where the positive effects of a connected solution reach many different beneficiaries and are able to create different kinds of value through the interaction of many systems and people.

1. **Smart city modules—the conceptual basis for a holistic smart city value model**

Through EU funding, a range of barriers has been overcome within the SCC1 project Triangulum, leading to a successful implementation of a broad range of smart city solutions in Manchester, Stavanger and Eindhoven in an integrated manner. The implementation process of these solutions in the EU-funded lighthouse
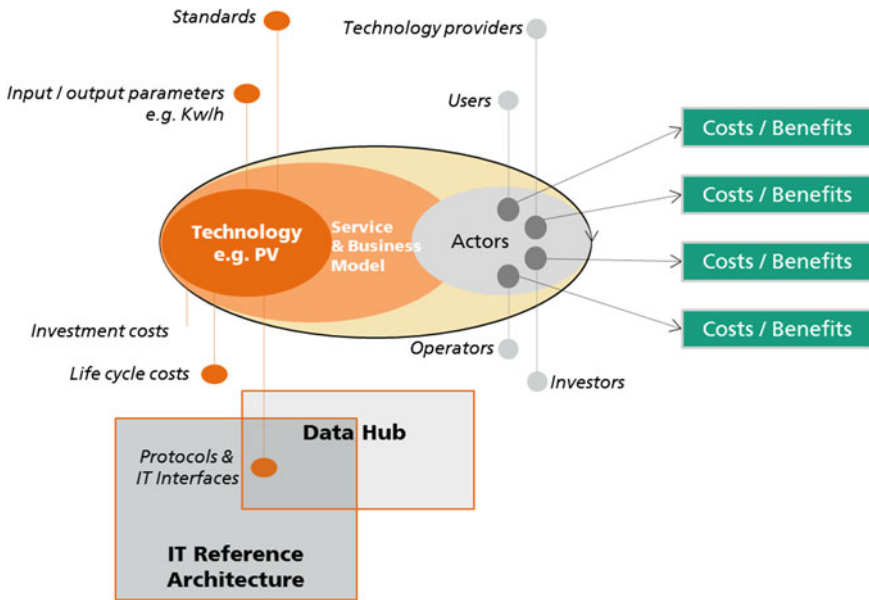
Fig. 13.7 Components of the socio-technical unit

cities is one of the few opportunities that allow learning from a large-scale implementation programme and developing the business cases around a new and complex system of urban value creation, which is derived from the smart city.

The lighthouse project Triangulum thus serves as test case to develop a modular framework that helps to systematise the factors that lead to a successful design and implementation of smart districts and prove the distributed benefits of smart and sustainable technologies in cities. This framework shall consist of a range of "smart city modules" that can be described as system solutions for smart cities. They represent core technologies that are organised around a business model and pursue a specific goal for cities and citizens. A set of smart city indicators will help distinguish between individual local factors and generic smart city success factors.

Connected solutions can be broken down into some core categories, leading to a finite number of connected solutions with specific characteristics. Thinking in Smart City Modules helps to systematise solutions and to operationalise them for an analysis, replication and further development. For Triangulum, it was proposed to operationalise Smart City Modules according to Figs. 13.7 and 13.8.

- At the core of the Smart City Module are distinct **socio-technical units** that serve to **deliver a specific service** to citizens, the city administration and/or companies in one of the districts of Manchester, Eindhoven or Stavanger.
- To implement each socio-technical unit, a **set of actors** is needed that have a specific interest in the solution and want to **achieve a core goal** and to produce a core output (*mostly gains in efficiency or return on invest*).
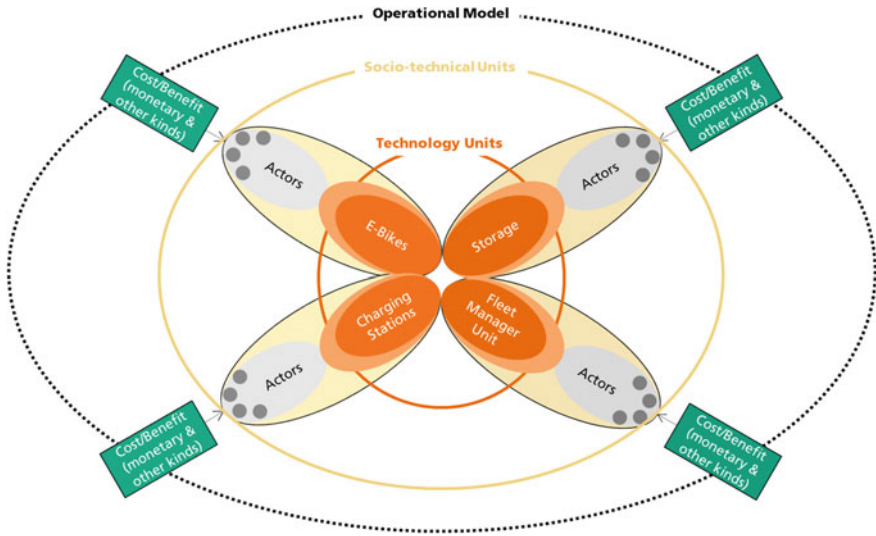
Fig. 13.8 Modular concept for smart city solutions (example: E-bike distribution system)

- Technology units and actors are linked through a **service and business model,** which describes and specifies interactions, responsibilities and operation details of the unit.
- Each socio-technical unit is linked to a set of other socio-technical units through digital interfaces and a larger operational model of the Smart City Module.
- The technologies within the technical system are linked to one another through **interfaces, protocols and communication**. At the same time, the module itself is linked to its environment and other infrastructures through technical interfaces in order to function properly.
- Usually, a **systems integrator** is responsible for coordinating the flow of data and information between the units and for delivering the operational value of the Smart city Module.
- The technical system needs to be integrated into **existing infrastructures**— therefore, the connection and linkage to wider technical systems need to be assessed, as well as the **dimensions and economies of scale** under which circumstances the solution is successful.
- Some of the technologies and interfaces already obey to **existing standards**, some of them do not.
- **Regulations and incentives** that are in place in Manchester, Eindhoven and Stavanger are relevant frame conditions that maybe hinder or support the roll out and uptake of some of the smart city solutions.
- In addition, **individual factors** like geography (wind, sun), the governance structure, society and culture or the political power setting have an impact on the smart city modules that are being implemented in the 3 lighthouse cities.
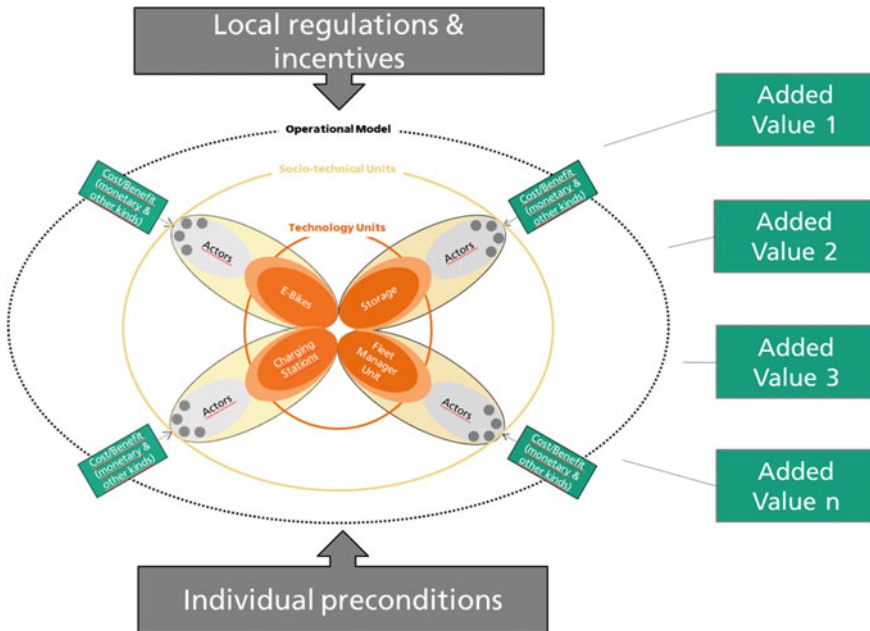
Fig. 13.9 Operationalising Smart City Modules for Triangulum

- The **individual benefits** and **additional beneficiaries** of each smart city module need to be estimated and verified with local stakeholders and beneficiaries, as shown in Fig. 13.9.

This setting allows for a clear structuring of the assessment of data and information within the lighthouse cities. The proposed steps to be undertaken for operationalisation are described below.

The basic concept for leveraging the additional value of connected solutions lies within identification of the additional benefits that come on top of the conventional efficiency or policy model. Therefore, all benefits that solutions like an e-car-sharing or smart lighting infrastructure are creating for a range of different stakeholders, need to be identified in a first step. In a next step, the benefits are allocated to main beneficiaries and underpinned with an estimation of the positive economic effect that the beneficiary will experience as listed in Table 13.1.

Having proven the impacts and the de facto creation of benefits, the model foresees that the identified beneficiaries invest own money (or use corresponding investment schemes like Smart City Bonds) into the solution proportionate to the benefits that they achieve.

Usually, a large part of the required ROI will already be generated through the efficiency model: smart lighting will pay almost off through efficient LED light-bulbs alone. Therefore, it is estimated that the identified beneficiaries will only need to invest a smaller share of their own estimated benefits (10–30 %), making the

Table 13.1 Example for an external benefits table used in the assessment of smart solutions

Benefit	Beneficiary	Economic effect	Time to impact
Less emissions	Climate –>Co2 certificates	1500 t CO2e/year × 6,50 € per certificate	After implementation
Increased security	Police/prisons	5 less prisoners/year x costs for 1 prisoner	2 years after implementation
Biodiversity/provision of ecosystem services	Utilities company –> less water purification needed	3 Mio l less to purify/year	2 years after implementation
Time savings	Commuters in district A	10 min. per commuter per day	After implementation
Increased quality of life	Local dwellers	7.5 % rise in real estate prices	2 years after implementation
More public space	Local cafés have space on sidewalk	15 % increase in turnover for 5 cafés	1 year after implementation

solution highly attractive to a range of beneficiaries. The cumulated investments will easily bridge the investment gap of the efficiency and the policy model; however, they need to be proven, organised and the return must actually occur.

The main problem with distributed benefits and shared investments is the risk that is connected to achieving the benefits. If it has not been proven that, e.g. an e-car-sharing solution frees up public space in a certain district by a certain amount of m^2 or that a smart refurbishment programme actually increases real estate value by a certain percentage, investments will not happen. In other words: **prospected benefits of smart city solutions need to be proven under reproducible circumstances in order to convince future beneficiaries to become smart city investors**!

This is the reason, why the HORIZON 2020 Smart Cities and Communities lighthouse projects represent such an important test bed for the development of holistic value in cities and allocation to selected beneficiaries. In these projects, public investments into innovative and smart solutions bridge the gap that prevents potential beneficiaries from investing, thereby creating a large number of use cases and precedence for smart solutions and their benefits.

The lighthouse project Triangulum is therefore used as test case for verifying the above-described Smart City Value Model with 29 different smart city modules, leading to a direct replication of some of the modules in the associated follower cities of the project: Prague (CZ), Leipzig (GER) and Sabadell (ES). The following table gives an overview over all modules that are currently under implementation within the three lighthouse cities Manchester (UK), Eindhoven (NL) and Stavanger (NOR) Tables 13.2, 13.3 and 13.4.

Table 13.2 Eindhoven modules

Energy	Installation and smart distribution of locally produced renewable energy
	Approach: The refurbishment of the Eckart Vaartbroek district will go along with the provision of local energy production from renewable sources by the placement of renewable energy facilities. The co-creation process involved a continuous dialogue with the residents, the local energy distributor (Endinet) and the housing association Woonbedrijf, who finances the local production investments and upon whose premises the sustainable energy is produced. Decisions will be taken about the role of the residents in this cooperation, and how the locally generated energy will be used
	Optimisation of heat provision in existing buildings of Strijp-S
	Approach: Supported by the national government of the Netherlands, with €25 M investment, a new biomass-based CHP plant in the Strijp-S district. It can provide renewable heating energy to an overall amount of 68,000 m^2 within the Strijp-S area, replacing a total of 13.3 M KWh of conventional heating. This solution provides a nearly CO_2 neutral heat supply and is the preferred approach to achieve significant emissions savings, above extensive and expensive refurbishment of the industrial building stock. In Triangulum, VolkerWessels will provide in-building installations and pipelines to connect the buildings to the CHP plant
	Refurbishment of family homes on a participative basis
	Approach: To fulfil regulatory requirements, Woonbedrijf's houses in the Eckart Vaartbroek district need to be renewed. The district includes 1,300 dwellings in total, and 200 dwellings with a total area of 20,000 m^2 will be refurbished during the project. The partners aim to reduce 800 tonnes of CO_2 per year through renovation. To achieve their goal, individual tenants will be given the opportunity to choose tailor-made packages offering energy saving measures and renewable energy options. The partners aim to achieve at least 20 % of the tenants will opt for a further upgrade that will increase rent but lower energy bills due to additional investment. This will be achieved through the co-creation process (WoonConnect), leading to increased awareness and ownership of the challenge. In addition, the general way of working of Woonbedrijf will be respected. This methodology, the Natural Step, pays particular attention to limitation of the use of harmful chemicals, the efficient use of resources and the human factor in all their operations
	Smart energy management for offices
	Approach: The system aims to reduce the energy consumption of the Strijp-S office buildings through measures that induce behavioural change of the tenants. The system includes three elements: (1) the individual control of working space by occupants; (2) self-learning capabilities of the control algorithm; and (3) prediction of dynamic working hours. Over time, the system will combine sensor data on patterns of office space presence and behaviour, weather conditions, sunrise and sunset, and so on to create a system that automatically optimises energy consumption
	Sustainable energy supply and soil sanitation:
	Approach: At Strijp-S, the use of heat pumps (using the warm and cold water of the deeper soil layers) is not allowed under Dutch law when the water is polluted. The soil needs to be cleaned first before construction can start. SANGERY provides a solution for this problem. The system will be implemented and provides an innovative combined approach of sustainable energy production and soil remediation, which will lead to annual cost savings of €25,000 in the energy provision (this does not include the benefits of soil remediation. Based on ground water circulation rather than storage, SANERGY accelerates natural decomposition of pollutants. It effectively eliminates the spread of subsurface

(continued)

Table 13.2 (continued)

	pollution through the smart design of infiltration and extraction wells while heat or cold can be extracted from the water
Mobility	Mobility management upgrade *Approach:* The module aims to develop an ICT-based tool for real-time parking guidance system and develop payment incentives for green alternatives and to stimulate car sharing. The transformation will be based on a business model that generates funds for mobility sustainability enhancements
	Smart charging infrastructure for electric vehicles *Approach:* This task involves smart charging of electric vehicles and improving parking management. To improve efficiency of the EV charging facilities, the project will develop a smart charging information service. The service is dependent on the MPLS (see also subtask 4.4.5. for a detailed explanation of MPLS service). The task will involve the purchase of several intelligent charging stations, an effective communication application system (through an app) with the user of the infrastructure, allowing for the more efficient use of the infrastructure by more EV users
ICT	Implementation and integration of a fibre-optic data infrastructure *Approach:* The aim of the module is to develop the second phase of Backbone, a strong fibre-optic data infrastructure including hardware and software. The second phrase will extend the control and monitoring possibilities of Backbone to include other systems such as parking, in-building (domotica) and urban media information or entertainment applications. Moreover, the second phase will extend the Backbone for the entire Strijp-S district throng the addition of a new generation innovation middleware. It will provide a high-quality urban environment with the highest possible service level to all users. Furthermore, during the project period, a Multiprotocol Label Switching (MPLS) will be implemented to enable integration of different data sets
	Sensor network in the public space *Approach:* The existing advanced public lighting system, developed through the Light-S programme, is capable of 16 million colours and light intensities that exceed Dutch regulations by 50 %. To adapt the lighting to the actual circumstances within the environment, a sensory field is needed. Sensor systems can include IR detection, Bluetooth and RF-ID. The sensor network allows for the development of additional and innovative services. In this task, a bottom-up dialogue approach will be conducted to understand inhabitants' needs. According to their needs, services will be developed, such as open WiFi. The installation of sensors in the public realm will generate a wide range of data, such as pedestrian density, traffic, weather, sound and pollution. These data will be connected to the existing platform of the municipality of Eindhoven
	Smart street lights *Approach:* Located in the middle of the Eckart Vaartbroek district, a 1-km unlit pedestrian route is not frequently used. The module will upgrade the route into a social interaction and health route lit by extremely energy-efficient LED lighting. It is self-sufficiently fed by PV produced energy and equipped with battery storage. It will also carry extra functions such as WiFi and sensors, which will enable and encourage the use of smart connections with surrounding facilities and users. It aims to optimise the integration of safety and quality of public space through ICT. One of the important components in this project is co-creation involving residents in the decision-making process

Table 13.2 (continued)

	Interactive process for dwellings in Eckart Vaartbroek
	Approach: the module will develop a 3D-ICT tool to facilitate an interactive refurbishment process by allowing the tenants to manage their energy consumption. The tool will visualise chosen measures and presents the cost effects in terms of rent/costs. It will also enable tenants to compose the combination of measures and plan the moment of realisation energy costs simultaneously. Meanwhile, it will create a database of possible solutions and measures matched to a specific type of housing and create a live 3D BIM archive of housing stock to be used for future maintenance. Moreover, it will support the process by registering decisions and generating necessary documents
	Stimulating the development of innovative services and applications
	Approach: Within this task, TuE—Innovation Lab (IL, the organisation for valorisation at TU/e) will coordinate to stimulate entrepreneurs to develop such services. Together with VW/EIN, and supported by BrightMove, an existing embedded fund initiative in the Eindhoven–Brainport area, a Smart City innovation fund will be created to provide support to smaller assignments within the scope of smart city development in Eindhoven. The task is composed of two parts: a stimulus fund for SMEs in Eindhoven and the development and establishment of a revolving innovation fund, developed for Eindhoven and replicated for Triangulum partners

Table 13.3 Manchester modules

Energy	Trialling a central energy controller:
	Approach: This module will deliver a Central Energy Controller that connects to existing energy infrastructure, and any additional assets installed by Energy modules 2 and 3, providing an extra mechanism to optimise energy generation, storage and consumption across multiple buildings. The controller will recommend optimisation by responding to simulated external signals with its capability of analysing market prices, tariffs, meteorological data and data on the distribution network. The Central Energy Controller will then communicate its requirement to an Energy Intervention Component (EIC). This component will interpret the message and seek to amend the output of individual assets to reflect the initial request; either by interfacing with the Building Management System (BMS), which controls the asset, or by interfacing with the asset directly
	Implementing energy optimisations within buildings:
	Approach: This module will identify buildings where energy optimisations can be implemented through a series of site assessments. Analysis of the output from the site assessments will identify which buildings can be optimised through improvements to operational practices and/or through the installation of energy control devices. The planning, preparation and implementation of any agreed optimisation will be realised as part of this module. Additionally, the module will develop and run campaigns targeted at building occupants to encourage changes in consumption behaviour, which in turn could lead to more efficient use of energy
	Installing low carbon energy generation assets:
	Approach: This module is designed to ensure the procurement, installation and operation of assets to generate a target of 1500MWh of low carbon energy over the course of the Triangulum project. The assets will be installed in MCC, MMU and UoM buildings. The initial stages of module development will involve technical evaluation of low carbon energy generation technologies at MCC, MMU and UoM

Table 13.3 (continued)

	sites. Additional generation assets will then be procured, installed and tested together with sub-metering to measure output
Mobility	Support for electric vehicle purchase or leasing: *Approach:* The Triangulum project will provide funding to organisations based within the Corridor (UoM and MMU) enabling them to purchase or lease electric vehicles. The funding will cover the additional cost of purchase or leasing an electric vehicle, relative to the cost of purchasing or leasing a conventional vehicle. The use of existing and newly purchased/leased electric vehicles within the fleets will be monitored to identify cost and environmental benefit. In turn, this learning will be shared to promote further uptake of EVs within the Corridor
	Electric assist cargo bike trial scheme: *Approach:* A trial electric assist cargo bike sharing scheme will be established within the Corridor; providing key organisations with the opportunity to use bikes rather than conventional vehicles to make deliveries within the Corridor. The use of cargo bikes will be monitored to identify environmental benefits. In turn, this learning will be shared to promote further uptake of cargo bikes within the Corridor
ICT	Trialling a data curation service: *Approach:* A data curation service will be trialled, offering access to data generated by the Manchester mobility and energy modules (hosted on the OSIsoft platform) and other related data sets. This service will enable for-profit organisations, ICT developers, community groups, students and other actors within the Corridor to create economic, social and environmental value from Triangulum project data and offer additional data sets for curation. At a technical level, the Data Curation Service will consider the integration of data and how data is stored and accessed as a resource. At a process level, the Data Curation Service will consider various other aspects, such as data quality, privacy, licensing and the ongoing business model for those providing and using the data. The trial will identify and clarify the components of the module
	Developing a data visualisation platform: *Approach:* A visualisation platform will be developed and trialled, offering supporting tools to enable visualisations of data generated by the Manchester mobility and energy modules and other related data sets. This platform will make data provided by the data curation service (ICT module 1) more accessible to actors on the Corridor and demonstrate the potential for visualisation to support data-driven application development. Hence, this module (similarly to module 1 and 3) will enable for-profit organisations, ICT developers, community groups, students and other actors within the Corridor to create economic, social and environmental value from Triangulum project data, using the latest visualisation and experiential approaches
	Data-enabled innovation challenges: *Approach:* To focus innovation efforts upon real city issues, an experience gathering process will be developed to capture issues and opportunities within the Corridor (as described above). This experiential data set will be captured in the Data Curation Service (ICT Module 1) as an additional data source. Data sets hosted by the curation service and presented on visualisation platform (ICT module 2) will then be made available in the form of an "innovation challenge". The challenge will present organisations and citizens with the opportunity to create innovative solutions using data. Hence, this module will promote use of the data curation service and visualisation platform

Table 13.4 Stavanger modules

Energy	Sustainable citizen service development: *Approach:* To offer citizens decision support based on open data, via household display and/or app. Providing truly personalised decision support depends on the app interacting with correctly identified specific users over time. The module will involve specific technologies such as a *personalised home display* and/or a smart phone app as a personalised extension of the household's home display. This app or home display acts as an interface between the user and home technologies such as innovative video or smart gateway
	Central Energy Plant: *Approach:* The specific approach to implementing the Central Energy Plant is still under deliberation. However, the initial concepts of a geothermal well park and pellet heaters have been found to be impossible in the context of local constraints. A recent review has recommended a new approach, the adoption of which will be decided later in January 2016
	Smart gateway introduction and energy management *Approach:* Within the Triangulum project, Lyse will install smart gateways (automatic measurement systems—AMS) in 100 residential and two public buildings, specifically a school and a nursing home. Existing fibre infrastructure facilitates the development of smart gateway capabilities
Mobility	E-bus demonstration project *Approach:* In cooperation with regional administrator of public transport, Kolumbus, Rogaland County Council will run a demo-project on e-buses. Any particular considerations about using e-buses in the public transportation system will be documented. Such lessons include to what extent the current system must be adjusted to make the best use of e-buses, for example installing charging stations. Another consideration may be differences in maintenance procedures from diesel buses
	Electric vehicle charging infrastructure upgrade *Approach:* Three stations will be fitted with additional combined chargers for both Chardemo and CCS (Combined Charging System) in addition to 43 kW AC charging. The stations were fully fitted during the summer of 2014, and further expansion is being considered
ICT	Analytics toolkit *Approach:* To provide a machine learning and statistical analysis toolkit. Based on the capabilities and design of the cloud platform, the data analysed can be of high volume and velocity. To showcase the capabilities thereof by applying the analytics to some of the various data sources connected to the cloud platform. To enable the development of external services, e.g. decision support apps for citizens
	Cloud Platform A cloud platform ("data hub") will be developed that collects and data from the lighthouse cities. Additionally, the cloud platform will provide storage and computation capabilities to partners and external users
	Sustainable citizen service development *Approach:* Existing infrastructure will be used to provide a new user-friendly video-call service via television screen. Innovative video is planned to be in production in August 2016

13.7   Analysing Smart City Modules in Triangulum

The operational approach for analysing the smart city modules is derived from the Smart City Value Model concept. The goal of analysing the smart city modules and their individual preconditions is to set up replicable structures, processes and investment schemes in other cities and with other stakeholders but under similar circumstances.

Therefore, the assessment of data throughout Triangulum is following five steps throughout the years 2015–2018:

STEP 1: **Identification and definition of Smart City Modules**
STEP 2: **Definition of the City & district indicators and of the action fields to be assessed**
STEP 3: **Assessment of indicators and action fields for Manchester Eindhoven and Stavanger**
STEP 4: **Data assessment on module level via templates**
STEP 5: **On-Site assessment through interviews and workshops in Manchester, Eindhoven and Stavanger: Identification of benefits and potential beneficiaries. Definition of metrics for measurement of benefits**
STEP 6: **Measurement of de facto achieved benefits after implementation**

This process is currently underway and will be finalised in the year 2018. By then the researchers hope to be able to present a full set of external benefits to smart technologies that can serve as evidence for the development of co-investment strategies—which is the final step to overcome the business model failure of smart technologies.

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Chapter 14
Visualization for Decision-Making in Smart Cities

Satyendra Singh, Günter Wenzel and Frank Brettschneider

Abstract Sustainable building construction encompasses ecological, economic, and social aspects. Economic and Social sustainability of large construction projects where a large number of people are affected is becoming increasingly critical without public participation. This is particularly relevant for development and redevelopment of city centres and urban areas. VisB+ Project led by Fraunhofer IAO explores the role of Visualization, BIM and Virtual reality to find sustainable and publically supported solutions and ensure public participation. Under the scope an investigation into existing legal and regulatory framework is also included which points out to public participation. Suggested visualization techniques combined with good communication management are increasingly becoming a central requirement to ensure the success of large projects.

Keywords Construction · Visualization · Communication · Smart city · Public participation · BIM

14.1 Background

The social sustainability of large construction projects is becoming increasingly important. Large infrastructure projects such as railway or airport expansions, extensions of roads, coal- and gas-based power plants, wind farms or hydropower schemes, and electrical transmission lines are frequently plagued by protests from a section of the population. The research project VisB+ explores the role of visualization technologies to involve citizens in the planning of large construction pro-

S. Singh (✉) · G. Wenzel · F. Brettschneider
Stuttgart University of Applied Sciences, Stuttgart, Germany
e-mail: ssingh27@hotmail.com

S. Singh · G. Wenzel · F. Brettschneider
Fraunhofer Institute of Industrial Engineering (IAO), Stuttgart, Germany

S. Singh · G. Wenzel · F. Brettschneider
University of Hohenheim, Stuttgart, Germany

jects. In the project VisB+, the Fraunhofer Institute for Industrial Engineering (Stuttgart) and the chair for communication science (540c) at the University of Hohenheim have joined resources for an interdisciplinary research network [1]. This ensures the citizen participation through simplification and allows a socially sustainable construction. The resentment is often articulated by local public initiative, and often, political parties also adopt a stance in these conflicts. The groups opposed to such projects question the expertise of the specialist and involve the owner, local and regional authorities, and sometimes even the parliament. According to a representative 2011 survey of the Allensbach Institute (IfD), 76 % of German citizens apprehend when people protest against a 'major project': majority of them react negatively merely by the word 'major project' despite project having job opportunities, progress, and growth [2].

Sustainable building construction encompasses ecological, economic, and social aspects. In any large construction particularly in residential areas where a large number of people are affected, sustainable development without public participation does not appear to be possible any longer. Therefore, the Ministry of the Environment (Umweltministerium) of the state of Baden-Württemberg in Germany has introduced a fourth aspect, namely 'public participation in construction projects', next to the three traditional pillars of sustainability. The Ministry has emphasized the significance of public participation procedures for sustainable building in municipalities, cities, and districts. This is particularly relevant for the development and redevelopment of city centres and urban areas to improve residential conditions and public services [3].

14.2   Objective of Project VisB+

Visualization can find sustainable and publically supported solutions and can be utilized as an essential tool to complement the ecological, economic, and social aspects of sustainable building with public participation. VisB+ Project is designed keeping in mind the following objectives:

- Identify the groups of designer, owner, associations, and other groups of civil society and assess the need of visualization.
- How different visualization methods affect in the context of building projects considering, in particular, the clarity and credibility of the methods?
- Check the appropriateness of different visualization to ensure participation at different stage from engineering design and the execution of the project.
- Prepare a guideline for visualizations for public participation.

VisB+ is supported by a project council including representatives from industry (Ed. Züblin AG, Bauwirtschaft Baden-Württemberg e.V.), local authorities (Tiefbauamt der Landeshauptstadt Stuttgart), and civil society (Bund für Umwelt und Naturschutz Deutschland, Verein Deutscher Ingenieure, VDI, Architektenkammer Baden-Württemberg).

14.3 Regulatory Framework

In Baden-Württemberg, an administrative regulation and its related guideline for public participation were put into effect on March 1, 2014. In addition, it declares that regional authorities shall encourage informal public participation for critical private projects. This is reflected in numerous research papers and guidelines describing how informal public participation can be organized [4]. The regulation refers explicitly to VDI Standard 7001 of the Association of German Engineers (Verein Deutscher Ingenieure—VDI), which was also published on March 1, 2014 [5]. In the VDI Standard 7001, good communication and public participation standards are described in each engineering phase. This is based on the nine Project Phases 'Leistungsphasen' of the German HOAI fee schedule for architects and engineers (Honorarordnung für Architekten und Ingenieure). The stages are as under:

- Design Brief (Grundlagenermittlung)
- Concept Design (Vorplanung)
- Analysis of themes and stakeholders,
- Developed Design (Entwurfsplanung)
- Permit Design (Genehmigungsplanung)
- Technical Design (Ausführungsplanung)
- Preparation and Participation in the Procurement (Vergabe)
- Construction/Supervision (Ausführung)
- Close-out (Objektbetreuung)
- Documentation (Documentation)

All these guidelines very explicitly propagate that communication is an indispensable prerequisite to reach a consensus. Method exists to analyse and optimize texts for construction projects and public participation procedures (project descriptions, presentations, informational letters, homepages, etc.). Clear and concise texts ensure the credibility of messages as well as their acceptance.

The language of the engineer is the drawing, but often these drawings are 'unreadable' for layman. Therefore, these drawings must be 'translated' into more easily understandable visualizations. How these visualizations should look, which visualization techniques could be implemented by owners, politicians, and local authorities, and what factors affect the results have been under researched. A guideline for visualizations as well as an evaluation of existing visualization techniques and adaptation of these methods for public participation procedures is also covered in the scope of work. These kinds of visualization techniques for design, evaluation, and simulation of construction materials, elements, systems, and methods are increasingly becoming a central requirement to ensure the success of public participation procedures. Based on this background, the project VisB+ covers following aspects:

- Visualization–communication–management
- BIM/5D
- Virtual Reality

(1) **Visualizations in Communication–Management**

Project owners and engineering staff need to acquire new skills beyond their technical, legal, and economic knowledge. The skills related to public participation procedures and the communication itself become critical. Therefore, communication–management must be made a central part of project management at all stages of project. The objective of all communication and participation efforts should be to gain backing from local citizens, community groups, non-governmental organizations, and public initiatives. Within this diverse group, publically supported solutions can be found together. Early, comprehensive communication and public participation ensure the suitability of the technical solution to serve the needs of society and simultaneously reduce the likelihood of conflict escalation. Therefore, in the development phase of infrastructure projects, owners, engineers as well as other stakeholders should engage in an intensive exchange of dialogue with the local community. Central to the discussion is on the one hand, the fundamental need for building and infrastructure projects from the standpoint of the owner. On the other hand, it is about the entire society's viewpoint of the technical, economic, ecological, and social impacts of these projects. Formal and legal procedures can be guided and amended through communication and informal participation procedures. Effective communication and public participation may be classified according to the objective:

(a) **Information Level**: the goal is to raise awareness among the general public about the project objectives and the current status of the design process. It is also about actively developing understanding for the use of the project. From the very beginning, owners must establish transparency.

(b) **Consultation**: in an intensive process, concrete proposals are discussed and ideas as well as recommendations for improvement are developed. The objective is to gather local knowledge and incorporate diverse input and perspectives in the design. In this case, suitable visualizations can significantly contribute to represent and evaluate alternative designs and proposals coming from the public. Appropriate visualizations support the comparison of variants by visible means and in an understandable way. In ideal cases, virtual models can be used for interaction in a public forum or planning workshop.

(c) **Collaborative Input**: the first step is a structured analysis of controversial, well-defined problems and diverging interests over the course of the design and construction process. The goal is to reach a mutually agreeable solution, which in the best case satisfies the interests of the different groups, but at a minimum clarifies the facts and establishes common ground, so together the parties can proceed in a more objective debate. For this purpose, appropriate visualizations facilitate essential information for the decision-making process much more effectively than other means of communication.

Each level has different communication requirements and demands appropriate instruments.

A thorough communication strategy with coordinated and harmonized information, consultation, and collaborative input increases the owner's flexibility and

will normally save time and money. The selection of the tools to utilize in each case and how and when the tools are to be combined depend on factors, such as conflict and escalation potential, the value of the project as perceived in the public debate, existing constraints, remaining flexibility for change, and available financial resources. To precisely tailor and implement the communication and participation tools, project managers must assess the public voices and emotions related to the project. They must try to grasp the reasons and background of the conflicts. Currently, the following visualizations are broadly used:

(a) **Real Estate Marketing**

3D architecture visualizations provide diverse possibilities to represent construction and industry design in a detailed and effective way. The offline rendering methods provide realistic visualizations. Interaction with data in the required degree of reality is possible using core algorithms of video game processing. Normally, special visualization companies are commissioned to develop a unique 3D model based on the design. From this one-off model, they process photo and film sequences. The company usually keeps the 3D model confidential and merely provides the photo or film result to the owner.

(b) **Communication between the Owner & Designer**

Computer supported animations are increasingly becoming an integral part of presentations to support the communication between the designer and owner. The representation of the planned project using perspectives up to photorealistic portrayals provides the space and material visualization of the design. Designers themselves create and maintain 3D models using specialized 3D modelling tools (e.g. Sketch-up) in parallel with 3D CAD designs. The designers retain and manage the data so that they can promptly and flexibly fulfil the visualization requirements in their communication with the owner.

(c) **Integrated Project Management Tool**

In the current research project Mefisto [6], digital building models and other cost, schedule, controlling, and risk models are linked and visualized in so-called multi-models. These are either building centric (by means of different scaled, coloured 3D geometric representations of the building models), schedule based (2D graph as a retrospective and forecasting planned actual schedule animation), topological (2D diagram overview representation of the level of completeness), or construction site based (3D representation as an overview of the construction progress in augmented reality). Any 2D display or projection system can be used as the medium for display.

(2) **Building Information Modelling(BIM)**

To support a model-based design process for building projects, data models are created and maintained. The involved professionals use rule-based sub-models, which are necessary for the development of their design contribution. A federated model composed of multiple sub-models contains a large amount of information.

Currently, basic success factors for the implementation of this method are the clear definition of the objectives, the purpose of the model for every discipline, and the functionality of the arising data interfaces. With regard to these factors, an intensive dialogue with the involved parties must be initiated before the start of the project.

The workflow is accelerated and supported by the creation of visualizations for public discussion of construction projects. With the adoption of BIM and the use of real design data, visualizations become less expensive and more readily available at a reasonable cost to effectively support communication in the public participation process.

(3) **Virtual Reality**

In the virtual engineering process of other industries (e.g. automotive), immersive product prototypes are an integral part of the product development process. In this context, the term 'Virtual Technologies' of interactive visualization systems includes augmented reality (AR), virtual reality (VR), and mixed reality (MR) systems. Immersive, interactive 3D real-time surroundings are implemented to realistically and clearly represent complex space data, processes, or products. To achieve this, 3D displays complemented by 3D interaction tools and user position-tracking as well as real-time visualization software are applied, which allows the seamless experience of virtual reality. A sensible perception of immersive technologies is purely of a user interface. Research and development are predominantly focused on the questions of efficient, user-oriented input and output of data, their representation, and the technology of the rendering.

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Chapter 15
Conclusion, Opportunities and Challenges

Satyendra Singh

Abstract Smart and economic development of Stuttgart region is greatly dependent on adding innovation and improving governance structure. Concept of urban manufacturing with ultra-efficient production processes, understanding of diverse economic value models and its implications are some of the key aspects which lead to sustainable development. Use of visualizations techniques supported by communication management in development of urban areas is another innovative approach which is studied in this framework. Enormous opportunities are present and of course challenges are foreseen to create conditions conducive to the scaling and extension of the most promising smart city approaches.

Keywords Smart economy · Innovation · Governance · Value model · Urban manufacturing · Visualization

The conclusion that emerges from the chapters can be grouped into four categories. The conclusion in this section is aimed at understanding development of Stuttgart regions in terms of governance and innovation. This provides the context and background to understand the level of economic development in the region on which other sections are built. The second section pertains to the inferences collected out of concept of urban manufacturing and ultra-efficient production processes. The third section deals with understanding gained from diverse value models and its implication on three lighthouse cities. The fourth section is aimed at analysis role of visualization at different stages of large construction projects. Finally, opportunities and challenges in each section are presented to create conditions conducive to the scaling and extension of the most promising smart city approaches.

As increased population transcends into urban settings, Stuttgart region has started adopting smart practices to address the economic, social, business and environmental challenges. There had been complex challenges for the region to

S. Singh (✉)
Stuttgart University of Applied Sciences, Stuttgart, Germany
e-mail: ssingh27@hotmail.com

expand its service, manage processes and governance and thoughtfully smarter governance practices were not put into place. It is expected that in the coming time smart infrastructure which includes smart Energy Management, Smart Mobility, Smart Education, Smart Water, Smart Security with various sub-segments of technologies, solutions and services can reduce environmental impact and offer citizens a better quality of life. Changing socioeconomic structure, urbanization, environmental changes, growing online culture continue to add new challenges and call for innovative approach.

The "Morgenstadt" concept which deals with some of the key aspects of such complex situations has been acting as knowledge platform for smart city communities at large. The knowledge coming out of the integration of various approaches in diverse projects is further disseminated to larger research communities. The approaches, related to ultra-efficient urban manufacturing and smart city value modeling, are some of such aspects which study the complex dynamics of forces directly or indirectly linked with economic aspects. The fundamental idea of these approaches remains the same which is linked with economic growth of these smart city regions.

The focus of emerging regions is shifting to developing more smart cities as they otherwise lack efficiency and productivity to compete globally, the developed regions in EU stress more on technological, commercial and social innovations needed to meet the challenges and tap new opportunities. These regions now focus more on efficient and multilayered governance structure, access to high innovations through research and development and democratic decision making by increasing citizens participation. The innovation which leads to better competitiveness is a key agenda of Stuttgart region which is also reflected in its policy mechanism. The decision-making practices adopted by WRS and VRS and support to innovation are a key growth driver of Stuttgart region. The region has been successful in maintaining a right balance with technology, governance and society to enable smarter economy adequately supported by its smarter mobility, smarter environment, smarter people, smarter living and smarter government. Promotion and adoption of Smarter and environmental friendly and greener technologies provide operational ease which makes Stuttgart region the engine of the smart cities market.

15.1 Urban Manufacturing

The concept of urban manufacturing which revolves around sustaining and growing manufacturing in cities is considered as sustainable and equitable economic solution to support small- and mid-sized manufacturers in urban areas. Revival of urban area as manufacturing location by applying ultra-efficient production processes has gained grounds globally, and lots of organization have started adopting the practices. The examples are growing in Germany with Volkswagen AG, Wittenstein Bastian GmbH, ebm-Papst GmbH Rieger Metallveredlung GmbH, Würth Elektronik GmbH, C&C Bark and others who are joining the race on urban

manufacturing in combination with ultra-efficiency concepts. These companies are successful in creating ultra-efficient production units which efficiently manage the diverse production processes. This arrangement helps share resources optimally for capacity balancing.

Historically, city has always been an important place for the production of goods due to availability of skilled workforce and optimal transportation. The development of Stuttgart region is characterized by process of suburbanization of economic growth, skilled workforce and industries. Stable industrialization and timely infusion of mobility infrastructure has improved employment scenario of the region. Growing prosperity with employment has given rise to individual mobility and more prosperous started moving in the outskirts to find natural surroundings and individual spaces. The urban manufacturing options adopted by companies in and around Stuttgart region are apt for economic development of state of Baden-Württemberg in Germany.

15.1.1 Opportunities in Urban Manufacturing

It is evident from the case studies of urban manufacturing that companies not only have revived in the new urban setting of work, but also have provided numerous development opportunities for the city and other stakeholders. They also profit from the availability of skilled and qualified workforce in urban areas and have realized knowledge-based products, together with profiting of the positive image of the city. They have been successful in promoting innovation and adopting highly optimized processes. The case of GMDC, NY where over 100 small- to mid-sized companies are located is a classic case in USA where a manufacturing hub of small manufacturing companies is reinvented out of unused properties which has managed to make unutilized properties functional by applying such concepts. GMDC replicated the same concept on Atlantic Avenue, NY where 1930s-era property was transformed into a functional and energy-efficient manufacturing center.

15.1.2 Challenges in Urban Manufacturing

Manufacturing had been defined in multiple ways globally. They include mass production companies along with urban craft production, merchant-owned new-style manufactories and rural household production. Globally, it is service sector which is responsible for creating most prosperous economies in the world though recent changes in urban manufacturing activity have been far more dramatic than in services. While traditional processes remained in the dominant form of production, it will take time to create an image of urban manufacturing as sustainable solutions the public mind. New units and larger manufactories employing still heavily depend on traditional technologies and conventional production

processes. Urban large productions still rely on trained laborers rather than the skill and educated labor. Thus, despite the infusion of ultra-efficiency, the growth of urban manufacturing was not always a positive development for skilled and educated population.

Contrary to this concept, the government in emerging regions of the world is promoting decentralized development planning and providing tax incentives, subsidies for associated infrastructure development. They encourage the development of factory sites that locate in lagging districts and remote areas. Special economic zone (SEZ) is being created to contribute to regional and national economy and being considered as catalyst of employment generation and economic development. They utilize benefit from agglomeration economies and are being considered as the sustainable solution. It is thought that development of these regions will spill over to other nearby regions as well as far off regions which are left behind. It is these indirect benefits to the regional economy which might be large and can spill over to several other sectors through multiplier effect on them.

Policies in many countries aimed at de-concentrating manufacturing employment. Policy interventions to address the main constraints to industrial expansion, such as infrastructure, in strategic growth centers with the potential to drive economic growth in an extended region are likely to be more effective in many cases although the establishment of SEZs in strategic locations could be instrumental in improving the economic well-being.

15.2   Holistic Value Model

This whole research on holistic value model for smart cities suggests a new way of looking at business cases for smart solutions in cities by drawing upon the concept of positive externalities and how a holistic value model for smart cities bares a potential solution to the current failure of business models for smart technologies. It is successful in providing a premium insight that can help the smart cities solution vendors and system integrators to identify the needs for modern energy and mobility infrastructure. It can be inferred that clean and connected technologies for cities combine a set of elements that require radically new forms of investing, building and operating urban solutions.

The outcome of the "Triangulum" project which involves Manchester, Stavanger and Eindhoven modules provide key insight into technology adoption trends, opportunities, challenges and best practices and pointers to future growth potential and key drivers in the smart cities market. The outcome of the project adds value in terms of economic, social and environmental dimensions and provides a clear direction for smart cities solutions and services for planning and developing the infrastructure for the future.

15.2.1 Opportunities in Holistic Value Modeling

Looking on the cities at various stages of development and their adoption rate in the smart cities solution, this section offers a lot of opportunities to examine growth potential market sizes and revenue forecasts across different regions. A modular framework is suggested to conceive smart solutions as a structured and reproducible set of technologies, services, actors and benefits. The EU SCC lighthouse project "Triangulum" will serve to test the concept with 28 different smart city modules in three European lighthouse cities.

The overall growth potential and estimate of smart cities market are yet to be estimated clearly. The pilot phases which are being carried out mostly with the help of government funded programs have managed to link innovative technologies in the energy system and the mobility system through integrated infrastructures. The EU Horizon 2020 lighthouse call Smart Cities and Communities (SCC) has been specifically successful in kick-starting smart city innovation in Europe. The broader implication is yet to be seen with more cities joining in at the later stage.

15.2.2 Challenges in Holistic Value Modeling

The key concept of smart city in developed world revolves around sustainable and socially inclusive urban developments while intelligently integrating diverse ICT and technological options. They deal with variety of aspects in transportation systems, energy infrastructure and public service delivery. However, these ICT and technological solutions still do not have clear estimate of the implementation in changing socioeconomic structure, pace of urbanization, changes in environmental conditions, which are faced by cities in developing economies.

Having recognized that cities are the engines of growth and are drawing a million people every minute from rural areas, there are a number of latent issues to consider when formulating a smart city strategy for developing world. The concept needs to incorporate issues such as poverty alleviation, water supply and sanitation. The integration of formerly isolated legacy systems to achieve citywide efficiencies can be a significant challenge in emerging economies. Total estimate of investment required for financing smart cities in different stages of development of the world is still a matter of great research. One needs to see how these projects will be financed and operationalized in diverse organizational setup. This poses a challenge on investing and financial sustainability of such initiatives in a long run.

There are technical constraints for cost-effective implementation and subsequent operations and maintenance of some systems. Other challenges include institutional setup in different regions responsible for smart city development. Some promote multivendor environment which gives rise to complex combinations of smart city ICT and technological solutions. Training of smart practices, dissemination of research outcomes, knowledge exchange and capacity building programs have been identified as other key challenges.

15.3   Visualization

The significance of early public participation in each stage of major construction projects is recognized as pillars of sustainability. For example, the prosperous state of Baden-Württemberg had no history so far of being extraordinarily political or debating, protesting on streets and demonstrating for big infrastructure projects. The project Stuttgart 21 has gone through 15 years of meticulous planning and democratic decision making. It came as surprise when local as well as regional citizens felt betrayed because they felt that they have not been consulted on the project. In Baden-Württemberg, an administrative regulation and its related guideline for public participation were put into effect. The visB+ project has been successful in establishing the importance of visualization techniques, identifying dynamics related to conflicts in infrastructure projects and evaluation of workable visualization techniques to ensure citizens participation. The project focuses more closely on visualizations types, means and management visualization techniques owners, politicians and local authorities could implement at different stages of the project.

15.3.1   Opportunities

Visualizations can significantly improve awareness and establish transparency among the different stakeholders of the project. This can be further developed as a knowledge platform to evaluate alternative designs and proposals from the public. Visualizations can facilitate essential information for the decision-making process much more effectively than other means of communication. This can significantly save the time of implementation and associated costs.

15.3.2   Challenges

Frequent upgrades in communication medium of public, technology trends in visualization, tools of decision making and approaches to change management are some of the issues which need to be integrated in different situations.

Part V
India-Calicut (Kozhikode)

Chapter 16
Transforming Economy of Calicut to Smart Economy

C. Mohammed Firoz and T.M. Vinod Kumar

Abstract Calicut City had a glorious history dating back to twelfth century with a vibrant trade base due to an established trade route connecting Europe and the South Asia thus making it once an internationally acclaimed city. Thus, the city was ruled by many rulers across the globe until India's independence. Of late, the city lost its global stature due to many reasons, though it still has much aspirations and potential to become one such city. Calicut is fortunate enough to have a reasonably good economic base with mostly employment in tertiary sectors along with service- and IT-based industries. The city is also a destination with a remarkable presence in the international tourist map. The city can boast about being the center for some of the best educational institutes in India. A good portion of the revenue comes from the remittance of expatriate nonresident Keralites along with income from industries, trade and commerce though other sectors like fisheries, and health tourism contributes reasonably well to the economic development of the region. The city and its surroundings have got some of the best socioeconomic profiles with high literacy rates, better female work participation and overall a high HDI, which is comparable with some of the well-developed countries of the world. Further, an analysis is performed based on the six key building blocks of smart city namely smart people, smart economy, smart mobility, smart environment, smart living and smart governance. Based on this analysis, it can be said that Calicut can truly aspire and has all the potentials to become a future smart city.

Keywords Spice route · International trade · Colonial invasion · Economic base · Socioeconomic and demographic profile · Future smart city

C. Mohammed Firoz
Department of Architecture, National Institute of Technology-Calicut, Kozhikode, India
e-mail: firoz@nitc.ac.in

T.M. Vinod Kumar (✉)
School of Planning and Architecture New Delhi (SPA-D), Kozhikode, Kerala, India
e-mail: tmvinod@gmail.com

16.1 Introduction

Calicut (locally and officially known as Kozhikode) is located in the southernmost state of Kerala, India, along the western coast. This city is the second largest one in the state of Kerala having a metropolitan urban agglomeration population of 2,030,519 persons as per 2011 census. Historically, Calicut was a port city and an important center of trade and commerce especially for spices trading for several centuries which thus earned its name as 'City of Spices.' 'Ibn Battuta,' (1342–1347) a famous Arab traveler and a six-time visitor to Calicut, gives the earliest preview of life in the city as ' One of the great ports of the district of Malabar where merchants of all parts of the world are found' [1]. This city was the capital of an independent kingdom ruled by the Samoothiris (Zamorins)[1] during the medieval period. Later, Portuguese sailor Vasco da Gama reached Calicut on May 20, 1498, which thus opened trade link between Europe and Malabar. This was followed by the arrival of British East India Company in 1615 and later by the French (1698) and the Dutch (1752), all for business purposes [2]. Thus, it can be concluded that the city had trade links with Europe, Arabia and China even from ancient time. In 1765, Mysore Kingdom under the king Hyder Ali[2] captured Calicut. Later, Calicut were ruled by kingdoms (mainly the Zamorins) who were under suzerainty to the British Empire till the middle of nineteenth century until India became independent.

According to Census 2011, Kozhikode has an average literacy rate of 96.8 % against a national average of 74.04 %. Malayalam is the most spoken language, though English, Tamil and Hindi are widely understood. However, historical record shows that people of Calicut in ancient India spoke many international languages because of the trade influences. The city is multi-religious and multiethnic with Hindu population forming the majority followed by Muslims and Christians [2]. Even today, there are traces of multiethnic communities from various parts of India and Arabia like the Jains and Marwari's from Gujarat and Rajasthan, Tamil Brahmins from Tamilnadu State of India, Arab Muslims from Oman, Parsie's from Maharashtra and the locally converted Hindu population, mainly Mappila Muslims. [3]. Such a cosmopolitan mixed community structure is a result of the historical trade relation Calicut City once had with other areas of India and the world.

According to a study conducted by 'Indicus Analytics,' an economics research and data analysis firm, and published by IBN Live a TV channel in the year 2007, Calicut is rated as the second best city to reside in India [4]. This could be probable because of the presence of high literate population, cheap and good quality accommodation, location of good schools and presence of India's most reputed institutes of higher learning and, moreover, the generosity and friendly attitude of the people.

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[1]Samoothiri (Zamorin): This is the royal title used by the Hindu Nair ruling family of Calicut. They ruled the city from twelfth to nineteenth century.

[2]Hyder Ali the king of Mysore Kingdom captured Calicut during the period 1766–1792, and later, his son Tippu Sultan ruled the city until British captured the city back.

16.2 Brief Overview of Calicut Study

Smart economy in smart city case study for Calicut (Kozhikode), India, is organized into four chapters, namely Chaps. 14–17. In Chap. 14, urban economy of Calicut was traced historically for several centuries. State-, district- and city-level statistics were also analyzed. Finally, based on past trend, the potential of Calicut converting itself to smart economy was explored. It was found the role of urban economy during British colonial days showed a downward trend, and Calicut almost missed first and second industrial revolutions. The recent prospects, IT industries along with several other tertiary sector employment potentials and knowledge-based industries and related services coupled with high socioeconomic profile, literacy and high quality of life of the people, will make it easy for Calicut to be part of the third industrial revolution. Chapter 17 is aimed at creating a city image of Calicut as a brand and then uses it to e-market Calicut as a city for developing its smart economy. The image is built around unique heritage components for international marketing. Chapter 18 take up further this image to participatory urban design strategies which are specially meant for developing a smart city with special reference to Smart Economy. A modified hybrid form-based code adaptable for smart cities is applied to 'Umami', a selected brown field smart city. This modified form-based code creates development code for urban design by participatory process using the Internet. Spatial dimension in smart city spatial codes of six smart city components, namely smart people, smart economy, smart mobility, smart environment, smart and smart government, for designing and managing smart city 'Umami' was developed. The success of 'Umami' largely depends upon how land is managed. Chapter 19 e-urban land management as business for 'Umami' attempts to study existing land management legislations in Kerala and how it is implemented by two detailed case studies, and after evaluating it proposes a participatory e-urban land management for the zone 'Umami.' Finally, a model of sharing economy for the business of developing a small part of 'Umami' was demonstrated after conducting a site design.

16.3 Geography and Location

Calicut City is the second largest city in the state of Kerala and has a great historical significance and international trade relationships [5]. It is located along the western coast in the Malabar region of South India and has a coastline with the Arabian Sea in the west and has the 'Western Ghats'[3] in the east. The city is located at approximately 11.25°N and 75.77°E at an elevation above mean sea level of 1 m along the coast to a height of 15 m along the highest point. The Calicut City and its

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[3]Western Ghats is a mountain range that runs parallel to the western coast of the Indian peninsula.
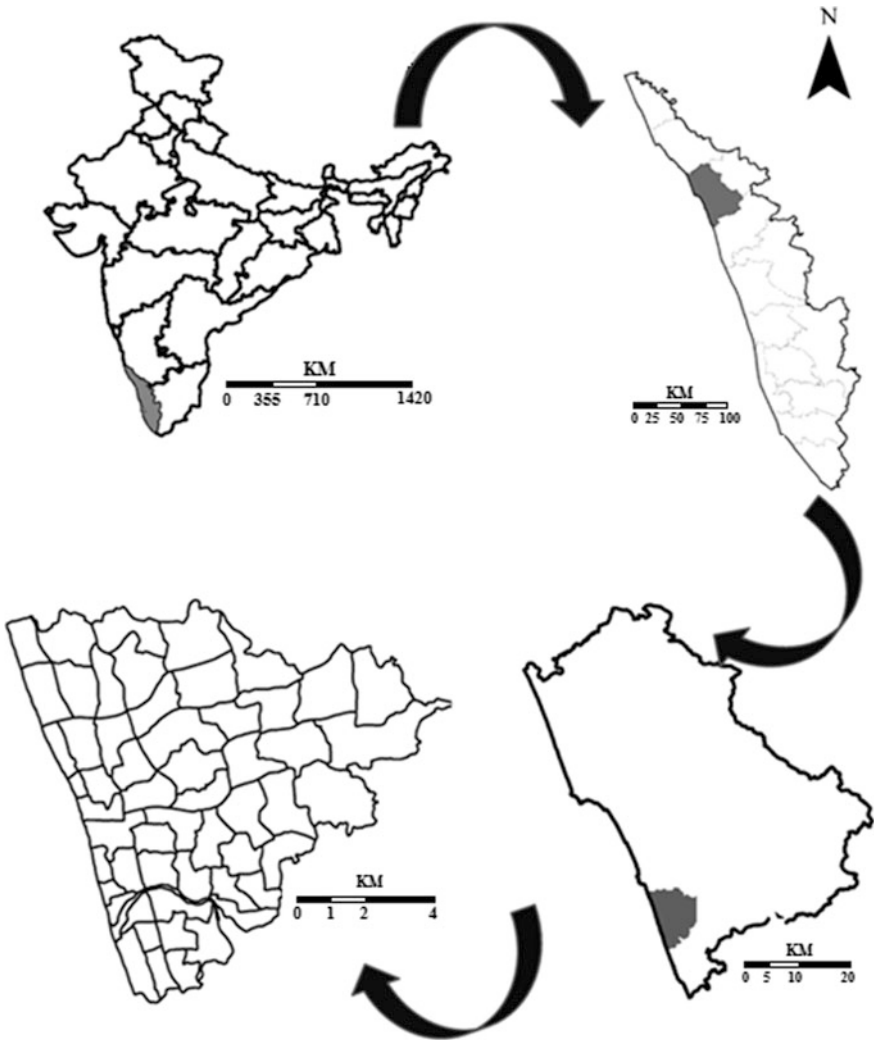
Fig. 16.1 Figure showing Calicut City with respect to India

surrounding regions fall under the lowlands and midland classification[4] of terrain. The city is fortunate to have five rivers flowing nearby areas along with the presence of an artificial canal (Canoli Canal) which flows through the city itself Fig. 16.1.

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[4]Lowland: The lowland regions are gently sloping or level lands, with altitude below sea level to 7.5 m. These areas occupy approximately 10 % of the total area of the state. The midland region, occupying approximately 42 % of the states land mass and is having slightly undulating topography. It has an altitude ranging from 7.5 to 75 m. above mean sea level [14].

16.4 History of the City

The history of Calicut City dates back to the twelfth century AD [3]. It was known as 'Kalikooth' for Arabs, 'Kallikkottai' for Tamils and 'Kozhikode' for Malayalees.[5] These 'Kalikooth' and 'Kallikkottai' were later called as Calicut by the Europeans from sixteenth century onwards.

According to historian K.V. Krishna Iyer, the city is believed to be founded along the marshy tracts of western Arabian Sea coast in the year 1034 AD following the downfall of the 'Chera'[6] Kingdom. After the disintegration of this kingdom with their capital as Kodungallor,[7] Calicut started developing as a city. The advantage of a port along with the native Muslim residents, most of them descendants of Arabs from the Persian Gulf improved the trade relations with them. Later trade relations established with the Chinese started, and the rulers gave full security and freedom to such merchants. Calicut had evolved as an independent kingdom by the end of fourteenth century under the Zamorins. Calicut along with other ports of the Malabar coasts was actively dominant in the trade of spice, silk and other goods.

There are many documented historical evidences to prove this. The famous traveler Ibn Battuta (AD 1342–47) a six-time visitor to the city noted that: '*We came next to Calicut, one of the great ports of the district of Malabar, and in which merchants of all parts of the world are found.*' These words show the multiethnic diversity of Calicut as a city in the thirteenth century [2]. The famous Chinese sailor, Ma Huang (1403 AD) depicts Calicut City as a '*great emporium of merchants from all around the world.*' Sha-Rohk, Abdur Razzak (1442–43), the ambassador to the emperor of Persia explains Calicut City as: ' *A harbor offering perfect security and perceives precious commodities from several maritime countries especially from Abyssinia, Zirbad and Zanzibar.*' The Italian traveler Niccolò de' Conti (1445) describes the city as ' *the market place of pepper, ginger, a larger kind of Cinnamon, myrobalans and Zedary.*' The Russian traveler Afanasy Nikitin (1468–74) describes the city as a '*big bazar*' meaning big market [2].

16.4.1 Early Trade Routes and the Geographical Advantage of Calicut

The trade relationship between the Kerala coasts and the other nations is believed to have a history of nearly 3000 years. The first-century Roman book named 'Periplus

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[5]Malayalees are the native Malayalam language speaking people of Kerala.

[6]Chera Kingdom: A Kingdom which ruled the Southern peninsula of India from third BC onwards.

[7]Kodungallor, the present name of 'Cranganore' was a famous trade centre and city which had its origin before Christ. It is also the place of first mosque in India, built in 629 AD.
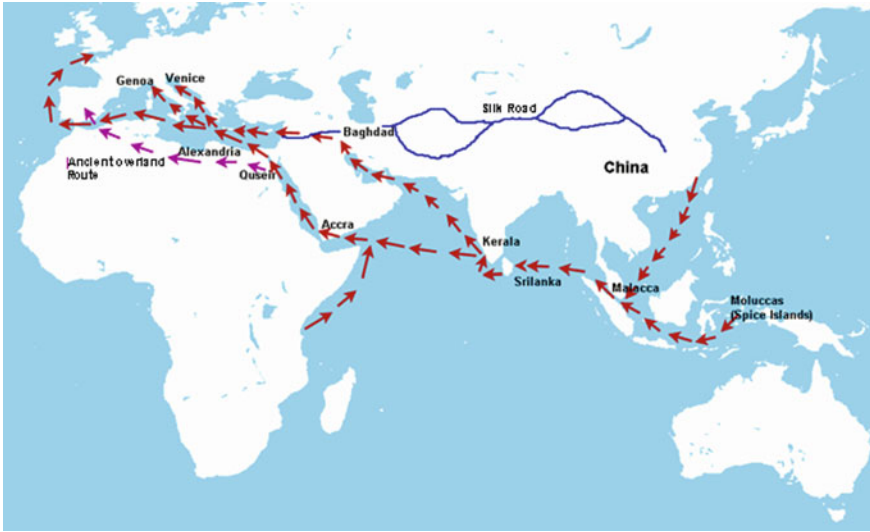
Fig. 16.2 Map showing the trade route for spices from Kerala and Moluccas (Indonesia) to Europe. *Source* [7]

of Erythrean Sea' clearly describes trade relationships between Rome and Muziris[8] and Tyndis[9] in the Kerala [6]. The trade route got it significance when Greek traveler Hippalus in first century BC discovered that the movement of monsoon wind has got a direct significance in the movement of ships (thus the trade routes) to the Indian coast. This discovery of direct sea route prospered the trade contact between the Roman Empire and India from the first century onwards, where large ships could cross the Indian Ocean to reach the Chola Kingdom of the present-day Kerala State. This discovery also made the travel through Arabian Sea less dangerous. Accordingly, a traveler from the Gulf of Aden in today's Yemen can reach the western coast of India/Kerala in 40 days if the travel is made in the course of the monsoon wind which starts in the end week of May. The sailors could travel back four months later after the end of monsoon in the reverse direction of the wind and could reach back in the Gulf of Aden.

Like the Silk Route on land connecting Constantinople to China, the spice route also had historical and trade significance (Fig. 16.2). This route connected Europe and Africa to the spice capital of the world, Calicut (Kerala), and from there to the eastern world mainly China and Japan. From AD 800 onwards, the Arabs controlled the monopoly of spice trade with Kerala for a long period as middlemen who then traded with the Europe. In return, these Arabs traded with gold and silver.

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[8]Muzris: It was a one of the greatest sea ports of ancient eastern world and a major urban center currently located in the present-day Kerala which had a history before first century BC.

[9]Tyndis: Tyndis was a major center of trade, next only to Muziris, during the Chera Kingdom period, possibly located near present day Kadalundi, Calicut City.
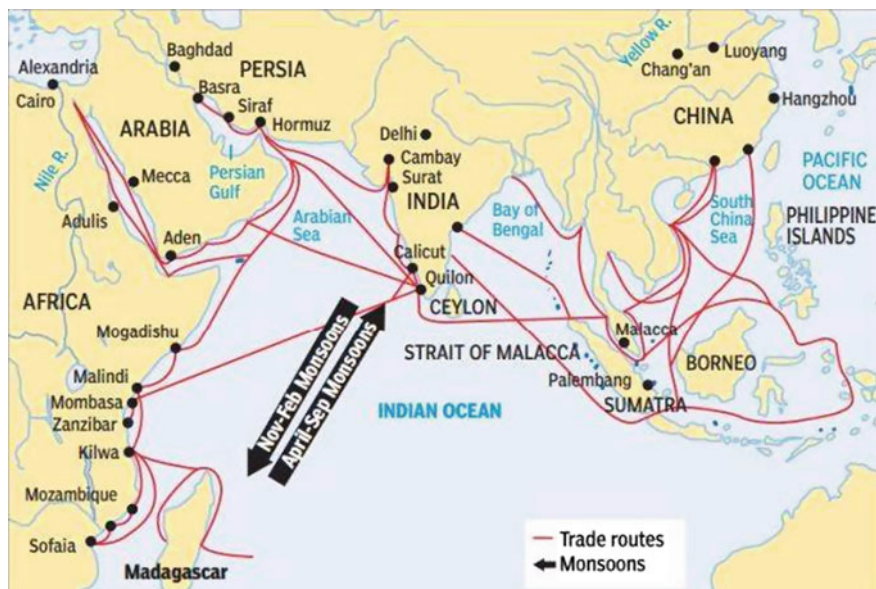
Fig. 16.3 A sailors' trading map showing India as a fulcrum of trade between AD 500 and AD 1000. *Source* [8, 9]

The major contribution which the Arabs made to India is the introduction of Islamic religion which made dramatic changes in the political history of India. During the same time, Kerala had spice trade relationship with the Southeast Asian countries in return to silk, pottery and others.

Hence, Kerala coast had explicit trade relationships with countries like China, Indonesia and other Southeast Asian countries toward the eastern sides, and Egypt, Arabia, Syria, Greece and Rome in the western sides. Though there were trade conflicts between the Arabs and the Chinese, Europeans were never in the picture until the invention of direct trade route from Europe to India by the arrival of Vas co de gamma in 1498. Figure 16.3 explains the sailors trading route map based on wind patterns showing the significance of Indian western coast as a fulcrum.

16.4.2   City During the Colonial Period

The Portuguese sailor 'Vasco da Gama' landed in Calicut in May 1498 which resulted in the establishment of sea route from Europe to India thereby avoiding Arabs as middlemen. Figures 16.4 and 16.5 exhibit an artistic image of the said voyage of Gama landing in Calicut coast as well as his travel route from Lisbon to Calicut.

Fig. 16.4 Vasco da Gama reaching Calicut coast. *Source* [10]

Fig. 16.5 Vasco da Gama's sea route from Lisbon to Calicut. *Source* [11]
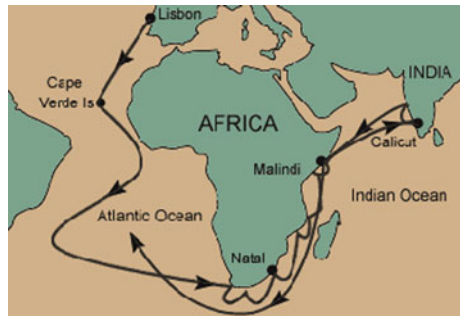
Later in November 1604, Dutch voyagers led by 'Steven Van der Hagen' arrived in Calicut which marked the presence of Dutch in the Indian coast. There were constant wars between the Dutch and the Portuguese to have a control over the spice trade. This rivalry for trade monopoly continued for a long period which ultimately resulted in the beginning of colonization of Malabar and later India. The year 1615 marked the presence of British in Calicut, led by Captain William Keeling [2]. In the year 1766, Mysore Kingdom attacked and captured Calicut and

the surrounding north Malabar coast after a bloody Anglo-Mysore war, which continued for a longer period later until 1792. Calicut became the headquarters of the Malabar District of the Madras Presidency of the British Empire. The British had a complete administration of Calicut and had also contributed to infrastructure developments like railways, educational institutions, trade centers which ultimately resulted in the cities social and physical development.

16.4.3 The City After India's Independence

After India's independence, Calicut which was under the then Madras Presidency of British India came under the Madras State of independent India, and later, the city became a part of the Kerala State after the state reorganization in 1956. Calicut which was earlier a municipality[10] since 1866 became a municipal corporation[11] in 1962. As on 2015, Calicut is rated as the second largest city in Kerala, and one of the six municipal corporations of the state of Kerala. The core city area (municipal corporation area) is divided into 59 wards with a population of half a million populations and a density of 6675 persons. The city region[12] (based on which the city's master plan is made) consists of roughly a million population and a density of 5683 persons. The urban agglomeration population consists of approximately two million people. This city has emerged to become one of the largest one in the Malabar region with its multifaceted base in agro-industries, tourism, education, hospitality, marine exports, spices trade and commerce, and is contributing to the economic development of the entire Kerala.

16.4.4 Urban Development in Post-Independent City

Calicut was one of the oldest cities in India planned on the basis of the 'Vaastu shastra,'[13] though modern day urban planning started a bit late until the architect 'Russi Khambatta' who prepared the first draft master plan during the period 1957–1962. Later, many statutory and non-statutory planning efforts were made with an interim development plan prepared during the period 1967–1981. The first

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[10]Municipality is a medium size urban administrative unit in the hierarchy of civic administration in India.

[11]Municipal Corporation or simply corporation is a bigger size administrative unit in the hierarchy of civic administration in India.

[12]City region constitutes the Kozhikode Municipal Corporation and outgrowth along with the surrounding panchayats of Beypore, Cheruvannur-Nallalam, Elathur, Feroke, Kadalundi, Olavanna and Ramanattukara. This is the boundary kept for the preparations of the master plan.

[13]'Vaastu shastra' is one of the oldest science of planning buildings and settlements based on Hindu religious principles.

development plan for Calicut urban area started operation during the period (1981–2001). Further, 17 detailed town planning schemes were also prepared catering to specific areas during this period. A perspective plan was prepared during the year 2003, and a city development plan was prepared during the year 2006. A new master plan is being proposed in the year 2015 and is in the final stage of approval. Though, there were some efforts for urban development at the city level, most of them were more of only spatial in nature and did not concentrate on the economic development of the city and the region. Hence, there is a need for some strong interventions required, both spatial and economical, to bring back the lost glory of an international city, Calicut. Hence, Chaps. 15, 16 and 17 address some of the different methods and interventions to make Calicut a smart, vibrant and jubilant city.

The study region Calicut and the state of Kerala are presented with a unique urbanization pattern of rural–urban continuum, with coexistence of urban and rural areas [12]. Therefore, it is difficult to delineate a study region, though the municipal corporation boundaries alone cannot become the study region. Therefore, the surrounding panchayats[14] of Calicut Municipal Corporation are also incorporated into the boundary of the study region. These are the same regions identified by proposed master plan (2015) of Calicut. Therefore, the study region consists of:

- Kozhikode (Calicut) corporation
- Cheruvannur-Nallalam Panchayath
- Beypore Panchayath
- Farook Panchayath
- Ramanattukara Panchayath
- Elathur Panchayath
- Kadalundi Panchayath

These areas are identified as the administrative boundary by considering the urbanization status as per Census 2011 as well as on the basis of the district urbanization report published by the department of town and country planning, Government of Kerala. This study region is different from the urban agglomeration boundary as defined by the census.

16.5 State of Economy of India—Past to Present

16.5.1 Global Wealth Shift Past and Present

This chapter earlier had discussed the international trade linkages of India in general and Calicut in particular from historical times mainly because of its strategic

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[14]Panchayat is a lower most rural administrative unit in the hierarchy of civic administration in India.

location in the international trade route. It is now important to summarize how wealth creation of India got affected through centuries on local manufacturing and global trade relationships. It is also significant to document the constraints and retardation of economic development imposed by colonial rule that kept India deliberately away from industrial revolution 1 and 2, and retarded penetration of economic development under colonial rule. Figure 16.6 explains the wealth status of India (marked as 2) when compared to the other countries of the world and USA (marked as 1) particularly in 1500 AD. Similarly, Fig. 16.7 shows the shift of wealth from Fig. 16.6 to the west in the year 1900.

India, which was internationally famous for its wealth creation that attracted international trade prior to seventeenth century, became poorer later day by day from a share of 25 % in 1750 global wealth in manufacturing to 2.8 % in 1880. This was mainly due the administratively rigidly controlled and constrained colonial rule of India which through instrument of repressive legislation controlled strictly the Indian economy by the colonial Indian civil service. Educational reforms of British were most useful to create pool of lower level English-speaking section officers and clerks in British administration than innovative technology creation and creators of new knowledge using research that would have lifted up rapidly industrial revolution 1 and 2 in India.

Figure 16.8 shows global distribution of wealth in the year 2015. Many countries in Asia including India and China became independent with their own constitutions; brand new administrative system suited 100 % to constitution and legal instrument that translate constitution to its implementation process through legislative codes. India instead of fully wiping out last remnant of colonial

Fig. 16.6 Wealth status of the World—1500 AD. *Source* [13]
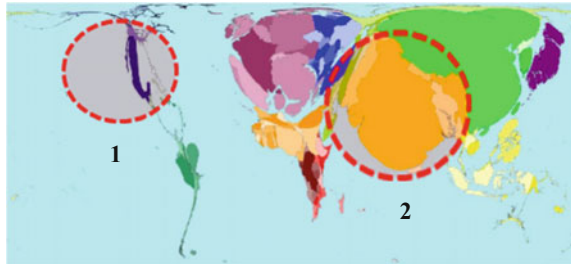
Fig. 16.7 Wealth status of the World—1900 AD. *Source* [13]
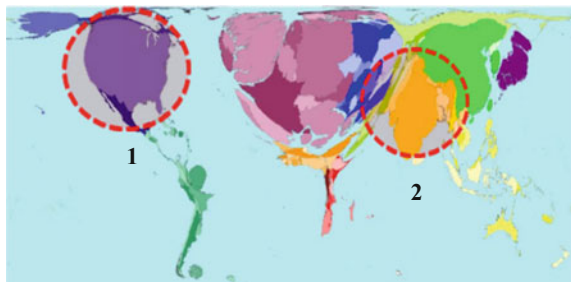
Fig. 16.8 Global wealth distribution 2015. *Source* [13]
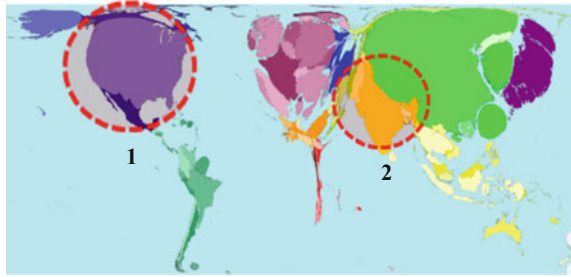
administrative system, its civil service and legal codes mostly unrelated to the constitution of India; they retained all of them until today. India paid a high price for this mistake. The result was that India was most difficult to do business with as per United Nations ranking, and e-governance of India was ranked at the bottom of list of countries since administrative system of the so-called iron frame of British India does not die easily unless deliberatively killed and made to sleep by parliament in Indian democracy. The restrictive and repressive nature of these instruments coupled with inherited university colonial self-serving educational system did not help in creating a rapidly rising economy in India in comparison with China.

16.6 Economy of Kerala State

16.6.1 GDP, SDP and Per Capita Income of Kerala State and Kozhikode District

Calicut City has got a greater amount of spatial, sociocultural and economic similarity at all levels with that of the Kozhikode District and Kerala State economy. The spatial hierarchy has to be studied to understand the trend that can make Calicut a smart economy. Unlike the USA standard metropolitan area economic statistics, India does not keep economic data on the basis of urban agglomeration, but keeps such data only at district and state levels for planning purpose since urban agglomeration planning does not exist in Kerala. The New Kerala Town Planning Ordinance 2015 has legislated and instituted Metropolitan Planning Committee, though the same is yet to be implemented.

A trend in economic and demographic variables in Kerala shows that it is moving toward an urban economy at a rapid rate of change which is the first pre-condition for smart economy in Calicut. The current chapter of the book thus talks that—Can the urban economy of a city be converted to smart economy?

In Kerala, practically there is no distinction between an urban area and a rural area, with coexistences of the primary, secondary and tertiary sectors in both in most of the areas [12, 14]. It can be seen that the urban economy in Kerala is characterized by predominance of tertiary and less of secondary sectors of economy

and gradual disappearance of primary sector economy. It is this tertiary sector that is dominating leaving secondary sector far behind. Hence, under these assumptions that the spatial distribution of settlements, quality of life and income disparity along with poverty rates are very less among the settlements in Kerala, an analysis of the GDP, SDP, per capita income and poverty rates along with their growth trends are analyzed to understand the economic status of Kerala which can be assumed to be similar to that of the district and the city region.

Table 16.1 gives time series data of sectoral distribution of Kerala's gross state domestic product (GSDP) during the period 1960–61 to 2011–12. On analyzing the percentage sectoral shares of income from primary, secondary and tertiary sectors, it can be seen that for the aforesaid period, the share of primary sector dwindled from 56 to 9.48 %. At the same time, percentage share in tertiary sector increased from 28.8 to 70.3 %. The share of secondary sector remains more or less constant all throughout the decade.

Table 16.2 analyzes the growth rate of gross state domestic product (GSDP) in primary, secondary and tertiary sectors for four periods from 2008 to 2012. Here also, it can be seen that the tertiary sector always recorded a positive growth (of 11.8 %) against the primary sector which had always a diminishing growth rate.

Table 16.3 below gives time series data of sectoral distribution of state domestic product of Kerala at constant prices from 1950–51 to 2011–12. On analyzing the SDP, there had been a very high increase over the decades which had drastically increased during the recent years.

Table 16.4 analyzes the growth rate of state domestic product (SDP) for a period from 1970–79 to 2011–12. On analyzing the growth rate of SDP, there had been

Table 16.1 Sectoral distribution of gross state domestic product at constant prices, Kerala 1960–2012

Sectors	Sectoral shares %							
	1960–61	1970–71	1980–81	1993–94	2000–01	2009–10	2010–11	2011–12
Primary	**56**	49.4	39.23	32.23	25.3	12	11.06	**9.48**
Secondary	15.2	16.3	24.37	20.32	19.5	20.7	20.13	20.22
Tertiary	**28.8**	34.2	36.4	47.45	55.2	67.3	68.81	**70.3**
Total	100	100	100	100	100	100	100	100

Source Department of Economics and Statistics (compiled) and [15]

Table 16.2 Sectoral growth rates in constant prices (%)

Sectors	Sectoral growth rate			
	2008–09	2009–10	2010–11	2011–12
Primary	2.18	−0.55	−5.06	−0.73
Secondary	0.3	7.35	8.38	7.03
Tertiary	8.07	11.67	10.26	**11.81**
Total	7.22	9.17	8.05	9.51

Source Department of Economics and Statistics (compiled) and [15]

Table 16.3 State domestic product (SDP) of Kerala at constant prices 1950–2012

Years	SDP (in crores)
1950–51	334 (at 1960–61 prices)
1960–61	432 (at 1960–61 prices)
1970–71	629 (at 1960–61 prices)
1970–71	1,254.64 (at 1970–71 prices)
1980–81	1,571.33 (at 1970–71 prices)
1980–81	3,822.73 (at 1980–81 prices)
1990–91	5,262.34 (at 1980–81 prices)
1993–94	23,851.07 (at 1993–94 prices)
1995–96	26,947.47 (at 1993–94 prices)
1999–00	32,716.15 (at 1993–94 prices)
2000–01	33,565.16 (at 1993–94 prices)
1999–00	62,034.31 (at 1999–00 prices)
2000–01	64,818.47 (at 1999–00 prices)
2004–05	84,950.67 (at 1999–00 prices)
2005–06	92,741.77 (at 1999–00 prices)
2010–11	1,91,866.76 (at 2004–05 prices)
2011–12	2,10,107.17 (at 2004–05 prices)

Source Department of Economics and Statistics (compiled) and [15]

Table 16.4 Growth rate of state domestic product (SDP)

Period	Growth rate (%)
1970–79 to 79–80 (at 1980–81 prices)	1.97
1980–81 to 89–90 (at 1980–81 prices)	2.87
1990–91 to 99–00 (at 1980–81 prices)	6.12
2000–01 (at 1993–94 prices)	2.60
2001–02 (at 1993–94 prices)	2.80
2002–03 (at 1993–94 prices)	7.30
2003–04 (at 1993–94 prices)	7.30
2005–06 (at 2004–05 prices)	10.09
2010–11(at 2004–05 prices)	8.05
2011–12 (at 2004–05 prices)	9.51

Source Department of Economics and Statistics (compiled) and [15]

very high increase over the decades from 1.97 % during the period 1970–79 to 79–80 to 9.51 % in the year 2011–12. It is interesting to note that the SDP had crossed 10 % for the period 2005–06, while the growth rates of SDP from 1970–2002 were mostly less than 3 % with the exception of 1990–91. It can also be seen that there had been drastic a increase in the SDP during the recent years.

Table 16.5 presented below gives per capita income at constant prices computed from 1950–51 to 2011–12. There had been a drastic increase in per capita income

Years	Per capita income (in Rs.)
1950–51	247 (at 1960–61 prices)
1960–61	259 (at 1960–61 prices)
1970–71	298 (at 1960–61 prices)
1970–71	594 (at 1970–71 prices)
1980–81	621 (at 1970–71 prices)
1980–81	1,508 (at 1980–81 prices)
1990–91	1,815 (at 1980–81 prices)
1993–94	7,988 (at 1993–94 prices)
1995–96	5,748 (at 1993–94 prices)
1999–00	10,409 (at 1993–94 prices)
2000–01	10,809 (at 1993–94 prices)
1999–00	19,736 (at 1999–00 prices)
2000–01	20,448 (at 1999–00 prices)
2004–05	25,687 (at 1999–00 prices)
2005–06	27,746 (at 1999–00 prices)
2010–11	55,122 (at 2004–05 prices)
2011–12	60,536 (at 2004–05 prices)

Table 16.5 Per capita income at constant prices

Source Various issues of economic review and [15]

over the decades. The recent year 2012 shows a high per capita income of Rs. 60536, which is very high by all means of Indian standard.

There is no estimate available of per capita income of urban agglomeration of Kozhikode. It can be seen that urban agglomeration covers mostly 66 % of the urban population of the district in the case of Kozhikode, and the contribution to primary sector outside the urban agglomeration is very less. Hence, district-wise per capita income can be used for approximated to per capita income of urban agglomeration. Table 16.6 gives district-wise per capita income at constant prices (2004–05).

On analyzing the district-wise per capita income of all the 14 districts of Kerala, Kozhikode District stands in the ninth position with Rs. 58,498 in the year 2011–12 according to 2004–05 prices. This is slightly below the state average of Rs. 60,536.

According to the National Sample Survey estimates (Refer Table 16.7), high rate of GSDP has drastically declined the poverty rate[15] in Kerala. During the period 1973–74, the poverty rate in Kerala was very high with 59.73 % against the national percentage of 54.88. However, the poverty rate had drastically declined in the case of Kerala and as on 2009–10; the percentage poverty rate declined to 12 % against the national percentage of 29.8 %. It is also interesting to note that, though

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[15]The Planning Commission of India measures the poverty level based on the recommended nutritional requirements of 2400 calories/person/day in rural areas and 2100 calories/person/day in urban areas. The % population below poverty line is estimated based on a sample survey of the National Sample Survey Organization (NSSO).

Table 16.6 District-wise per capita income at constant prices (2004–05)

S. No.	Districts	2010–11	Rank	2011–12	Rank	Growth rate (%) 2010–2011
1	Thiruvanathapuram	59,885	4	65,419	4	9.24
2	Kollam	51,741	10	56,132	10	8.49
3	Pathanamthitta	61,325	3	66,940	3	9.16
4	Alappuzha	56,014	7	60,989	6	8.88
5	Kottayam	63,708	2	69,259	2	8.71
6	Idukki	56,406	6	60,127	7	6.6
7	Ernakulum	81,768	1	89,131	1	9
8	Thrishur	59,080	5	64,629	5	9.39
9	Palakkad	51,182	11	55,365	11	8.17
10	Malappuram	36,068	14	39,005	14	8.15
11	**Kozhikode**	**53,670**	**9**	**58,498**	**9**	**8.99**
12	Wayanad	40,997	13	44,123	13	7.62
13	Kannur	54,492	8	59,354	8	8.92
14	Kasaragod	46,161	12	50,122	12	8.58
	STATE	55,667		60,536		8.75

Source Various issues of economic review and [15]

Table 16.7 National Sample Survey estimates of poverty in Kerala

Year	Poverty rate (%) (Kerala)			Poverty rate (%) (India)
	Total	Rural	Urban	
1973–74	59.73	59.19	62.74	54.88
1977–78	52.22	51.48	55.52	51.32
1983	40.42	39.03	45.68	44.48
1987–88	31.79	29.10	40.33	38.86
1993–94	25.43	25.73	24.55	35.97
1999–00	12.72	9.40	19.80	26.1
2004–05	15	20.20	18.4	27.5
2009–10	**12**	**12.00**	**12.1**	29.8

Source Planning Commission 2011 and NSS data and [15]

there was high disparity between the urban and rural poverty levels, the recent trends show that there is no disparity between urban and rural areas. The most striking unconventional feature is that whenever there is a disparity in poverty rates, the rural percentage are always lower than the percentage urban poverty rates. A phenomenon not seen elsewhere in India.

Hence, it can have be concluded from this section that, though the whole of analysis of GDP, SDP, per capita income and poverty rates along with their growth trends when analyzed using the Kerala State data, most of the positive factors like GDP, SDP and per capita income hve been increasing over the period. The negative factor like

high percentage poverty rate has been decreasing over the period. Hence, Kozhikode District, where Calicut City region belongs to, is also expected to have increase and decrease in such positive and negative factors of growth as that of the Kerala State.

16.7   Economic Base of the Calicut City

Calicut is one of the most vibrant business cities in the state of Kerala. Historically, it was a major trade center which mainly exported spices. Later, the city got its prominence in trading of timber, copra[16] and cotton. The post-independence period environment and social fabric of the region did not support major industrial developments. Hence, no large-scale industries were present in the region, though there are traces of one or two medium-type industries mainly related to steel processing. The other small-scale industries related to rubber products manufacturing, food and dairy, handloom, wood, textile and a few chemical-based industries are present mostly in selected industrial estates like the SIDCO Industrial Estate, industrial estates in West Hill, the estates at Elathur, Cheruvannur-Nallalam, Beypore, Nellikkode and several other areas. Today, many of such industries are neither yielding much of the revenues, nor giving much of the employment.

16.7.1   Service- and IT-Based Industries

Currently from the traditional manufacturing and allied industries, the economy of the region is slowly shifting toward the tertiary and service-based industrial units. The late 1990s showed a boom in the real-estate business, mainly targeted to the nonresident Indians working in the Middle East Gulf countries which is still continuing even today. Calicut is booming up to become the next IT hub of South India, because of its equidistant presence between two major IT cities of South India, namely Mangalore and Kochi. The Silicon Valley of India, Bangalore, is only 360 km, making it very well accessible and having potentialities for a major IT hub. Accordingly, two major IT parks started to be operational in Calicut which is likely to create 100,000 jobs [16]. The works of an advanced Technology Park in Ramanattukara and Kinfra Marine Park in Beypore is underway which is expected to bring more of employment and revenues to the city.

The construction of a research and development center called 'NIRDESH'[17] mainly catering to ship building is underway in Calicut at an expected cost of 6000

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[16]Copra is the dried kernel of the coconut used to extract coconut oil.

[17]NIRDESH (National Institute for Research and Development in Defense Shipbuilding) is the first defense research and development centre in ship building presently undergoing construction in Calicut.

million rupees. This unit is expected to create and employment of 10,000 jobs directly and around 5000 jobs indirectly which includes jobs from research scientists toward jobs in construction, fabrication, small-scale manufacturing and supporting industries.

There are other expected upcoming projects like the Birla IT Park (at Mavoor) and a Malaysian satellite city (at Kinaloor) along with a few other industrial parks at the Kinfra Park. Kozhikode District which has got 8 % population of Kerala and contributes to 12 % of the state's income [17]. The city is fortunate enough to have an international airport and a small intermediate port at Beypore. The Beypore port is also famous for its traditional ship building (Uru) industry which once was an internationally acclaimed center, but now concentrated on selected exports of wooden-made ships.

16.7.2   Tourism

Calicut is a famous tourist destination in Kerala as well as India. It contributes considerably to the total economy of the region together with the provision of employment. The city is famous for its boat-building yards of Beypore, beaches, mangroves, bird sanctuaries at Kadalundi, historical religious places (like the Thali Temple, Misqual Mosque and the Mother of God Cathedral), museums (like the Pazhassi Raja Museum, V.K. Krishna Menon Museum and Art Gallery and Planetarium), unexplored backwaters, ayurveda treatment and Kalari health care systems along with the mouthwatering cuisines of Malabar, which makes it a dominant destination for tourists. Being a major tour and transport hub of the regional tourist destinations including Wayanad, Kasrakode and Kannur districts, the city and the surrounding regions have high potential for tourist developments.

Fortunately, the region has a good network of backwaters, long beaches and river fronts, navigable canals, etc. which can serve for better recreational tourism. The presence of mangrove reserves can also serve for good ecotourism. The region is of high potential for cultural tourism with its diverse folk/classical art forms. The cuisines of the region are very famous because of their multicultural and multiethnic foods flavors with mix of various food habits.

16.7.3   Education

Historically, even during the medieval period, Calicut was a major center of learning. The Zamorins promoted centers of teaching and attracted scholars from various parts of South India. The 'Kuttichira Misqual Mosque' was also historically significant learning place for the Islamic and Arabic literature. In the first half of nineteenth century, modern education started its roots in Calicut with the starting of the 'Basal Evangelical Mission' School at Kallai. Later, a few educational

institutions were started by the British and the 'Zamorins' until India became independent.

Today Calicut is the hub of higher learning in India. It has got two premier educational institutions of national importance, namely the National Institute of Technology Calicut (NIT-C) and Indian Institute of Management, Kozhikode (IIM-K). The University of Calicut campus has its base in the city along with government medical, dental and homeo colleges, etc. Calicut also houses some of the research institutions like Indian Institute of Spices Research (IISR) as well as the Centre for Water Resources Development and Management (CWRDM). Apart from these reputed educational centers, Calicut has got various other arts-, science- and engineering-based institutions with wider range of students' population from different parts of India and abroad.

However, the quality of infrastructure and educational facilities in the schools are not up to the mark. Based on a study by Department of Town and Country Planning and others for the master plan of Kozhikode, there are 225 schools in the region of consideration. The schools are crippled with infrastructure shortages with 33 % of schools not having playgrounds, 6 % do not have separate toilets for ladies and gents, 3 % of the schools facing water scarcity, 73 % do not have proper IT infrastructure, with 38 % of schools not having good computer labs with Internet access. However, the most positive thing is that almost all the schools follow the government prescribed teacher/student ratio of 1:30.

16.7.4 Fisheries

Fishing is a major employment provider, which also contributes generously to the economy in the region as well as the state. In Kerala, in the year 2008, fisheries contribute 13.33 %[18] of the GDP making it a larger contributor than agriculture. Calicut, fortunately is blessed with a larger coastline 12.2 % of the total coastline of Kerala. Therefore, there are three fishing harbors located in the region, namely Beypore, Puthiyappa and the recently upgraded harbor at Vellayil, which contributes largely to the fisheries, both for export as well as local consumption.

16.7.5 Health

Calicut being a major regional economic base of Kerala is also famous for its advanced health infrastructure facilities. The city and its precincts are fortunate to have one of India's best hospitals with specializations in all major disciplines at an affordable rate. The region is blessed to have reasonable penetration of health

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[18]Based on the data of mospi.nic.in.

infrastructure to all sectors of the society through its efficient public health systems from primary health centers to medical colleges in ayurveda, homeo and allopathic medicines.

These high quality medical and treatment facilities are comparable to international standards with best treatments with relatively low cost. Therefore, Calicut attracts a large number of international medical tourists, especially from Middle East Arab countries as well as the SAARC[19] countries. The nearby destination Kottakkal[20] is a world-renowned ayurvedic[21] tourist destination.

16.7.6 Gulf Immigration

Immigration from Kerala, especially to the Gulf countries like UAE, Saudi Arabia, Oman, Kuwait, Bahrain and Qatar, started with a few thousands in 1973. The historical spice trade and the matrimonial relationship between the Arab world and the predominant Muslim population of the Malabar coast (where Calicut was the major city of trade and travel) had already created a strong cultural bond between the two regions. The relatively high level of literacy in these regions further paved as an important step in the immigration to the Gulf countries.

As a consequence [18], there has been a steady increase in the migration of people starting from 186 thousand in 1980 to 1.1 million in the year 2000 which roughly constitutes the 35.75 % of the total immigrants in the Gulf countries from India. This increased to 2.2 million in the year 2008. From Table 16.8, it can be seen that among the migrants, four districts of Malabar, namely Thrishur, Kozhikode, Kannur and Malappuram, contribute maximum to the migration thus forming 43 % of the total migrant population. These four districts constitute 44.5 % of the total remittance in Kerala.

Kozhikode District also contributes enormously to the total remittance by means of contributing toward 9.2 % of the total state remittance, through its 9.1 % of the total migrant labor in the Gulf region. The Kozhikode District also has approximately Rs. 60,000 per capita remittance which is the fifth highest in terms of remittance in Kerala. According to [20], remittances to Kerala in 2011 were as much as one-third (31.2 %) of Kerala State's net state domestic product. This simple statistic signifies the contribution of foreign remittance in the region's economy.

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[19]SAARC countries: South Asian Association for Regional Cooperation (SAARC) is an organization of eight countries that are located in South Asia of the subcontinent. The countries include Bangladesh, Sri Lanka, Nepal, Afghanistan, Bhutan, India, Maldives and Pakistan.

[20]Kottakkal: A small city located approximately 40 km away from Calicut City.

[21]Ayurveda: A kind of traditional treatment mainly using plants.

Table 16.8 District-wise remittance details

S. No.	District	Remittance from immigrants in the year 2008			
		% Immigrants	Total amount in crores	% Remittance in 2008	Per capita remittance in 2008
1	Trivandrum	14.1	4801	11.1	55,465
2	Kollam	9.5	4477	10.3	66,460
3	Pathanamthitta	5.5	2211	5.1	68,361
4	Alappuzha	6	1970	4.6	36,159
5	Kottayam	4.1	2271	5.2	46,351
6	Idukki	0.3	156	0.4	5390
7	Ernakulum	5.5	2984	6.9	37,254
8	Palakkad	8.7	3448	8	58,365
9	**Thrishur**	**13**	**5961**	**13.8**	**81,588**
10	**Malappuram**	**15.3**	**6486**	**15**	**103,585**
11	**Kozhikode**	**9.1**	**3988**	**9.2**	**60,860**
12	**Kannur**	**5.4**	**2800**	**6.5**	**53,090**
13	Wayanad	0.6	571	1.3	30,099
14	Kasrakode	3.1	1164	2.7	45,077

Source Generated from [18, 19]

Based on the studies of [18–20], it can be said that the impact of migration to Middle East is the basis of economy and quality of life in the region. This migration had reduced poverty and unemployment, and had contributed considerably to the savings and investments. The social impact because of high quality of life and income is also praiseworthy, thus contributing largely to the advanced development of the region, as well as the state of Kerala, when compared to other places in India.

16.8 Socio-demographic Characteristics of the City Region

Calicut City, the Kozhikode District and the Kerala State is fortunate enough to have a good social and demographic characteristic feature when compared to the rest of India. Referring to Table 16.9, it can be seen that the Calicut City region has a high sex ratio of 1084 females against 1000 males, thus showing a better socioeconomic profile. The average literacy rate is close to 96.2 % literates with a male literacy of 97.7 % and female literacy of 94.8 %. It can be seen that there is very less difference between the literacy rates of males and females showing again a better socioeconomic profile.

Table 16.9 Demographic profile of the city region

	Population	Pop density	H.H density	Sex ratio	Percentage literate		
					Male	Female	Total
Kozhikode (M Corp. + OG)	550,440	6674.4	1457.7	1093.4	97.7	95.1	96.3
Total city region[a]	928,342	5683.5	1219.9	1084.3	97.7	94.8	96.2

[a] Total city region includes the Kozhikode Municipal Corporation and outgrowth along with the surrounding panchayats of Beypore, Cheruvannur-Nallalam, Elathur, Feroke, Kadalundi, Olavanna and Ramanattukara

Source Compiled from primary census abstract Kozhikode using Census 2011

16.8.1 Educational Profile

Figure 16.9 gives the breakup of the educational status of people in the city region; it can be seen that close to 41 % of the people are high school graduates, a number relatively very high when compared to other cities of India as well as to that of some OECD countries such as Turkey 34 %, Mexico 37.3 %, Portugal 38 %, Brazil 45 %, Italy 57 %, Chile 57.5 % [21]. Close to 9 % of the people are graduates, 1.7 % people are postgraduates, 1.95 % are technical graduates, and 1.6 are professional graduates. This proves that the people in the city region are not just literates,[22] but have reasonably good educational background.

16.8.2 Workforce Characteristics of the Region

From Table 16.10, it is very clear that the major employment in the region is that of other workers[23] with 97.2 %, which includes employment other than primary sector and secondary sector employments. The percentage of workers in tertiary activities has been increasing in Kerala with more and more population shifting from primary and secondary sectors to service-based industries [14]. The case is true in Kozhikode District is no distinct with the percentage engaged in tertiary sector gradually increasing from 1991 to 2011. It is also interesting to note that 88.3 % of the total populations are main workers.[24] The work participation rate[25] is close to 31.2 %.

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[22]Indian Census defines a person who can just read and write as a literate.

[23]Other workers as % of working population category shows predominantly tertiary sector employments in transport and communication, trade and commerce, construction, non-household manufacturing, etc. [26].

[24]Main workers: Those workers who had worked for the major part of the reference period (i.e., 6 months or more) are termed as main workers [26].

[25]Work participation rate: It is defined as the percentage of total workers (main and marginal) to total population [26].
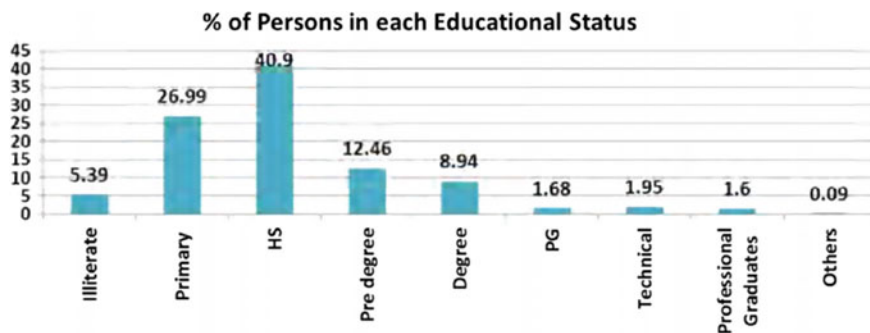
Fig. 16.9 Breakup of educational status of Calicut City region. *Source* Primary census abstract for Kozhikode using Census 2011

Table 16.10 Workforce characteristics of the city region

Region	Work participation rate (total)	Main workers % (total)	Marginal workers (total)	Sector-wise employment (total)		
				Cultivators and agricultural labours as % of working pop. (total)	Household laborers as % of working pop. (total)	Other workers as % of working pop. (total)
Kozhikode (M Corp. + OG)	31.6	89.4	10.6	1.5	1.2	97.3
Total city region[a]	31.2	88.3	11.7	1.5	1.2	97.3

[a]Total city region includes the Kozhikode Municipal Corporation and outgrowth along with the surrounding panchayats of Beypore, Cheruvannur-Nallalam, Elathur, Feroke, Kadalundi, Olavanna and Ramanattukara

Source Compiled from primary census abstract Kozhikode using Census 2011

16.9 Possibilities of Calicut as a Future Smart City

A smart city system comprises of six key building blocks, namely smart people, smart economy, smart mobility, smart environment, smart living and smart governance. These six building blocks are closely interlinked and contribute to the smart city system. This Sect. 16.9 explores the possibilities of Calicut as a strong contestant for being a smart city by highlighting its positive aspects based on the aforesaid six building blocks.

16.9.1 Smart People

Calicut truly fits into the domain of smart people. The highest rate of literacy rate (around 96 %) with high rate of female literacy (around 95 %) itself is a strong indication of the quality of human resource available. According to a study conducted by the planning commission, [22] among all the states of India, Kerala ranks the highest Human Development Index (HDI) of 0.790 in the year 2006, which is a clear indication of the quality of the human resources available in the state. The HDI of Calicut District is 0.781 which is almost comparable with that of the Kerala State. This HDI is above many countries like Russia, China, Brazil, South Africa. In the year 2012, based on a study conducted by [23], the HDI of Kerala is 0.911 which is comparable with the HDI of many developed countries such as USA, Britain, Japan.

Calicut City had always been a welcoming city. Historically, all the kings and rulers who ruled the city or the region had always welcomed new traders and entrepreneurs for business, be it Arabs, Portuguese, Jews, Romans or Chinese. Thus, the city interacted with all over the world through international trade and people migrating to other countries for work. There were ample evidences of relationships from trade to marriage between the inhabitants of the city and various other nationals showing the cosmopolitan, open-minded, and multicultural perspective. Due to the trustworthy nature of the people, the city was historically called as 'the city of truth' [3].

16.9.2 Smart Economy

Historically, Calicut has been a trading city where the port acted as the fulcrum of international trade. Though the city lost its glory mainly due to the policy of colonial power to retarded economic development and international trade, it still has all the potential to regain its prominence at least as a city of national importance. The growing IT market at the two IT parks can definitely bring a lot of international trade connectivity to the city. The supporting real-estate business with world class shopping and entertainment malls, residential townships, international schools, etc., has already started to come in the city anticipating a major IT growth. Several other tertiary and service-based industrial units, industries related to food and food products, jewelry, etc., are also booming in Calicut.

The city and the surrounding region is already a prominent tourist destination of international repute. The presence of three reputed research and educational institutes such as NIT Calicut, IIM Kozhikode, and the Government Medical College, Calicut, increases the potentiality of a smart city with students from various regions of India along with some international students. The port at Beypore, once developed, can act as an export zone for fisheries and allied industries related to food and food products, thus increasing the potentialities of Calicut as a smart city. The

advancement in the health sector with patients coming for medical tourism mainly from Arab countries adds a lot of significance to Calicut as an aspiring smart city.

From the 1960s onwards, Calicut and especially Malabar region's economy had been dependent mainly on the remittance from Middle East to some limited amount from North America and Europe. Majority of the people in this region had been working in cities of those countries which are potentially smart cities. Living for several years in many advanced cities, such people have affinity to learn new technologies and ideas which can be implemented in Calicut. Thus, they accept ethnic plurality and have no ill feeling toward immigrants who work in Calicut. Thus, adaptability to smart conditions and the smart economy will not be a problem in context of Calicut.

Start-up culture and incubators in technological institutions are churning out many entrepreneurs. In one of the IT parks, the state government had initiated a new startup in UL Cyber Park with an intention for at least 1000 technology startups over the next 10 years. Calicut had in the past and in the present has an image of international market place which can be cultivated further by application of ICT. This creates an international embeddedness. Productivity can be enhanced by embracing modern technologies.

16.9.3 Smart Governance

The state of Kerala has achieved 100 % mobile density and 75 % e-literacy[26] [24]. The state also has highest digital banking rate when compared to national standards and broadband connection up to panchayat level. Of the villages, 97 % have at least an Internet cafe against the national average of 17 %. Due to this high track record of implementing Digital India Vision, Kerala had achieved the status of becoming India's first 100 % digital state [25]. Kerala is in the process of achievement of e-governance. Many of the government officials who work in various departments have earned a PG Diploma in e-Governance. There are plans to implement 'mobile governance,' 'Wi-fi hotspots in government schools,' 'paperless government offices,' 'digital literacy - phase-II,' 'Electronics@School' and more penetration of e-banking.

Government approach of people's movement of annual planning is a good example of participatory planning practiced in Calicut since 1990s from ward level to municipality level and then to district- and state-level multi-level planning system. Efforts are being undertaken to use ICT in people planning through the usage of computers and mobile phones. The 'Akshaya'[27] centers in private sector give access to computer and e-governance services for those households having no

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[26]e-literacy: One person in every family knows how to use a computer.

[27]Akshaya centers started to spread e-literacy through Akshaya projects. This is the largest one in India and one of the largest Internet protocol-based wireless networks in the world.

computer at home. As on 2014, there are about 25 % of government services are accessible by e-governance portal.

16.9.4 Smart Environment

Fortunately, Calicut is blessed by natural heritage, unique natural resources, biodiversity and environment, thus making it a leading tourist destination. The city region is blessed with many biodiversity hotspots with its large span of coastal areas, estuaries, mangroves, river banks, wetlands, paddy fields, sacred groves and ponds. One of the panchayat in the city region, namely Kadalundi, is declared as a bio-reserve with variety of mangroves and a place of migratory birds and its sanctuary. There is also the presence of 'Kottuli Wetlands' identified as an urban wetland by the Ministry of Environment and Forests under National Wetland Conservation Programme. The presence of 'Canoli canal,' a water transport system used in the earlier times (which requires a face shift) together with the presence of large number of domestic water bodies like ponds and wells makes the area an ecosensitive region. The people of Calicut have been accommodative to these environmental assets, and even today, there is much care/protests for any developments in such areas. Birla Rayon Mill, the largest industry in Calicut when found polluting the Chaliyar River, was forced to be closed despite revenue generation and high rates of employment. The core city area has got an urban wetland, preserved more or less intact.

As explained earlier in the introduction part, a study conducted by a New Delhi-based economics research and data analysis firm called 'Indicus Analytics': Calicut City has been ranked as the second best livable city in India. Apart from Calicut, four other cities in Kerala are ranked in the top ten cities of livable cities in India, thus indicating the quality of life and environment in the state. Another study by ABP News in the year 2015 has rated Calicut as India's best city in terms of environment and quality of life, whereas all other cities under different heads of analysis are the major metro cities of India including the planned city Chandigarh.

Calicut is a low-density city with less household density when compared to most of the other cities of India of comparable standards. This is because of the unique rural–urban continuum settlement pattern with coexistence of urban and rural characteristic featured settlements. Hence, most of the dwellings are made in individual plots and distributed evenly all over the habitable areas [12]. Accordingly, there are a lot of open spaces in many of the house compounds even in cities, thus making it more green and open. Another aspect of the settlement pattern of Kerala is the equitable distribution of infrastructure facilities to the suburbs, thus reducing the pressure on a single urban city [12]. Hence, better quality of life and less of migrations from urban centers to rural areas are seen in most of cities in Kerala, including Calicut.

16.9.5   Smart Living

Calicut City has a celebrated local history, vibrant culture with rich heritage and art forms. The quality of life is good with lesser conventional urban problems, when compared to other cities of India. There are several places including tourist destinations for outing. The presence of a beach, several public gardens and the recent shopping and entertainment malls add to the life of people in the city. The city is famous for its tolerance especially toward women and other weaker communities. There was hardly any communal clash with people of all class, religion living harmoniously with open-mindedness, cosmopolitan and flexible attitude and outlook. One of the most dominant aspects of Calicut City is its cuisines. The rich Malabar cuisines have a lot of admirers, and some of the cities' restaurants are rated as the best in the field. There is a decent night life, and it is relatively safe for women, during wee hours also. Historically and even today, Calicut has given stress on cultural facilities, educational facilities, and improved health of people. There are many schools upgraded to international standards, and few schools of international standards are being established. The housing quality is generally good but needs to be upgraded.

16.9.6   Smart Mobility

Calicut has local accessibility of bus system that move people from interior part of the city, and there is a light metro being implemented in Calicut. High-speed rail system that connects Thiruvanathapuram and Kannur, and then Mangalore in the second phase, is under consideration to implement. There is an international airport located 27 kms from the city, and there are navigable waterways connecting Beypore port by coastal shipping to Lakshadweep and western coastal ports. There is an inland waterway which needs full implementation to reap benefits. There is scope for creating innovative mobility system for Calicut and increase transport safety and above all speed for average mobility, once smart city is fully implemented for smart economy.

16.10   Conclusion

Calicut was a city with rich history, legacy and international connectivity. Once a major city of world prominence, the city lost its glory mainly after the start of colonialzation. Even today, fortunately, the city has a reasonably good economic base with higher socioeconomic profiles including high HDI and Quality of life parameters. The city has reasonably good infrastructure, presence of health and educational facilities of repute, and all other potentials which can supplement for a

smart city. With possible interventions in terms of re-branding the city, urban design and planning exercises and proper land management and economic development, Calicut can be modeled into a unique case of a smart city, thus reforming back to once lost glory.

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Chapter 17
Marketing and Branding of Calicut as a Smart City Destination

Deepak S. Kumar, Lakshmi Manohar and Priyanka Singh

Abstract Branding is the process of creating and communicating a unique position in the minds of the target customers. This holds good for branding destinations as smart cities too. Place branding thus suggests that places, cities, regions or countries could be considered as brands, as long as it is perceived so. There are lot much challenges in place branding. Due to the changes in the economical, cultural and social changes in the global landscape, there exists a fierce competition among multiple destinations for resources, business relocation, foreign investment and visitors and even for migrants and residents. Based on the prevailing definition of marketing from American Marketing Association, this chapter attempts to use the basic formwork of creating value, communicating value and delivering value in explaining the marketing process of Calicut as a smart city destination. Four elements that are unique to the cultural and geographic aspects of Calicut are identified, which include Calicut cuisine, Uru (traditional vessel), Kalaripayattu (traditional martial art form) and Calicut trade hub. These elements have different value propositions and thus cater to different target customers refer as stakeholders. Using Aaker's model of brand equity, a detailed study about these elements is conducted and a set of brand elements are identified. Subsequently, other aspects of the brand charter including the brand promise, colour and typology are also identified. Finally, the way of delivering the value to stakeholders through e-marketing and social media platforms is also discussed for all the four elements.

Keywords Marketing and branding of Calicut · Smart city branding · Aakar's model · Calicut cuisine · Uru · Kalaripayattu · Calicut trade

D.S. Kumar (✉)
Amrita School of Business, Amrita University, Coimbatore, India
e-mail: deepak.skmr@gmail.com

L. Manohar · P. Singh
National Institute of Technology, Calicut, India
e-mail: architect.lakshmimanohar@gmail.com

P. Singh
e-mail: ar.priyankasingh@yahoo.com

17.1   Introduction

Calicut (Kozhikode) which is a district in Kerala state of India was the most important region of Malabar province during the Colonial era and was the capital of powerful Zamorins then ruler of the region. Calicut is now a crowded, prosperous and ordinary developing city in Kerala, built on the ruins of a historical harbour town, which was the capital of the medieval kingdom of Kozhikode. Even at the beginning of the twelfth century, it was just a no man's land with saltpans and marshes. In the fourteenth–fifteenth centuries at the end of which Vasco da Gama visited the Zamorin Raja of Calicut in 1498 AD, it had been transformed into one of the most prominent centres of international trade, the meeting point of east and west, in the streets of which merchants from china and Southeast Asia brushed shoulders with those from Abyssinia and Europe [1]. Calicut also enjoys a significant place in its cultural uniqueness. For instance, since time immemorial, food had been one of the facets of Calicut's culture that projects the very essence of Calicut. Calicut cuisine is a standing testimony to the colourful history, trade, traditions and the sincerity of the people of Calicut. So this chapter illustrates our attempt to capitalize on some of the geographical, cultural and economical lifestyle and traditional roots of Calicut to market and brand Calicut as a smart city destination.

Marketing of places, especially urban cities, has been in practice since nineteenth century [2], where there is an increased focus in these directions in last few decades [3]. Due to the changes in the economical, cultural and social changes in the global landscape, there exists a fierce competition among multiple places for resources, business relocation, foreign investment and visitors and even for migrants and residents [4]. So most of the nations across the globe are trying to market themselves and to manage their brand identity so as to attract more tourists, foreign investments, exports, talented human resources and so on and so forth.

As evident from American Marketing Association (AMA) definitions of marketing, the concept of marketing is still evolving. According to AMA, the current definition of marketing is that "marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large".[1] The core of marketing as given in the definition is about providing value to the customers, in a way which is beneficial to all. Quite often value concept is perceived one, and it is the consumer's overall assessment of the tangible and intangible benefits of a marketing offers based on perceptions of what is received and what is given [5]. So value is very subjective in nature and may changes with the targeted segment of customers. Hence, to identify the right group of customers, the market has to be segmented and all the resources have to be aligned in such a way to cover the segment effectively and efficiently. This study also focuses on creating values, communicating values and delivering values of Calicut as a smart city destination

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[1]https://www.ama.org/AboutAMA/Pages/Definition-of-Marketing.aspx.

Fig. 17.1 Marketing scheme

| Creating Value: Identifying elements | Communicating Value: Branding of elements | Delivering Value: e-marketing of elements |
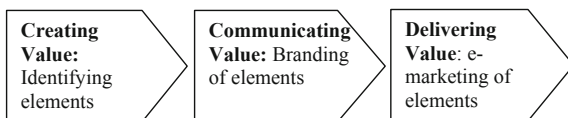
and its core elements to the targeted segments. The chapter is organized in the following sections, as shown in Fig. 17.1.

17.2 Creating Value—The Smart City Concept

A Smart City System comprises of six key building blocks: (i) smart people—the fundamental building block, professionally excellent, high human development index, flexible, capable and creative people; (ii) smart city economy—which understands the economic DNA, values creativity and open to new ideas, prepared for challenges of globalization, develops and supports national brands, etc.; (iii) smart mobility—mobility of people, vibrant streets, manages pedestrian traffic and traffic congestions, balanced transportation options, seamless mobility for differently able people; (iv) smart environment—strong sense of place that is rooted in its natural setting, values its natural heritage, natural resources, biodiversity and environment, effective waste management system and resilience to climatic changes; (v) smart living—strong shared values, celebrates local history, culture, heritage of the city and nature, provides safety and ideal place for women, children and senior citizens, improves quality of life and high-quality public spaces; and (vi) smart governance—accountability, responsiveness, transparency (ART), efficient and effective public service delivery, e-governance and e-democracy [6]. As mentioned in Chap. 1, the smart city concept referred here is built on a combination of ideas on how ICTs might contribute to improvements in the functioning of cities, improving their competitiveness, enhancing their efficiency and finding new ways to tackle problems of poverty, social deprivation and poor environmental management.

In the case of place marketing, all philosophies and techniques applicable in traditional product marketing can be applied to places, where the only differentiator will be the market offerings or the "product P", which are the tangible or intangible benefits of the place. Yet, as Ashworth and Voogd [7] suggests for successful place marketing attempts, special type of marketing such as e-marketing may also be attempted. This is in line with our approach to use ICT to increase the competitiveness and the reach. When it comes to branding of places, it refers to what image does people have about the place and what kind of relationships they have with it [8]. Place branding and marketing strategies have become a common point of intersection of research in diverse disciplines like geography, marketing, regional planning studies and tourism. The various branding trends prevail in today's place branding scenario including place of origin branding (approach using qualities,

specialities, stereotypes of the place or people living in that place to brand), nations branding (approach using the historical/geographical realities of the nation to be reinvented to suite with the current context), culture and entertainment branding (approach using cultural, leisure and entertainment industries prevailing in a place) and destination branding (approach using the tourism aspects of the place). Among these prevailing trends, most of the studies related to place branding have focused on the tourism aspects of the place [9]. Hence, we have also taken a similar approach in identifying the key elements which can deliver value to the various stakeholders.

A secondary research based on various case studies available in published sources related to tourism destinations is done to understand the images of various cities which were being projected globally and the marketing strategies adopted by different cities around the globe. It was then followed by research on various image creating elements of Calicut, those elements which are inherited, deep-rooted and unique to the custom, culture, way of living and economy of Calicut. Few core elements were shortlisted for this study such as cuisines, religious harmony, medical and therapeutic techniques, art forms and craftsmanship of the region. Further extensive research on these headings was carried out by the fifth semester architecture students of National Institute of Technology, Calicut, and based on the relative relevance of them and on the researcher's judgements, four unique markers (referred as elements in this study)—that are closely integrated to Calicut as a destination—are identified. The elements are Calicut cuisine, *Kalaripayattu* (traditional martial art form and school of orthopaedic health care), *Uru* (traditional vessel) and Calicut trade hub. Out of these, the first two are proposed in Umami which is a brownfield smart city development in Calicut based on the existing economic activity of this zone whose specialization includes food processing and Ayurvedic tourism. Umami also promotes smart mobility through its trade hub which can help in the functioning of Calicut trade hub. The value proposition for these elements is explained in the later part of the chapter for all these four elements. Once the value propositions are identified, the next aspect will be on communicating the value for the target customers. Brief descriptions about the potential target customers for all these elements are also included in the detailed study.

17.3 Communicating Value—Branding of Smart Cities

Quite often, people get confused between branding and marketing and use these terms in wrong order of occurrence or use interchangeably. However, there exists a distinctive difference between these two concepts: branding is one of the aspects of whole marketing activities (called 4 "P" marketing mix, which are product, place, price and promotion [10]) taken by a firm and branding is the subset of the "P"— promotion, which, based on the marketing plan adopted by this chapter, relates to the communication of value. Branding has become an integral aspect of any market

offerings, be it goods, services, individuals, destinations, organizations or idea, and has been used extensively in today's fast changing environment. Brand, as defined by American Marketing Association (AMA), refers to "name, term, sign, symbol, or design, or a combination of them, intended to identify the goods and services of one seller or group of sellers and to differentiate them from those of competition[2]". These different components of a brand that identify and differentiate it are called the brand elements. But in actual practice, brand is just more than its elements; it is something that has actually created a certain amount of awareness, reputation, prominence, and so on in the marketplace. With the progress of time, brands have evolved to strategic assets, which in many cases have become more valuable than the market offerings from the companies [11]. In other words, brands have the ability to alter the value proposition, either positively or negatively of any kind of offerings. It also provides differential benefits for the users and the marketers. So it is not just branding is what matters, but the branding attempts should be successful. The classical branding theory put forth by Aaker [12] is one of the most widely accepted branding models in marketing literature. Aaker's model of consumer-based brand equity postulates that a brand acquires its value from four main factors, namely brand awareness, perceived quality of the brand, brand associations and brand loyalty. The building blocks for customer-based brand equity have four steps with six stages. The six stages include salience (brand awareness), performance and imagery (the points of parity and differences), judgements and feelings (positive accessible reactions) and resonance (intense loyalty towards products). This is represented in the form of a pyramid in Fig. 17.2. Chernatony and McDonald [13, p. 237] define a successful brand as "an identifiable product, service, person or place, augmented in such a way that the buyer or user perceives relevant, unique and sustainable added values, which match their needs most closely". Hence, the
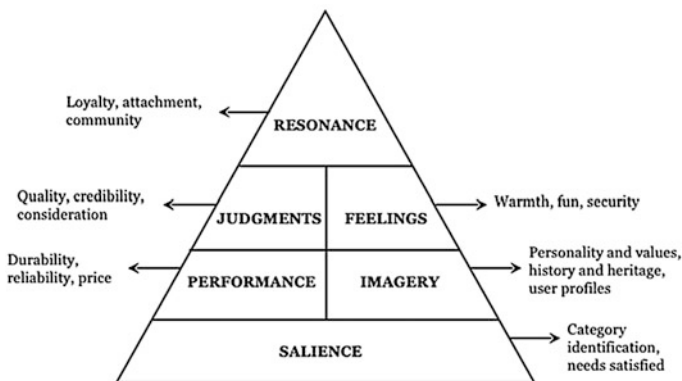
Fig. 17.2 Brand resonance pyramid. *Source* Aaker [12]

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[2]https://www.ama.org/resources/Pages/Dictionary.aspx?dLetter=B.

steps which are required to take a brand from the salience stage to resonance are what are attempted here.

The major activities that come under the place branding exercise include creation of a suitable elements such as name, symbol, logo, word mark or other graphic that readily identifies and differentiates a destination and reinforces the emotional connection people have with the place to reduce the consumer's risk associated with search and the services [14]. In order to have the salience for the destination branding, one approach would be to leverage the image of the destination, which can help in conveying the value propositions much more easily to the targeted audience. This is otherwise known as imaging. This concept of imaging has originated from the realization that images can be effectively communicated, while the market offerings to which they relate remain vaguely delineated, as in cases of places [7]. The term image represents the sum of attitudes, beliefs and impression that a group of people has on a place. Generally, a place's image results from multiple aspects like its geography, history, art, music, culture and famous personalities. At times, there could be instances where ill aspects can also imparts image of a place, like for instance riots, poverty, crime, etc. [4]. Just like any secondary associations help in building the brand equity, an image of the place can also be diligently in building place brands as it assists customers as a shortcuts for information processing in consumer decision-making heuristics. Hence, it is quite critical for the marketers to choose those set of images which helps people to memorize and recall easily and has meaning and should be likable. So, in line with the framework suggested for image management by Barich and Kotler [15], we attempted an image management exercise for all the elements chosen. We have detailed out the image generation processes under various studies below. Based on the chosen images, a whole set of branding exercises are proposed for each element in the form of a brand charter [16], which is a document that provides relevant guidelines to the decision-makers regarding the scope of the branding exercise. Once the branding is done, the next aspect will be in communicating the brand aspects to customers.

17.4 Delivering Value—E-Marketing of the Smart Cities

Internet is considered to be the next important innovation after the invention of printing press [17]. Information and communications technology (ICT) adoption has changed the way the marketing activities are carried out around the work. It has altered or combined the various "P's" of the marketing mix. It is one thing that has revolutionized all 4Ps of the marketing mix, be it product, price, place and promotion to a single unified platform. E-marketing takes away the concept of channel intermediary by directly connecting with the target customers at a reduced transaction cost and by removing the location-based and time-based behavioural patterns [18]. E-marketing is defined as using the Internet and other interactive technologies to create and mediate dialogue between the firm and identified customers [19].

In this section of the study, we focus on how ICTs can be put to use to deliver the value proposition to the target customers, in terms of reaching out to the target audience through Websites, digitization of other activates in the logistic and supply chain and e-commerce, how some aspects of the place "P" can be altered through ICTs, where the marketplace itself is becoming virtual like most of the retailing Web portals. In our study also, to deliver value to customers, we proposes a set of Websites which can help in reaching out the target customers. The next section provides the details of the 4 elements chosen.

17.5   Element-1: Kalaripayattu

The history of Calicut mentions about "Kalaripayattu"—meaning "battleground" or "gymnasium"—(Kalari), "method" or "art"—(Payatt), known to be practised for more than 500 year, and traces its divine origin to Parasurama*,[3] who created it as a dynamic art of "offence and defence" for all [20]. The eulogies glorify Parasurama and his feats which lead to the establishment of kalaris and his instruction to gurus on this art has been passed on as legendary poems orally. Research on this art form has accepted Kalaripayattu as a holistic art that not only encompasses defensive techniques but also involves therapeutic techniques. Kalaripayattu improves the physical and mental health of the practitioner greatly. "Kalari-Uzhichil[*4]" augments the secretion of hormones from the hormone-producing glands related to "Shadadhara Chakras", thus improving and balancing the healthy functioning of the human body.

The outcome of these researches and its popularity has resulted in getting Kalaripayattu accepted as a major martial art for health care by the government. However, there is a critical lack of popularity and awareness on Kalaripayattu among the masses, including people of Kerala, except a few who are interested in exploring and learning this ancient art form. This thus is an untapped treasure trove of culture in this region leaving us with numerous opportunities to boost the economy of Calicut. This necessitates careful and thoughtful planning, branding and marketing of Kalaripayattu, with the SMART approach, to attract the global audience.

Based on expert reviews, understanding of the marketing process and analysing similar case studies, the imagery aspects were prepared to brand and market this unique art. This was also polished and strengthened by discussion with gurus and students of this art. After this, we arrived at possible way of branding by showcasing Kalaripayattu as a STRONG, FLEXIBLE, DISCIPLINED, CONDENSED and FOCUSED art.

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[3]Parasurama—Sixth avatar of Lord Vishnu as per Indian mythology and puranas.

[4]Uzhichil—Malayalam word for a type of massage.

17.5.1   Image Creation and Branding of Kalaripayattu

The marketing strategy aims to target researchers who are interested to learn the art form, patients who are in search of Ayurvedic massage treatment due to ailments or fractures, other tourist who come in search of medi-tourism and fitness enthusiasts and artists/yoga practitioners who make use of the art form to achieve a flexible body and focused mind.

Brand is named "Kalari" which is direct indication of the product and the services provided with the brand slogan of "Mother of all Martial Arts" and with brand promise of "Not just a martial art, it's a spiritual healing". Marketing focused on using ICT and enabling viewing of the content in all lingua franca, marketing through social media, blog aggregator, etc.

17.5.2   Key Stakeholders

Future potential of kalari is we aim the products for the following stakeholders:

- Students who are interested to learn the art form.
- Fitness enthusiasts and other foreigners who come in search of medi-tourism.
- Patients who are in search of Ayurvedic massage treatments due to ailments and fractures.
- Artists and yoga practitioners who make use of the art form to achieve a flexible body and focused mind.

17.5.3   Branding

Brand slogan is "MOTHER OF ALL MARTIAL ART" because The ethnic Indian martial art of KalariPayattu (Kalaripayattu)—meaning "battleground" or "gymnasium"—(Kalari), "method" or "art"—(payatt), has a special significance for practitioners of the Tibetan and Chinese martial arts. In tradition, the Shaolin temple martial art of China was introduced by the Indian Buddhist patriarch and founder of ch'an' (zen) buddhism; bodhidharma (450–523 AD).

Brand positioning statement: *We provide training for students with the best combat guidance than any other martial arts. We do this by body preparative exercises, training in wooden weapons and training in combat weapons. We also provide therapeutic treatment for every fracture and ailments, helping you achieve a fit body and focused mind and providing training and treatment along with the best combat guidance than any other martial arts.*

Brand promise "not just a martial art, it's a spiritual experience" Kalari (short for Kalaripayattu) is more than a martial combat. One who learns Kalari is experiencing a way of life, of how to make one strong, determined and focused.

Brand personality is a few personality traits to highlight the brand or how the brand would think and feel like a person STRONG, FLEXIBLE, DISCIPLINED, CONDENSED and FOCUSED. The movements of Kalari are very flexible and disciplined. It provides one with focus. The way it is trained provides one with the complete knowledge on one's body and helps one to condense it. Being a martial combat, it brings in an image of strength.

Brand voice: It is not only what you say in terms of content and message, but also the tone in which you say it. The words that emphasize this are BOLD and INSPIRING.

Brand logo is inspired from the movements of kalaripayattu and the weapons used Vaalu (Sword) and Paricha (used for self-protection), as shown in Fig. 17.3.

Brand typography: The colours that represent the costume of kalaripayattu and the font is TYPEWRITER FONT (ROYAL 200). This font represents old type of font system which we intent to express that the kalari is an ancient art form (Fig. 17.4).

Fig. 17.3 Kalaripayattu logo

Fig. 17.4 Kalaripayattu typography
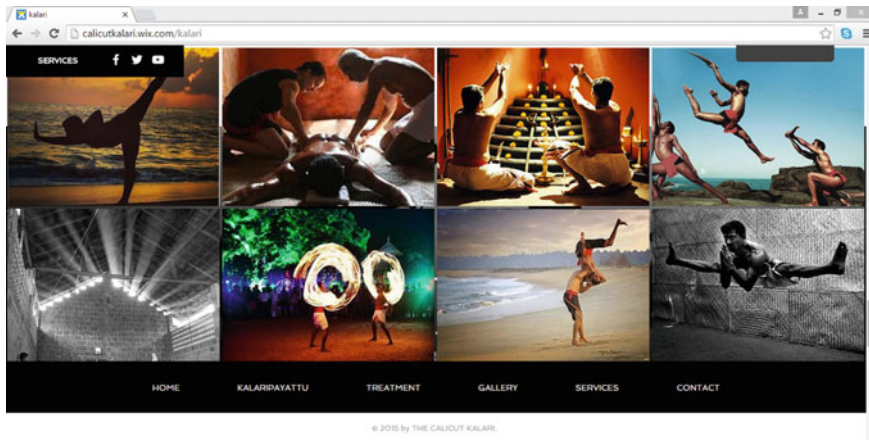
Fig. 17.5 Kalaripayattu typography

17.5.4 Deliverables

Brochures were designed to bring out clear idea of how to go about promotion in terms of stakeholders, their benefits and the services provided. A video targeting the stakeholders was prepared and then a Website was also made to bring all the elements of Calicut under one umbrella (refer Fig. 17.5). It briefs the target group about this art, treatments associated with it and services provided with some photographs and clippings to give an overall idea.

17.6 Element-2: Calicut cuisine

Calicut cuisine is one of the integral aspects of Calicut culture. The significance of food can be seen even in architecture of Calicut and visible in the ancient Muslim homes which usually had a separate courtyard attached to the kitchen for the sole purpose of biryani making, and some homes even had as many as 6 kitchens. The increasing trends of migration of Calicutites to foreign lands have caused the demand of authentic Calicut food overseas. With the development of ICTs, and transport systems, it is now possible to order any traditional food that one desires from another city, to be delivered to them all the way from Calicut.

17.6.1 Food Varieties

Mappila Cuisine: Well before Abu Fazl wrote about how dozens of master cooks whipped up delicacies for the imperial Mughal kitchens of Akbar in his

Ain-i-Akbari,[5] Calicut was already breaking fasts with culinary delights based on recipes brought across the seas from west Asia. Calicut was a gateway to the world's greatest pepper-growing region. To this day, though regions elsewhere grow pepper, Malabar reigns supreme in its quality, dominating the high end of the market. The Arabs and Yemeni merchants who controlled the spice trade for centuries settled along the Malabar Coast marrying local women. The Muslim community in Malabar, in the northern districts of Kerala, boasts of a unique cuisine that even today shows telltale signs of Arab influence carried across time.[6] Consider *alissa*, a wholesome wheat and meat porridge, hand-rolled wafer-thin *aripathiri* (rice bread), or *muttamala* served over *pinnanathappam* (delicate thin strings of egg yolks cooked in sugar syrup served over steam-cooked cardamom-scented egg white pudding), dumbiriyani and much more [21]. They derived an exotic style of cooking inherited from their seafaring ancestors while embracing deep influences where they settled. Therein lies an irony, since it was spices, in particular pepper, that drew the Arabs here to begin with. Mappila food meanwhile is certainly spicier than west Asian food, but not as Indian food.[7]

Beach and street food: Calicut's beaches are an integral part of Calicutite's life. It is perhaps the most publicly active beach in Kerala. The *Ice uradhi* (shaved ice with sweet or savoured flavours)—delicacy unique to Calicut's beaches. Raw mangoes, pineapples, cucumber, carrots, papaya and gooseberry pickled in brine are very much relished. Vast array of sherbets such as milk *sherbet* and *kulukisherbet* are much favoured street drinks.

Seafood: Calicut with its seaside location has an abundance of fish and seafood, making fish curry an integral part of the local diet. This fish curry is made in a special claypot, where it is cooked in a fresh ground paste of coconut or coconut milk with seasoning of curry leaves and shallots. The availability of various types of fishes depends on the seasons.

Sweets and chips: The *MithaiTheruvu* (Sweet Meat Street) is a street wide stretch of shops selling sweets in Calicut. The Sweet Meat Street dates back to the time of the Zamorin when the ruler invited Gujarati sweet meat makers to the city and accommodated their shops just outside the palace walls. Halwa is mainly made from flour, coconut oil and good amount of sugar which results in a unique rubbery but soft texture. Calicut is also famous for its crispy banana chips fried in coconut oil, which is now being exported to many countries abroad.

Ayurveda food: The *Karkkidaka* (monsoon) treatment is a widely accepted form of rejuvenation in Calicut and attracts the locals and foreigners alike. The human body, to put it very simply, is governed by three doshas or humours, and any disease—such as diabetes, high blood pressure, cardiac problems, insomnia, arthritis, skin problems, allergies, migraine or general fatigue—is a manifestation of an imbalance of these forces. The aim of the treatment is to rebalance them. The

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[5]http://scroll.in/article/738373/arab-flavours-from-7th-century-still-sparkle-in-kerala-cuisine.

[6]http://scroll.in/article/738373/arab-flavours-from-7th-century-still-sparkle-in-kerala-cuisine.

[7]http://www.outlooktraveller.com/food-and-drink/oh-calicut-1005436.

Karkkidaka diet is known for its cleansing properties. The main dish of the *Karkkidaka* diet is the *oushada kanji* (medicinal gruel) prepared out of whole grains and herbs.

17.6.2   Image Creation and Branding of Calicut Cuisine

Umami, the brownfield smart city of Calicut, has food-processing industry as its core. Food has been a strong cultural heritage of Calicut, and with the help of ICT, we are able to serve authentic Calicut food prepared in the kitchens of Calicut which can be ordered from anywhere on the atlas.

17.6.3   Key Stakeholders

The following stakeholders are identified:

- Culturally curious food lovers, mostly young people who might want to taste something different.
- Keralites settled outside, who are more likely to order the traditional food from Calicut to be delivered at their city of residence.
- Restaurateurs, who will want to buy or sell their products.
- Local housewives, who are willing to take part in this programme which leads to women empowerment.
- Traditional chefs and cooks, whose traditional skills of cooking and secret recipes can be marketed at a higher potential.
- Local traders and vendors, who trade ready-made Calicut special food.
- The key stakeholders aimed at are the Keralites who are not within the immediate vicinity of Calicut. The idea is to provide those who reside outside Calicut, a feeling of their home through authentic Calicut food. By bringing Calicut to their dining, we are in part bringing them a piece of Calicut city. Next in line are the restaurateurs; the brand proposes to promote their business by identifying their iconic dishes and marketing them. These are followed by the local veppukar (traditional chefs and cooks), the local housewives and the local traders and vendors. These are people who have held on to the fast fading flavours of the age old traditional cooking practices of Calicut. The brand intends to popularize the traditional recipes, and since the brand characteristic is that of authenticity, the brand will procure these rare delicacies straight from these stakeholders, thus bringing them under the brand umbrella.

Focusing on these stakeholders represents a strategic decision to concentrate the limited investment cost-effectively in attracting people towards Calicut's best prospects where the greatest return on investment is likely to be generated.

17.6.4   Branding

Brand Name: Calicut kitchen
Brand Slogan: *Taste the Happiness*
Brand positioning statement
Calicut kitchen aims to bring the authentic taste of Calicut to the dining table of those who reside outside the Malabar region. No matter where you are whether in the sprawling Middle East or just the outskirts of Calicut, we bring to you a sumptuous feast hot from Calicut's very own kitchens.
Brand promise
From the Biriyanichembu to the sweet golden raisins: 100 % pure Calicut.
Brand personality
A few personality traits to highlight the brand or how the brand would think and feel like a person.
AUTHENTIC, TRADITIONAL, ETHNIC, EXCLUSIVE, UNIQUE
Brand voice
The brand voice is not only what you say in terms of content and message, but also the tone in which you say it. The words that emphasize this are as follows:
QUALITY, UNIQUENESS, VIBRANCY
Brand logo and theme
See Fig. 17.6.
The logo shows a steaming pot of Malabari biriyani, an iconic dish of Calicut. This symbol cements our brand statement of providing ethnic Calicut food hot from the kitchen to the patrons.
Brand colours
Since Calicut food is found in a myriad of hues, the same quality has been taken in case of brand colours; instead of favouring a single dominant colour, the brand has included a wide range of colours to project the vibrancy of the food.
Brand typography
Brandon Grotesque

Fig. 17.6 Logo of Calicut Kitchen. *Source* Unpublished IMDL Report—2015, Department of Architecture, National Institute of Technology Calicut

17.6.5 Deliverables

The deliverables include designing brochures which gave a detailed idea of the
services offered. This was succeeded by a video compilation and a Website launch
as the final promotional steps. Other communication aspects include word of mouth
by Calicutites—advocating Calicut as a food travel destination. Calicutites can be
the best ambassadors for their city and region if they have the knowledge and
recognize the benefits they derive personally from these, in terms of employment,
facilities and quality of life. Awareness of what Calicut offers in terms of food is
low among potential visitors; many have a limited, and sometimes distorted, view
of what the city and region have to offer. Addressing this will require a creative and
highly targeted marketing communications strategy.

A Website: An interactive platform like a Website will be developed that
enables communications between potential visitors or buyers, previous visitors and
buyers and tourism experience providers. This will enable tourism service provi-
ders, event organizers, retailers and restaurateurs to have a conversation with
potential visitors. It will also enable social communications between all interested
parties as is now expected in the digital age (Figs. 17.7, 17.8 and 17.9).
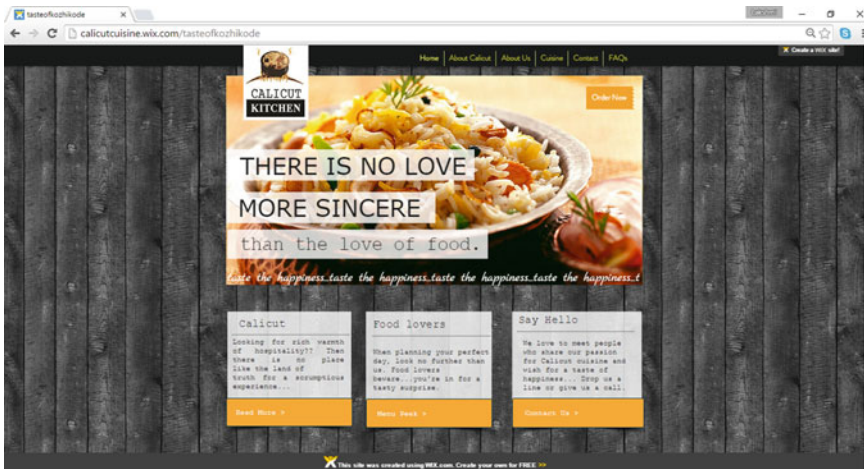
Fig. 17.7 Website designed for "Calicut Kitchen". *Source* http://calicutcuisine.wix.com/
tasteofkozhikode
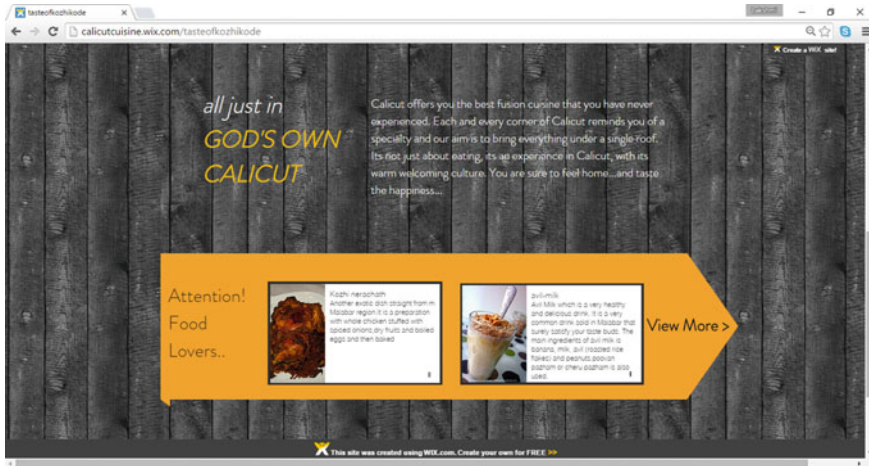
Fig. 17.8 Website designed for "Calicut Kitchen". *Source* http://calicutcuisine.wix.com/tasteofkozhikode

Fig. 17.9 Video trailer made for marketing "Calicut Kitchen". *Source* http://calicutcuisine.wix.com/tasteofkozhikode

17.7 Element-3: Calicut as a Trade Hub

Calicut is known since ancient times, and it is also a part of the spice route and silk route where the Arabs, Chinese and Europeans traded spices, silk, timber, coconut and so on. Even today, these products are of high value. Calicut is the pioneer of

foreign trade in Kerala because of its good connectivity with major trade centres and cities due to the presence of natural harbour with port and well-connected railways and roads. Its location being central to most of the south Indian domestic airports is advantageous in reviving its lost glory as an international trade hub.

17.7.1 History—Emergence of Calicut Port

The last Kerala king—Cheraman Perumal—partitioned the kingdom among his dependants (feudatories) and secretly left to Mecca with some Arab traders and embraced Islam and lived for a few years in obscurity and peace in Arabia [1]. The governor of Eranad was treated as a favourite of the Perumal and thus granted him a small tract of land on the seacoast, in addition to his hereditary processions. This area was a patch of wasteland called the Cullikad.

Calicut does not seem to have come into existence as an important port town till the end of the twelfth century. The earliest Arabian traveller whose observations have come down to us is the merchant Sulaiman, who embarked in the Persian Gulf and made several voyages to India and China, in the middle of the ninth century. It can be seen that Sulaiman has not mentioned anything about Calicut in his accounts. This implies that Calicut was not an important trade port during that time. The rulers did not take interest in developing the northern most area of their empire which included the area where Calicut port sprung up because their empire was concentrated on Mahodayapuram—capital city (towards central Kerala near Kodungallur). During this period, Calicut port was in Poland—the territory of another feudatory, Polathiri. But it was not an important international port.

As an important town and port, Calicut seemed to have come into existence only sometime in the thirteenth century after the conquest of Poland by Eradis of Nediyuruppu—the ancestors of Zamorins—the rulers of Calicut. The Eradis had their ancestral headquarters at Kondotti, in the interior which was cut off from the sea. They wanted to move to Poland—territory of Polathiri, since this lay between Cullikad and Eranad. So they defeated Polathiri—the ruler of Poland in war and conquered his territory and established a small port.

Arab newcomers were looking for new openings, and the foundation of Calicut was the answer to their prayers. The King of Eranad who moved to Calicut port in the beginning of the twelfth century befriended the Arabs. Arabs had started trade in Kerala way before Islam came. But after Zamorin gave special concession for Arabs to trade and settle in Calicut, they patronized the port of Calicut in preference to all other ports on the West Coast and developed it into the greatest emporium of trade in West Coast. The first country that successfully circumnavigated Africa was Portugal, and in 1497, four vessels under the command of Vasco da Gama rounded the Cape of Good Hope, eventually sailing across the Indian Ocean to Calicut, India. This success marked the beginning of the Portuguese Empire. Spanish, English and Dutch expeditions soon followed, and the growing competition sparked

bloody conflicts over control of the spice trade.[8] This led to the emergence of Calicut as a port with a stable government of the Zamorins.

It was not merely a question of the Arab merchants looking for a new harbour and patronage, but a lucky combination of several circumstances that helped the Zamorins to rise to power. The advent of Chinese into the Arabian Sea under the leadership of Chenho, the European demand for luxury goods in the wake of early renaissance, and the opening up of America for trade and adventure—all these factors contributed to the prosperity of Calicut in the centuries following the partition of Kerala [22].

17.7.2   Decline of Calicut as an International Trade Hub

Though Calicut was a flourishing international trade hub which was indeed inevitable for the Arabs and Europeans, it started losing its importance. The spice trade till then had been in the hands of two major groups of traders—the Arabs and the Genoese–Venetian syndicates. Arabic spice merchants would create a sense of mystery by withholding the origins of their wares and would ensure high prices by telling fantastic tales about fighting off fierce winged creatures to reach spices growing high on cliff walls.[9]

Till around the thirteenth century, bundles of spices would commence their long journey from Malabar Coast and take the Silk route, which was protected by the might of Genghis Khan to Aden and later into the hands of the Venetian merchants. Once the Silk route was closed, spices started travelling in Arab dhows and Chinese junks to Jeddah (which replaced Aden), where the local rulers levied a tax on the cargo. It then crossed the Red Sea and reached the city of Tuuz (near Mount Sinai) where again it was subjected to tax. Finally, the cargo of spices travelled by camel back to Cairo; this was a hazardous trip due to the threat of banditry. From Cairo, the cargo was sent down the Nile River to Rosetta, where a tax was again levied. There it would again be loaded on camels for a day's trip to Alexandria where galleys from Genoa and Venice would be waiting for the precious cargo. By the time these spices reached the retail markets of Europe, the price would be more than 1000 times of what had been paid at Calicut.

It was this lucrative trade that the Portuguese had destroyed by discovering the Cape route to Calicut. Spices could now be transported to Europe untouched by Arab or Venetian hands. The distance was longer than the Cairo route, but cost of transhipment and taxes could be saved. No wonder, the Venetians received the news of Da Gama's adventure with a sense of shocked disbelief. Within the next couple of years, economic depression engulfed many of the trade centres of Europe, with firms collapsing and banks failing. Though Calicut and Venice—the largest

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[8]http://www.silkroadspices.ca/history-of-spice-trade.
[9]http://blog.calicutheritage.com/2010/12/calicut-and-decline-of-venice.html.

seller and the largest buyer of spices—did not have any direct trade links, the loss of Arab supremacy over spice trade in Asia led to the fall of Venetian monopoly on the retail distribution of spices in Europe.

17.7.3 Calicut as an International Trade Hub Today

In today's context, Calicut is well connected by sea routes, air routes and rail and road network to various parts of the world (see Figs. 17.10, 17.11 and 17.12). The locational advantage that had been the main reason for the ancient trade and the development of rail, road and air routes that gives Calicut its wide network of transport is an advantage to revive and strengthen the image of Calicut as a trade hub.

The products of trade during the ancient times were pepper, timber, calico, cardamom, etc. Apart from these products, today Calicut has the potential to trade IT technology due to the presence of innumerable IT professionals and upcoming IT hubs.
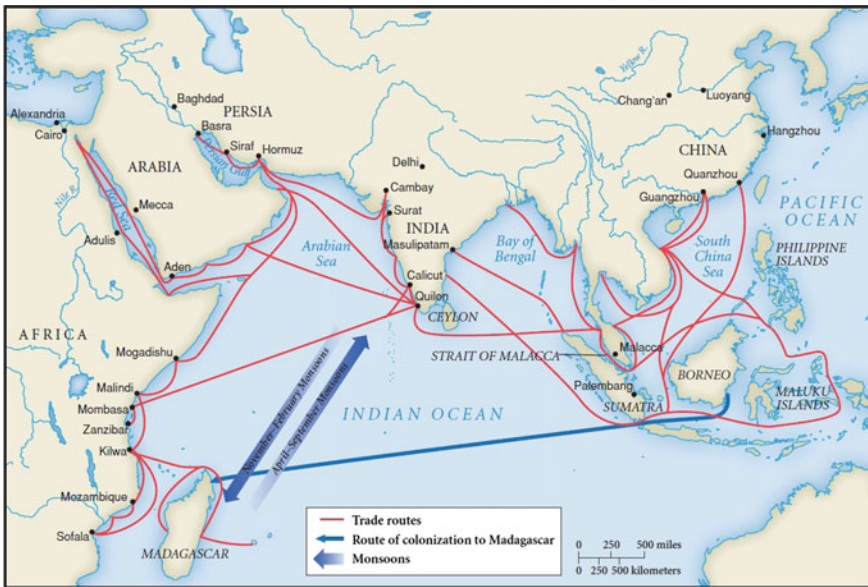
Fig. 17.10 Sea routes. *Source* https://www.thinglink.com/scene/712683454738726912
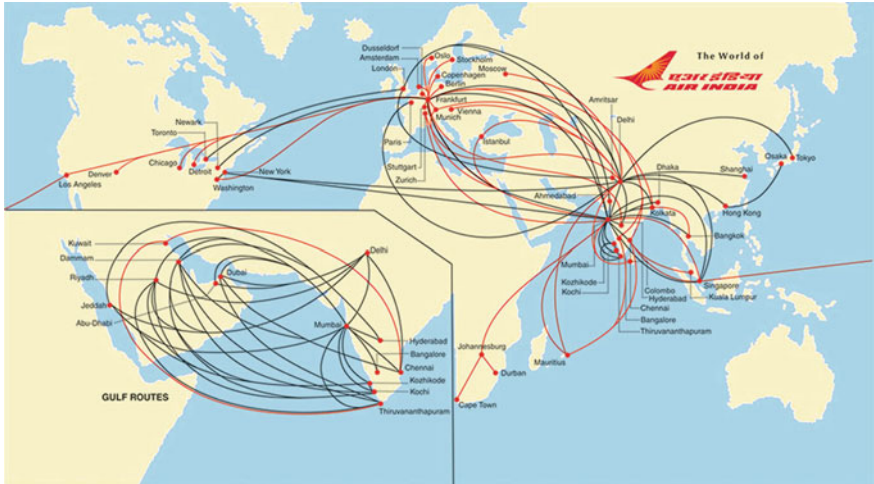
Fig. 17.11 Air routes. *Source* Air India's international network map

17.7.4 Image Creation and Branding of Calicut Cuisine

The element identified was TRADE AND ITS CONNECTIVITY. Extensive research about the history of trade, commodities traded and connectivity was conducted while identifying the trade centres and major transport systems available in Calicut. Visits to important trade hubs of Calicut like Big Bazaar (Valiyangadi) to explore its markets includes copra bazaar, gunny street, pandikashalas, Kallai timber trade centres, Beypore port and IT hub at Thondayad to understand the modern trend in trade. Cyber park and the HI-LITE business park are the modern extent of the IT sector.

17.7.5 Key Stakeholders

We identified the following stakeholders that offer potential for significant growth and marketing:

- International and national traders, who will be provided direct access to local products, nearer port, connected to silk route, cheaper products and convenient transport.
- Local traders, who will be benefitted by quicker delivery of products, reducing/eliminating number of middlemen, better profit, exposure to global market.

Fig. 17.12 Road network. *Source* National highway network map—2006

- Common people and localities, who/which will benefit by getting employment opportunities in production and transport of goods. The localities will also receive infrastructure development on the long run along with rise in land value.
- Government will benefit from the custom and tax charges, increase in import export revenue.

Focusing on these stakeholders represents a strategic decision to concentrate the limited investment cost-effectively in attracting people towards Calicut's best prospects where the greatest return on investment is likely to be generated.

17.7.6   Branding

Brand name:
KOZHIKOTTANGADI
Brand voice:

"Come trade with us"

Brand slogan:
Trade. Trust. Transit
Brand promise:
Ease of delivery, Quality of product and service, Friendliness, Clean and fair trade, Hospitality of people
Brand personality:
Welcoming, Friendly, Fair, Traditional, Vintage, Inviting
Brand logo:
See Fig. 17.13.
This logo represents the Indian currency getting on the global economy through the trade in Calicut. It also represents the friendly, welcoming and hospitable nature people of Calicut.
Brand colour:

The shades of blue pay tribute to the ancient sea routes that were vital in the course of trading history. As we are revitalising these routes, we have taken the mentioned colours.
Brand typography:
KOZHIKOTTANGADI
(BANKGOTHIC MD BT)

Fig. 17.13 Logo of Kozhikottangadi. *Source* Unpublished IMDL Report—2015, Department of Architecture, National Institute of Technology Calicut
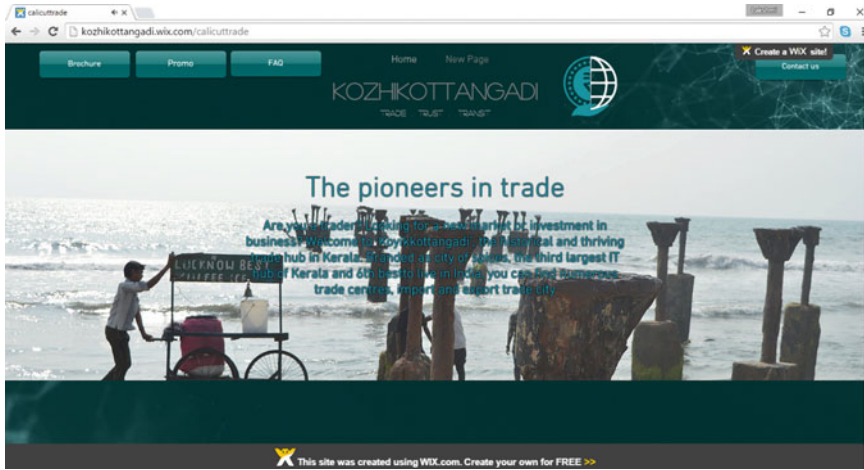
Fig. 17.14 Website designed for "Kozhikottangadi". *Source* http://kozhikottangadi.wix.com/calicuttrade

17.7.7 Deliverables

- A powerful trade hub marketing communications strategy: lack of awareness of what potential Calicut offers in terms of its trade history and current opportunities has been addressed by a creative and highly targeted marketing communication strategy. A video was compiled as a trailer inviting people from across the globe to trade with Calicut. The filming was done elaborately visiting the above-mentioned places and highlighting the various features of trade and its rich connectivity.
- A Website: An interactive platform like a Website has been developed that enables communications between potential traders or buyers and service providers. This will act as a portal highlighting the glorious trade of the past, enumerating the present trade hot spots and giving future trade prospects. It will also enable social communications between all interested parties as is now expected in the digital age (Figs. 17.14, 17.15 and 17.16).

17.8 Element-4: Uru

The term *Uru* is associated with the traditional shipbuilding culture of Kerala. The art and science of making these ships came from the Arab world some 1500 years ago.[10] Arabs called this urus as dhows which eventually became the traditional Arabian trading vessels.

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[10]https://www.keralatourism.org/malabar/beypore-uru-kozhikode.php.
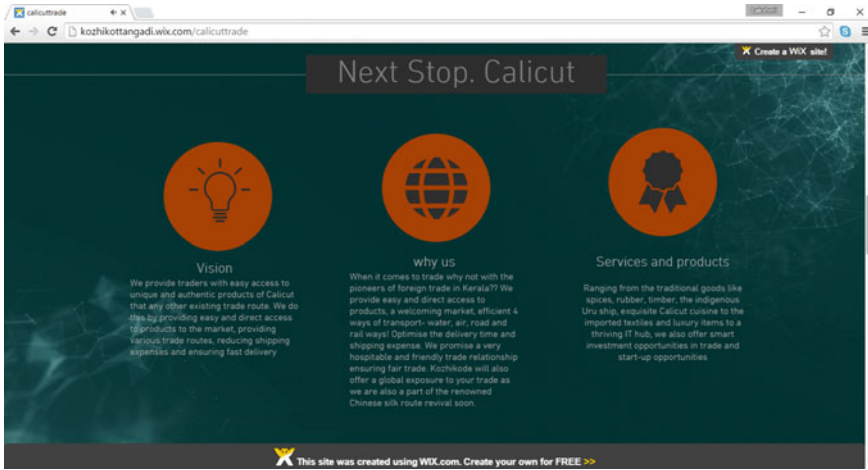
Fig. 17.17 Website designed for "Kozhikottangadi". *Source* http://kozhikottangadi.wix.com/calicuttrade

Fig. 17.16 Video trailer made for marketing "Kozhikottangadi". *Source* http://kozhikottangadi.wix.com/calicuttrade

To understand the importance of Uru, it is essential to go back to the time of major trade in the world during the times of silk route*.[11] The history mentions about Beypore, a major trading centre few kilometres south of the city of Calicut,

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[11]An ancient network of trade routes that were central to cultural interaction through regions of the Asian continent connecting the West and East from China and India to the Mediterranean Sea.

from where long time ago, huge ships made of wood, called uru, loaded with the spices of Kerala were part of this major trade via sea. Beypore was also known for its technological inheritance that earned it a unique position in the maritime history, and since then, it began to flourish as a centre for shipbuilding.

Uru was known for their quality and longevity and was much in demand by merchants of the Middle East. These sturdy ships were built at a time when none of the modern tools were available, by highly skilled craftsmen called "the Khalasis" who were traditional shipbuilders of Beypore, Calicut. The Arabs, the first mariners from the Middle East, who came to Beypore for trade, were amazed by their skill in making these ships and by the timber wealth of Kerala. Beypore still carries on that tradition of shipbuilding. An exciting fact about the shipbuilding industry in Beypore is the way in which the crafts are built and the variety of which can be found. Even today a visit to the Beypore shipbuilding yard is worthwhile, where one can see the Khalasis working with timber to meticulously construct huge vessels like the uru. What is more fascinating is the fact that its beautiful and intricate carvings and arches are all made using traditional tools and techniques without the aid of any modern equipment. Even more incredible is the number of people dependent on this industry. More than 500 families are directly and indirectly dependent on the shipbuilding industry.

17.8.1   Construction

Uru is a large and sturdy traditional shipping vessel made by connecting together neat planks of teak*[12] wood manually. Building a single uru is a mammoth business demanding the skill and the labour of more than forty Khalasis over a period of minimum four years. An astonishing feature of the technology of Uru construction is that there are no documents, work plans or technical data sheets involved, right from the concept stage to completion stage. The construction details are assigned on a day-to-day basis to the assistants and the carpenters by the main khalasis (Fig. 17.17).

Though the Uru lost its past glory, Beypore has not bid farewell to this industry yet. There are Khalasis still building Uru, though not in huge numbers as in the past. These are handcrafted urus where people work from sawing, sticking and tying the wood till they are fitted on to the boat, and no machines are used. And once the work is over, the boat is pushed to the nearby river, which is connected to the sea. The launching of an Uru is itself a festive ceremony, attended by a large number of people, and after the successful launch, a feast is laid out for all who have contributed to the shipbuilding effort.

"Recently, the launch of an Uru got completed which was 140 ft. long at the keel, 200 ft. in length and 14 ft. high from the keel, with about an 18 ft. high cabin above the deck. It involved 30 workers and three and a half years to construct,

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[12]Teak is considered as one of the best woods for construction as its weights are less and strength is more. In medieval times, teak from the Nilambur forest was used for this purpose.

Fig. 17.17 An inside peak into the art of dhow-making. *Source* Indian Express, published: 19 March 2015, Kerala

Fig. 17.18 Woodenboat, claimed to be one of the biggest in Asia, at Beypore in Kozhikode. *Source* Indian Express, published: 19th March 2015, Kerala

which weighed about 1500 tonnes and has been made completely of teak wood, which was imported from Burma"—The Indian Express 2015 (Fig. 17.18).

It is a unique educating and inspiring experience of this magnitude which one cannot find anywhere else in India. The atmosphere is really exhilarating with tons of wood stacked in the compound, workmen teeming around and the process involving no machine at all. Also, the yard being very close to the Beypore harbour, one could see many coloured trawlers close by to the yard which are used by locals for deep-sea fishing.

17.8.2 Image Creation and Branding of Uru

Uru ships are indigenous to Beypore, Calicut. For branding and marketing uru, stakeholders were identified which are the craftsmen, involved in shipbuilding industry, sailors (Individual or Crew) who specialize in the sail of wooden ships and are traditional by nature and entrepreneurs from Arab countries and European countries such as France and England who are interested to invest in the uniqueness and quality of the ships made.

The Uru ship makes use of the best wood from Nilambur forest and the most talented craftsmen pitching in with their skills. All these if marketed smartly together as a product will bring in the money flow to Calicut hence boosting its economy.

Brand is named "Uru Shipbuilders" which is direct indication of the product and the services provided.

17.8.3 Branding

Brand slogan is "CRAFTED JUST FOR YOU" where each uru is specially crafted according to the customer's need and satisfaction.

Brand positioning statement: *we provide entrepreneurs, sailors and craftsmen with the world's most authentic, best quality and custom-made wooden ships. We do this with the help of uniquely skilled craftsmen, designs and methods handed through generations and the best quality wood.*

Brand promise: "Ensuring the best quality ships enhanced by unique craftsmanship of the Uru builders of Beypore". The crafting techniques of an Uru ship is handed down through generations of craftsmen and so these techniques of wood work are not seen anywhere else in the world, and only the best wood treated to perfection in the Kallayi River is used for this ship.

Brand personality taken for URU is CREATIVE, SKILLED, EXPERIENCED, TRADITIONAL, SIMPLICITY, PROUD, EXCLUSIVE. If this brand was considered as a person, the above-mentioned qualities would be part of his or her personality. The extreme skills and talent needed to make an Uru would definitely be a highlight. A sense of pride revolves around the Uru due to its importance in history and in the making of the Calicut city. It is exclusively made in the Beypore port city and hence indigenous.

Brand voice: The words that emphasize this are QUALITY, UNIQUENESS, PRIDE, INDIGENOUS. When one speaks about the Uru, there is a sense of pride in the voice as they are boasting of the uniqueness and the high quality of the ships.

Brand logo is an abstract form of the uru ship with the sails. Also if observed carefully, the logo spells Uru when read vertically, as shown in Fig. 17.19.

Brand typography: The colours chosen to indicate the colour of the wooden Uru ship and the different shades of blue of the sea, as shown in Fig. 17.20.

Fig. 17.19 Uru logo. *Source* Unpublished IMDL report (2015–16)

Fig. 17.20 Uru typography. *Source* Unpublished IMDL report (2015–16)

This cursive stylish font was chosen as it represents the importance of the ship in history. The font represents the time in which the Arabs and Portuguese came to Calicut for trade.

17.8.4   Deliverables

Thus, a brand charter was formulated to convey our marketing strategy for this element and the operational guidelines. Brochures were designed for the marketing strategies to bring about a clear idea of how to go about promotion in terms of stakeholders, their benefits and the services provided. A video targeting the stakeholders was prepared (https://www.youtube.com/watch?v=vdS3Irk1V6M&feature=youtu.be) which clearly demonstrates the transformation from floating logs to a monumental ship, the making of Uru, at every stage, capturing its intricate details, perfection that marks the skills of the craftsmen (Fig. 17.21).

Fig. 17.21 Screenshot of the URU Shipbuilders video. *Source* Unpublished IMDL report (2015–16)

Fig. 17.22 Screenshot of the URU Shipbuilders Website. *Source* Unpublished IMDL report (2015–16)

Finally, a Website (http://calicutelement1234.wix.com/urushipbuilders) was also designed which included the video as well, as shown in Figs. 17.22 and 17.23.
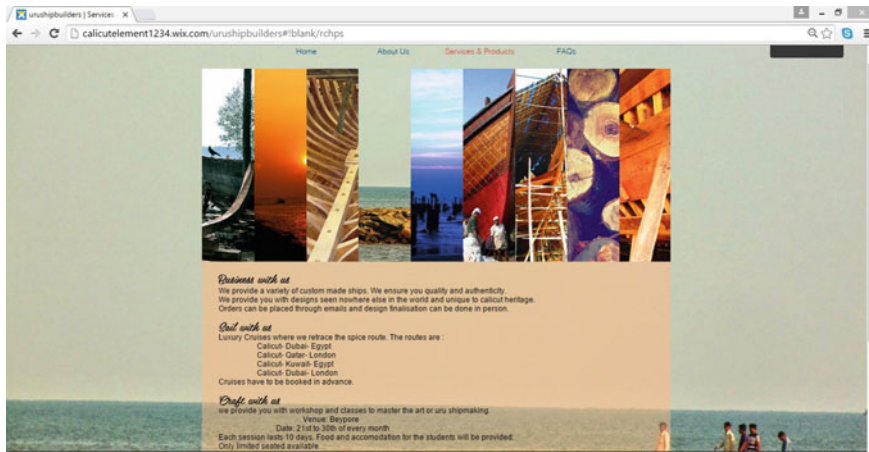
Fig. 17.23 Website indicating services for different stakeholders. *Source* Unpublished IMDL report (2015–16)

17.9   Conclusion

As mentioned in the initial part of the chapter, branding is an exercise which encompasses multiple aspects right from identifying the value propositions, communicating the value propositions through multiple entities and delivering or distributing the value proposition to multiple stakeholders. Owing to the very nature of place as a value proposition, this task becomes all the more complex, when it comes to destination branding. Based on the definition of smart city given in Chap. 1, which has six key building blocks: (i) smart people, (ii) smart city economy, (iii) smart mobility, (iv) smart environment, (v) smart living and (vi) smart governance, this study has attempted to focus on four markers (core elements) that are strongly connected to Calicut geographically, culturally and historically and to suggest a branding approach for each and every one of them. The core elements we identified are *Kalari*, Calicut cuisine, Calicut trade hub and *Uru*. These elements are in sync with the six key building blocks of smart city definition we adopted and can act as vital markers in showcasing Calicut as a destination in the global landscape. We have attempted in illustrating the key value propositions; each of these elements offers to multiple stakeholders. These brand elements have the potential to getting linked with the well-received Kerala and Indian tourism promotional activities. As part of the study, a few promotional videos are also developed. These videos also can be synergistically used with the much acclaimed "Gods own Country" theme-based promotions of Kerala tourism. These four core elements we believe have the potential to differentiate Calicut as a destination from other similar destinations in the country. Yet another powerful means of popularizing the destination could be to leverage on social media. Social media has emerged as a very strong platform where the users can be empowered to spread the messages. This can be

done by creating an online community of various stakeholders who are interested in these various core elements. In similar way, for an effective implementation of these four core elements, it is proposed to have a common portal where all these elements can be linked to. This helps in extending the destination branding with multiple items in the future. Eventually, it is very much possible that this can further be brought under a unique umbrella brand, where the stakeholders can easily relate to and to have top of the mind recall. To conclude, all said and done, branding is all about communicating value to the stakeholders. If we are not effective in delivering the value, branding will not be of any use and may end us as a futile exercise.

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Chapter 18
e-Design of Umami by Smart People for Smart Economy

T.M. Vinod Kumar, P. Bimal and C. Mohammed Firoz

Abstract The economy is the heart of any Smart City. As the world progresses to third industrial revolution, the economy focus is expected to shift from large-scale production industries to industries with cultural and ethnic uniqueness. Urban form of a city is its biggest brand image of its culture. A Smart City needs to maintain its urban form to highlight its cultural and ethnic uniqueness and evolve a branding for its products. This chapter like many other chapters in this book is the outcome of an academic project conducted by Department of Architecture and Planning at NIT, Calicut. The project is to develop a Smart City within the premises of Calicut City, with a smart economy at the core. Malabari food production is the core economy of Umami. This chapter proposes a systematic approach for derivation execution and management of the city's urban form to function it as brand image. It is necessary to turn to the collective wisdom of various classes of people to ensure unique solutions. Bringing people to participate in every stage of urban design is a challenge. All stages of urban design in this chapter use e-Design, which relies on various digital communication techniques to bring in unique solutions from a large number of stakeholders and arrives at an acceptable-to-all solution. A modified Hybrid Form-Based Coding Regulation is used for structuring urban design process and its implementation. The process addresses issues from a broader perspective starting with a Zonal Plan and goes into minute details like signage, architectural features, and landscaping. It also proposes various smart technologies required in Smart Mobility, smart environment, smart governance, etc.

T.M. Vinod Kumar
School of Planning and Architecture New Delhi (SPA-D), Kozhikode, Kerala, India
e-mail: tmvinod@gmail.com

P. Bimal (✉) · C. Mohammed Firoz
Department of Architecture, NIT Calicut, Kozhikode, India
e-mail: bimalp@nitc.ac.in

C. Mohammed Firoz
e-mail: firoz@nitc.ac.in

18.1   Introduction

Chapter 15 has shown that Calicut (officially, Kozhikode) is characterised by less of poverty which is being eradicated rapidly, but low on employment opportunities, less than the national average on female participation in employment, and more of the urban economy than rural. There are more employed in the tertiary sector than secondary sector, while the primary sector is gradually disappearing. The growth of tertiary occupation is more than that of secondary occupation, which is stagnant.

There is labour shortage partly due to the ageing of the population and out-migration of workers to the Middle East and other countries, and many labour forces are coming from eastern states of India to fill in this gap. The labour wage rate is higher than the national average that may affect the price of products and services generated from Calicut. While there is the presence of small industries and one medium industry in Calicut, no large industry is available now, but there existed in the past one large industry Mavoor Rayons. It is no more functioning due to labour strikes and river pollution it created.

Chapter 16 has attempted at branding and marketing of Calicut, showcasing unique goods and services as part of the ancient cultural heritage of Calicut. The city can market its products to its people living all over the world or to the interested global citizen. Chapter 15 traces the international trade relation and maritime linkages of Calicut for many centuries. However, during two centuries when Calicut was part of British Empire as a colony, this ancient tie was deliberately erased. This was one reason industrialisation of Calicut was below par.

When Calicut was compared with the six components of smart cities discussed in Chap. 1, it was found in Chap. 15 that it had great promise to be a Smart City on their inherent strength. While Calicut has missed on Industrial Revolution 1 and 2 under British colony, there is every chance that it can be developed under third industrial revolution which is triggered by ICT and broadband network in the smart economy of Calicut. Two IT parks being built in Calicut, for employment of about 100,000 IT-related workers can steer Calicut to the third industrial revolution by supporting the unique goods and services, Calicut can deliver using ICT. Calicut is capable of providing globally goods and services as per illustration, given in branding and marketing exercise conducted in Chap. 16. Using six components of smart cities, discussed in Chap. 1, Calicut City enables ICT to resurrect the old trade relations Calicut enjoyed for centuries globally, discussed in Chap. 15. ICT and the Internet that propel a third industrial revolution in Calicut expand the service area of Calicut to the whole globe, and Smart Mobility developed in Calicut as part of spatial planning allows goods and services to reach all part of these expanded service areas.

The strategy adopted in Calicut was that brownfield Smart Cities in Calicut are developed by converting Calicut by modular zone by zone. Each zone should have a dominant economic theme based on what exists in the locality and what is ideal for the region's economic development.

Economic activities of Umami are built around the traditional cultural heritage of Malabar and Calicut, namely the famous Malabar food, production and marketing of unique spices and masalas, health and recreation tourism based on Kerala Ayurveda, which is made as part of the third wave of industrialisation propelled by Internet of Things. Employment and income generation of Umami are deliberate in Umami to expand its service area internationally. Plan for creating a digital Umami takes inspiration from the ruling National Democratic Alliance Policy of Digital India, with universal high-speed broadband, free Wi-Fi at selected spots, and flow of big data in Umami. The digital economy of Umami will revolutionise every industrial and commercial sector envisaged in Umami, disrupt the workings of virtually every conventional industry and commerce, bring with it unprecedented new economic opportunities, put people back to work, and create a more sustainable low-carbon society to mitigate climate change.

Brownfield Smart City Development in Calicut involves transforming existing cities zone by zone. Umami is one such zone. Based on a study of existing economic activity of this zone, a significant economic activity as a Smart City theme is identified. In the case of Umami, it was food processing of heritage food, spices, and masala and generation of recreational and health tourism-based township on local cultural activities and Ayurveda well-being treatment. An area of five square kilometres at a gross residential density of 200 persons per hectare was delineated to generate a module of 100,000-size brownfield Smart City Umami.

18.2 e-Design of Umami

The traditional model of top-to-bottom planning and governance is ineffective in addressing diverse situations of countries such as India, where the way of life is intervened with various sociocultural, linguistic, political, religious sentiments. Indian Parliament had decided to go for a bottom-up process in line with Gandhian philosophy through 73rd and 74th amendment of Indian constitution. When planning and execution of development process are initiated and decided by people, it becomes participatory planning. Participatory planning is meaningless if there is no effective way of participation for the stakeholders in the process. In the present-day globalised community, physical presence is not necessary for participation. The electronic form of communication will be the best solution available for participation. Participation in a process like planning will require a higher level of electronic communication [1], in which all forms of information transfer such as broadcasting, peer-to-peer communication, information collection, accumulation need to take place simultaneously. e-Design refers to a system of design, which allows collection of various inputs for the design process using automatic methods

as well as with active involvement of users. It provides relevant analysis results to help the participating designers to produce designs through a common platform. It also provides methods to simulate or visualise various design options to find the most suitable one. e-Design recognises urban design as a cyclic process. This cyclic process can be roughly classified into four stages [2], namely.

1. Design evolution,
2. Execution,
3. Maintenance, and
4. Review.

Hence, for evolving an urban design for Umami, we have adopted a web-based participatory approach, which facilitates the participation of various stakeholders. The home page of the Umami website, which acts as a platform for interactions with all stakeholders of the Smart City, is given in Fig. 18.1. The system can be further developed to automatically collect all the necessary information for design making from the big database of the Smart City and provide them with all required tools to analyse the collected data.
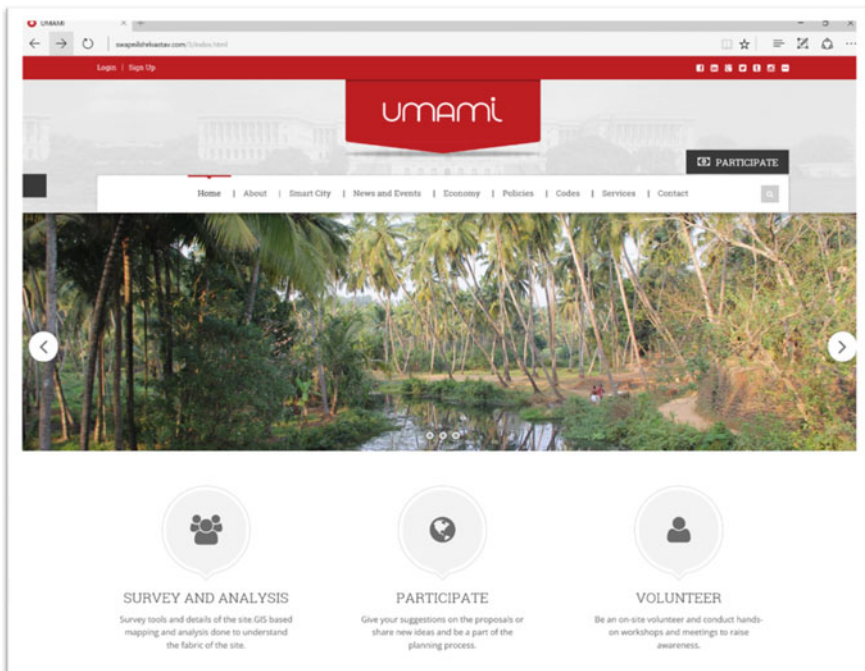
Fig. 18.1 Website of Umami—platform for e-Design

18.3   Smart Economy of Umami Based on Transformation of Urban Economy of Calicut

18.3.1   Historical Importance of Calicut

Chapter 15 had already summarised historical significance of Calicut for many centuries. The image and brand that emerged are ably discussed in Chap. 16. This resulted in the Smart City being designed as an international brand that can be electronically marketed.

18.3.2   Transformation to Current State of Economy

Digital economy of Smart City Umami shall create a new economic system with three elements which interact with each other to enable the system to operate as an integrated whole. The new communication technologies such as interactive web-based and smartphone enabled, capabilities can make Umami more efficiently manage heritage and a cultural oriented unique set of economic activities envisaged, including food processing industry and related e-commerce. ICT enabling will expand the existing service area many folds, resulting in more income flows and employment generation. The new sources of energy generated in Umami discussed in this chapter will enable Umami economy to be more efficiently powered. The new modes of transportation allow more efficient economic activity by promoting ICT-enabled Smart Mobility.

In the nineteenth century, steam-powered printing and the telegraph, abundant coal, and locomotives on national rail systems gave rise to the First Industrial Revolution. Coal power changed over to electric power from many sources such as biomass power, hydel power, and nuclear power. In the twentieth century, centralised electricity, the telephone, radio and television, cheap oil, and internal combustion vehicles on national road systems converged to create an infrastructure for the Second Industrial Revolution. The Second Industrial Revolution is gradually evolving towards the third industrial revolution. Calicut City is not a demonstrator of First and Second Industrial Revolution since the British colony days, but it has all capability to be an active demonstrator of the third industrial revolution.

18.3.3   How Can that Be Extended to the Smart Economy?

Here in Umami, the digitalised Communication Internet is converging with a digitalised renewable Energy Internet, and a digitalised automated Transportation and Logistics Internet, to create a super-Internet of Things (IoT). In the Internet of Things era, sensors will be embedded into every device and appliance, allowing

them to communicate with each other and Internet users, providing up to the moment data on the managing, powering, and moving of economic activity in a smart Digital Umami. Hence, the economy of Umami is based on the third industrial revolution.

Sensors will be attached in Umami for all primary economic activity envisaged for resource flows, warehouses, road systems, factory production lines, the electricity transmission grid, offices, homes, stores, and vehicles, continually monitoring their status and performance and feeding big data back to the Communication Internet, Energy Internet, and Transportation and Logistics Internet. The idea is to expand the service area through a third industrial revolution in Umami for products and services in Umami to all over India, the Middle East, and South-east Asia where a percentage of Kerala population cherishes the product and services of Umami. Connecting everything and everyone via the Internet of Things offers enormous economic benefits including democratising the economy. The smart technology involved in Umami will not be elaborated in this chapter hereafter, but the urban design and spatial planning which enable the application of smart technologies for Smart City Umami will be discussed in this chapter.

18.4   Locating Umami

Food processing is the economic theme of Umami. The food processing industry will get the essential spices from the high ranges on the eastern side, and grains and flour through railway line located along the western side of Calicut. Hence, the proposed location should have good connectivity to the east side as well as goods handling centre of Indian Railways at Kallayi. Kerala has fertile soil, abundant rain, and agreeable climate. The industry can utilise these favourable factors to produce perishable vegetables within the city, which will expand its economic base and allow opportunities for people of different skills to be part of the Smart City. Higher-standard living offered by the Smart City may help to get rid of the existing stigma of educated younger generation against agriculture. Hence, if the selected location has enough of cultivatable land, it can become a high-performing asset and serve its ecological role.

Products of the Smart City will be finished food items with retail packing. The industry should be capable of sending custom-prepared food packets to national as well as international locations as per their order over the Internet. Also, the industry can produce and ship finished products such as pickles and masalas. The former category of packets needs to reach the international customers still warm. These packets are to be transported to the airport with least possible time. The latter class of packets can be moved through a slower mode optimising the cost. Hence, the location should have close proximity to the airport also.

Location for Umami was selected keeping these considerations in mind. The chosen location is close to the high-speed corridor running north–south as shown on
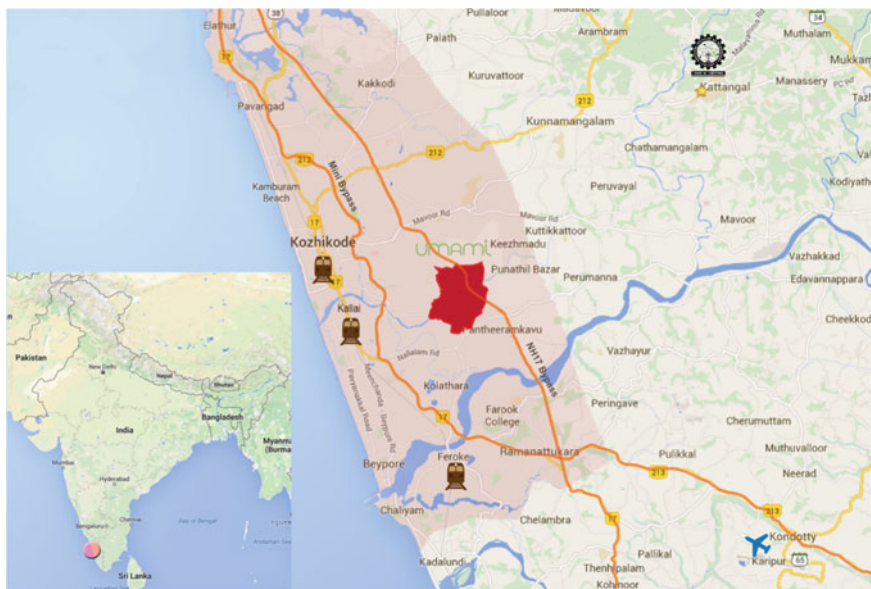
Fig. 18.2 Location of Umami

the location map given in Fig. 18.2. Also, the road from eastern side joins to this corridor and this configuration allows the goods to reach Umami without affecting the traffic of the mother city Kozhikode. There are large chunks of different varieties of cultivatable land which are suitable for vegetables, pepper, coconut, fruits, etc. The airport can be accessed by the high-speed corridor and is within 15 min of travel from the location. In addition to this, the selected area has a river, which is beautiful, combining this with showcasing of the food production, and the site also has tourism potential.

18.5   Image of the City and Its Marketing

Food processing is the base industry of Umami. The city believes in its strong cultural heritage and wishes to root its economy on this. It wants to invite people to experience its cultural heritage and keep a pleasant memory of it. Hence, Umami's unique selling point is authentic Malabari food prepared in Malabar, which can be ordered from any part of the globe. This is deeply rooted in the Indian philosophy, of not conquering other nations, instead treat the guest as the God, and win their minds. Calicut was a sought-after destination for the world trade, before the 200-year-long British rule. The city earned its name as 'City of Truth'.

18.5.1 Creation of Umami's Image Based on Tradition of Calicut

Imaging strategy for Umami is already executed in Chap. 16. The aim there was to study in depth the heritage marketed in Umami and showcase it in website Calicut City to attract clients from all over the world. Imaging also determines the architectural standards of Umami in tune with the heritage. Chap. 16 had already discussed the food processing of heritage food in detail and also Ayurveda well-being treatment in the rainy season.

18.6 E-Urban Design for E-Economy

The built environment of a city can contribute to the economy more than its primary purpose of giving shelter to activities and people. The built space in such a city should work like a machine, which needs to be designed to optimise the cost of production, logistics of goods, and transportation. At the same time, the city has its sociocultural face as well. Unlike the industrial age development, the urban space should be designed keeping the very idea of providing highest possible living conditions for the lowest level stakeholders. This is made possible with a proper urban design with the help of ICT.

18.6.1 Role of Urban Design in E-Economy

Urban design for a Smart City can play three important roles in promoting its economy.

(a) As an enabler
(b) As a packaging-image creation
(c) As an attractor for workforce by its smart environment

Urban spaces should help the economic activity to function most efficiently and have a role of enabler. The quick and efficient mobility of people and goods, smart infrastructure, which adapts itself to the demand, smart governance which takes care of the functioning of the city in the background, are all can be attributes of enabler.

Urban design of the city can act as a brand image for all the products it produces. For products which are marketed on the heritage values and local culture, the city can work as a place to experience its legacy, which the visitors will always cherish, and relate to the products produced by the city. For example, a tourist, who visits Umami, experiences the warm hospitality, enjoys its 'ghazal evenings', late-night 'Kathakali', 'Kalari' workshops, and tastes the Malabari cuisine, will always recall

these experiences when they see 'Product of Umami' logo on products. Hence, the urban design of a Smart City can contribute actively to building up a brand image if it provides a unique experience to the users. The uniqueness of the city needs to be identified from its cultural and historical roots and has to be translated to experience through all the urban design elements of the city.

The urban design methodology generally involves understanding the given site in its totality and exploring its socio-economic, cultural, and historical settings, and its physical and social infrastructure, etc. A set of issues and potentials are identified through a detailed analysis of the aspects mentioned above. The design process attempts to solve these issues by means of modifying its physical form, road networks, as well as activities. In a nutshell, the whole process is oriented towards identifying present issues and solving them.

In the case of Umami, the task is to prepare the current place for many folds of economic activity and generate an urban space which also serves as a brand image for this economic activity. Hence, the methodology used for the urban design of Umami concentrates more on generating the required urban form. The existing scenario is studied extensively to assess its preparedness for the proposed activity, issues it might face, how to minimise interventions, etc. Form-Based Coding (FBC) was found to be one of the most useful tools to prepare and implement an urban design for Umami.

18.7   Adapting Form-Based Coding for Smart Cities

Form-based code (FBC) is a new kind of enforcement of urban planning and urban design to guide the development to a predictable urban form in multiple stakeholder environments [3]. They differ from current existing urban design guidelines in two aspects. Firstly, Form-based codes foster predictable built results and a high-quality public realm by using physical form (rather than separation of uses) as the organising principle for the code. Second, they are regulations, not mere guidelines, adopted into city or county law [4]. The form-based code can be used to define the built form based on the street, micro-, and macro-transect it is located, and the proposed vision plan. Form-based codes address the relationship between building facades and the public realm, the form and mass of buildings in relation to one another, and the scale and types of streets and blocks. They are draughted to implement a community vision plan. They try to achieve a community vision based on time-tested forms of urbanism [4, 5].

FBC in its real sense proposes to regulate the form of the buildings and public realm and leaves the land use to be decided by the market forces. From our previous experiments with FBC in Indian scenario, we concluded that it will be more effective if we go for a Hybrid FBC (HFBC), where the land use is regulated by a Zonal Plan and built form of public realm governed by an FBC Regulation [2]. HFBC groups various regulations that control the urban form under 10 heads. These are given in Table 18.1.

Table 18.1 HFBC components

Hybrid Form-Based Coding components	
1. Zonal Plan	A loose zoning regulation to ensure equitable distribution of facilities, prevention of harmful activities in ecologically important lands, etc.
2. Regulating plan	A plan or map of the regulated area designating the locations where different building form standards apply, based on clear community intentions regarding the physical character of the area being coded
3. Building form standards	Regulations that control the configuration, features, and functions of buildings which define and shape the public realm. Minimum and maximum values are mandated for various measurements which define the perceived urban form
4. Public space/street standards	Specifications for the elements within the public realm, e.g. sidewalks, travel lanes, street trees, street furniture are provided
5. Administration	A clearly defined application and project review process
6. Architectural standards	Regulations controlling external architectural materials and quality
7. Definitions and Annotation	A glossary to ensure the precise use of technical terms; Text and illustrations explaining the intentions of specific code provisions

Source Based on [2, 6, 7]

18.8   Proposed FBC Structure for Smart City

Smart City can be envisioned as made up of six building blocks [8]. They are (i) Smart People, (ii) Smart City economy, (iii) Smart Mobility, (iv) smart environment, (v) smart living, and (vi) smart governance. Chapter 1 of this book elaborates on these six building blocks and enumerates the most important aspects of each.

Smart People is the most important component of a Smart City. Chapter 1 elaborates on 10 properties of Smart People. Most of these properties are the way a smart person operates and their aspirations, but few of them can be influenced by the urban form. As discussed at the beginning of this chapter, urban design of the city can complement its smart economy in three ways. These three roles are finally implemented through a set of guidelines and regulations governing the development of urban form. Smart Governance coordinates the process at the city level, while Smart Mobility, Smart environment, and Smart living define the urban form by its respective details.

FBC is accepted as the methodology for developing, communicating, and implementing urban design considering its merits in this. In order to adapt HFBC for Smart City, the elaborated list of aspects of Smart Mobility, Smart Environment, Smart living, and Smart Governance was re-looked with a question of how to support the effort of the city to achieve its Smart Economy through its urban form. Further, we attempted to regroup components of FBC to fit them to this Smart City structure. This helps to retain the efficiency of FBC in developing, communicating, and implementing the urban design, while maintaining the continuity of Smart City structure. Proposed modified HFBC Regulation structure for Smart City is given in Table 18.2

Table 18.2 Modified HFBC Regulation structure for Umami

HFBC section	FBC components	Application in urban form of Smart City	Level of action
Smart People	Nil	(1) Distribution of e-Centres to aid extending learning capabilities (2) A web-based platform for promoting creative solutions by individuals and a system to make use of such collective knowledge (3) Urban space should promote the cosmopolitan style of life with less social divisions	• Whole city
Smart economy	Nil	(1) Industrial and commercial spaces with least possible controls which promote the development of wide variety of economic opportunities for the citizens (2) Welcoming urban spaces for tourists to tap potentials of tourism, generated by economy deeply rooted with the ethnic values of the place and the local architecture supporting it (3) A sustainable system for natural resource utilisation. The Smart People understands that without natural resources its economy will not function indefinitely	• Whole city
Smart governance	Governance and regulation plan	(1) Web-based interactive governance for urban planning and design (a) Urban land management, (b) HFBC for Smart City (i) Zonal Plan (ii) Transects (iii) FBC components for Smart City (2) Web-based urban management governance for (a) maintenance and collecting fees and (b) Smart Cities administration	• Whole city

Table 18.2 (continued)

HFBC section	FBC components	Application in urban form of Smart City	Level of action
Smart Mobility	Nil	(1) Walkability and ability to use cycle (2) Smart connectivity and smart transportation both for goods and for personal mobility using all available modes	• Whole city and • Specific solutions for regions within the city defined by the regulation plan
Smart living	• Built form standards • Architectural standards • Landscape standards • Signage standards	(1) Public realm standards (open spaces and civic spaces, with all possible recreational activities including swimming pool and all cultural and space standards for religious activities) (2) Built form standards (3) Architectural standards (4) Landscape standards (5) Smart signage standards	• Unique to small regions within city defined by the regulation plan
Smart environment	• Environmental standard	(1) Hybrid KSEB and photovoltaic grid (2) Complete recycling of water and reuse (3) Application of green standards as given by confederation of indian industries 'model building bylaws for sustainable development of built environment in cities' (4) Strategic interventions to make smart cities zero garbage Smart City	Unique to small regions within city defined by the regulation plan

18.9   Smart People

'Smart People' are the fundamental building block of a Smart City System. Smart People opt for lifelong learning through the use of e-learning tools. Such tools allow one to learn at any time anywhere if they have access to the Internet through a suitable smart device such as smartphone, laptop, e-book readers. Hence, this directly may not require a particular physical space. However, a network of kiosks, with facilities for such e-learning, will be a useful facility. These kiosks should be a place where one could hook to the Internet, shut themselves out of the noise and hustles of the city life, and indulge themselves in the learning or creative work. Such a facility may have small cubicles which block noise, provide excellent views of green spaces outside, and have provision for the supply of snacks and beverages. e-Centres are equipped with all facilities required for upgrading its citizens about the developments in the technology and possibilities. The facilities may include training rooms with state-of-the-art systems, training personnel hired for imparting specific courses, etc. Also, they may provide facilities such as reprography and video conferencing. This will help in reducing the marginal cost of conducting training programmes.

In Umami, this was easily implemented by upgrading the existing 'Akshaya' centres, which is a Government of Kerala initiative to extend the ICT to the poor in the private sector which is found to be income and employment generator [9–11]. These centres generically may be called as 'e-Centres' and as 'Akshaya e-Centres' in the case of Umami to retain the well-proven Akshaya centres of Kerala. They can also support the economic activity directly by allowing even a small entrepreneur to quickly arrange a video conferencing with her clients or collaborators anywhere on the globe with a marginal expense. In Umami, such e-Centres are strategically located to ensure maximum utility as shown in Fig. 18.3.

The community is expected to be highly creative. Umami believes that all kind of people living in it are potential creators, and encourages them to find unique solutions for problems they come across in their daily activities. The Knowledge Management System of Tata Steel is an excellent case study for promoting wisdom of employees of various levels and documenting it for the benefit of the company [12, 13]. Umami incorporates a knowledge-sharing mechanism in the design and management of its urban spaces. The design of the urban spaces is done through the e-Design platform, explained in the first part of this chapter, while the maintenance is managed through an e-Governance platform. A detailed implementation of e-Governance in a similar situation can be found in the book e-Governance for smart cities [2].

The zoning of residential space is done without any segregation of income classes, religion, cast, or race as the Smart People are expected to be above any such division of minds. The spatial distribution, and character of residential units are decided by the geographical location, identified by the transects. Also, certain building types were proposed for certain transects in order to accommodate requirements of household industries associated with the adjacent economic zone.
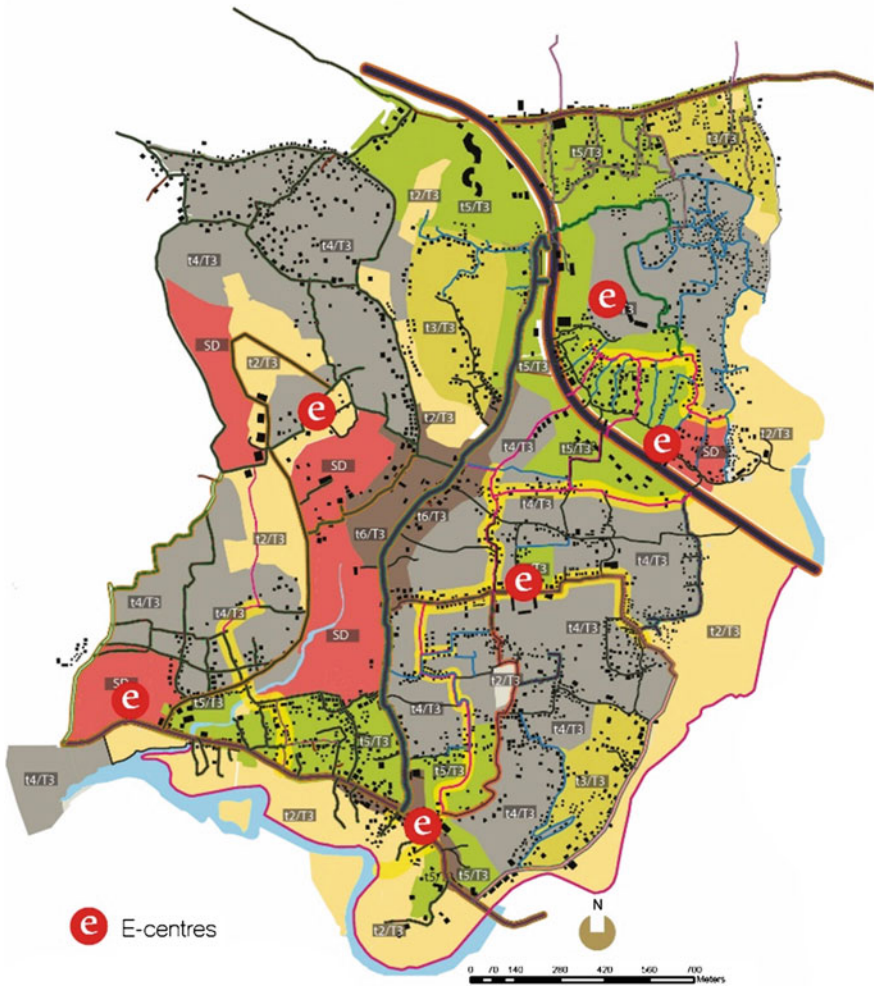
Fig. 18.3 Location of e-Centres within Umami

18.10 Smart Economy

The smart economy of Umami is based on two core industries: food production and tourism. There is a multitude of other industries which are required to support the requirements of these two industries. They include logistic companies, food processing centres, IT support, banking, commerce, etc. The Zonal Plan is developed around an idea that it should impose a least possible restriction on the use of land.

The restrictions are applied to ensure the environmental quality as well as to ensure smooth functioning of the economic activity.

The women participation in the workforce in Kerala was highest at 35.9 % compared to national average of 27.6 % in 1931 [14]. It is a paradox that the female participation in Kerala declined when the state became a role model in development with its Kerala Model Development. The workforce participation dropped to 16.9 % in 1991 [14]. It declined further to 15.3 % in 2001 [15]. Kerala government initiated Kudumbasree Project as a response to the poverty, identifying that female employment is the key factor alleviating poverty [16–19]. The smart economy of Umami is expected to be largely managed by women, as currently many of the food processing units in the region are managed by Kudumbasree units. Due to the declining growth rate of population in Kerala [20, 21], the labour force in Kerala is in a decline and this will definitely attract more migrant workers from another part of the country and may be from other nations also. This will create a diverse group of citizens for the Smart City, and the city should be able to welcome such a mixture. The built-up spaces of the city should not create any divisions in terms of caste or ethnicity as required by the cosmopolitan Smart People of the city.

Tourism is the second major industry for Umami. In fact, the tourist potential is evolved out of its industrial activity rooted in its ethnic and cultural heritage. The systematic branding campaign promoting its ethnic values not only sells the food products but also attracts visitors to experience the environment which cannot be experienced entirely by digital media. At this point, the urban design of Umami should be able to present an experience to the visitors which do justice to the brand image generated. Hence, tourism is also taken as an important industry in this project. Umami could showcase its production units, urban spaces, if they were built with this purpose in mind. The rich heritage of Kerala, and Malabar, with its variety of art forms, can make Umami important tourist destinations in Kerala. The Malampuzha River on the southern side of Umami is a beautiful place with coconut plantation along the quiet and safe river. The river is currently under threat of illegal encroachments as the place is gaining economic value after the commissioning of the bypass road. Such encroachments on the sides have blocked the flow of the river and made the water almost stagnant at places. The place also has a discarded quarry, which is located on the slope of a hillock. These locations with proper treatment and design can be turned into a tourist attraction.

Figure 18.4 shows the tourism strategy of Umami. The river, waterfront development, food museum, water sports around the quarry, and Ayurvedic wellness treatment are the major tourist attractions planned. The urban spaces, the transportation system, and hospitality facilities are the enablers required from urban design for this. The Smart City includes various facilities such as performance theatres, open stages for experiencing cultural programmes of ethnic origin, 'Kathakali' (Fig. 18.5) being one example.

The Smart People of Smart City understand that the natural environment and natural resources are their primary assets and essential for the survival of the smart economy. This is all the more important in the case of Umami as it is based on food

Fig. 18.4 Tourism strategy of Umami

production and its inputs are agricultural products partly cultivated within Umami. So the city wishes to retain its farm lands and paddy fields within the city and improve the produce by the excellent use of ICT for agriculture. They employ precision farming [22] technologies such as precise distribution of fertiliser by analysing spectral properties of the leaves. This helps them to cause less damage to the environment by precisely targeting fertilisers and biopesticides [23], but earn sufficient produce from the farm land. The tourism industry of the city is partially based on the natural beauty of its riverfront. In order to prevent damage to this environment, the city needs to find sustainable solutions for the solid and liquid waste management within the city. Being a city with food-based industry in its core, the city should be prepared to handle large volumes of biodegradable organic waste and other chemical wastes used in the processing industry. Hence, the city demands a sustainable waste management and strategy for nurturing of natural biodiversity from the urban design.

Fig. 18.5 Kathakali
performance

18.11   Smart Governance

S. Jayasree and G. Marthandan compare different phases of transition from government to e-government [24]. Vinod kumar [9] elaborated on five phases of e-Governance as proposed by UN [25] and discussed its applicability in a Smart City. He concludes that at the global level we are in the 5th phase, where the web integrates all functions of the Smart City and becomes a well-connected network. Smart governance of the Smart City deals with all aspects of the city from the planning to the maintenance of its urban spaces, management of traffic and other operations, administration and promotion of its industries being few examples. Also, it is important that this whole process should happen on a web platform. This will not only make citizens interaction with government easy, but will also allow automation of many functions of government to make it quick and efficient. Hence, the Umami website presented before is designed to serve all the governance aspects of the Smart City. Vinodkumar and Bimal [2] discuss the structure and implementation of an interactive web for governance of public space. A similar structure is used in this case after adapting it to accommodate Smart City structure.

There are two functions of smart governance web that are connected with the urban design and management as enumerated in Table 18.2. They are (1) web-based interactive governance of urban planning and design and (2) management of the city of its regular operation. In a traditionally designed and managed city, these two activities may be considered as completely independent, but in a Smart City, these two functions are highly related.

Smart City perceives urban design as a continuous process and comprises the process of collection of data, analysis of data, deriving design, and implementing of urban planning and design. While in operation, the suggestions and alternate ideas generated by Smart People on improving its functioning will be captured on a regular basis. The big data collected through the galaxy of sensors around the city and outputs of data mining algorithms working on this big data help the city to generate alternate design solutions to improve its functioning. During the next cycle of design, these insights gained by the city and suggestions and alternative options generated by the Smart People are used to improve the urban design. The cycle duration of design may vary according to the component it concerned with. The HFBCR for the city may be revised every five years, while some of the components such as the routeing of buses and signage standards may be revised on shorter cycle if required.

18.11.1   Land Management

The proposed area for Umami comprises of public and private lands, latter being the majority. Being a democratic country which gives the right to the citizens to decide on the land they hold, it is not easy to avail land for the government. Though land acquisition legislations are there, it is time-consuming and prone to public protests and litigations. In Umami, a land management solution is proposed as an alternative to land acquisition. This allows the landowners to retain their ownership while availing enormous benefits coming out of the efficient use of land in the Smart City. Chapter 17 of this book elaborates on this. Chapter 17 examines the urban land legislative tools of Kerala through two case studies and postulates E-Urban land management to elicit the participation of stakeholders. Then it goes on preparing a business model of sharing economy to demonstrate how Umami can be converted profitably to a Smart City of all stakeholders.

18.11.2   Hybrid Form-Based Code for Smart City

Hybrid FBC incorporates zoning regulation to original FBC, as explained before in this chapter. Zonal Plan allocates different uses and intensity of use through zonal codes to the urban land [26], after studies and calculation of area requirements for various functions envisaged by the overall vision for the city. Extensive data
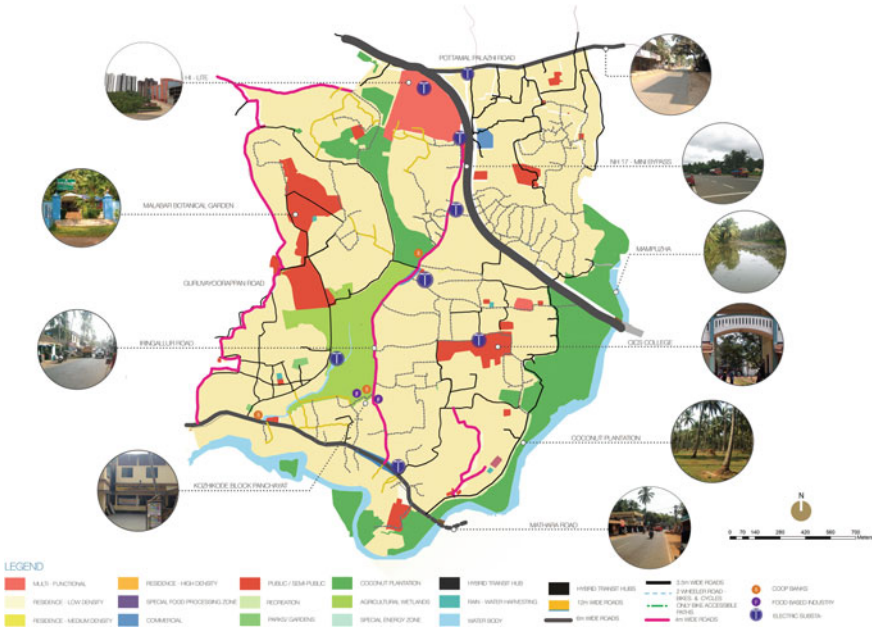
Fig. 18.6 Existing site features

collection was performed to collect both primary and secondary information. On-site surveys were done to trace roads and lanes, identify buildings, the age of buildings, the physical state of buildings, economic class of people, etc. The data collection was done in a collaborative manner involving student team as well as few volunteers from the current residents. In reality, when the Smart City is functioning, majority of the data collection was expected to be sourced through various sensors and other digital means. Since this is a student work, it was not practical to have dedicated sensor network and the participation of local volunteers was very much limited. The community engagement is simulated by students dividing themselves into groups and collecting information about a small area, and uploading the same to the website. Road networks and location of buildings and other features were captured through GPS devices available on smartphones, and the same was corrected by comparing it with satellite imagery of the area available in various online sources (e.g. Google maps, Bhuvan, Open Street Maps). The collected information was rectified and digitised if required, and all these were organised in a GIS database as different layers. Geo-tagged photographs were taken, and this was overlaid as a separate layer. Figure 18.6 presents the existing site features of Umami. A stretch of National Highway (NH) Calicut Bypass Road passes through the selected area. Mathara Road, and Pottammal–Palazhi Road are briefly touching the site on north and south, respectively.

18.11.3 Land Resources and SWOT Analysis

The terrain of the land was analysed using the SRTM digital elevation model to assess the suitability of land for various economic and other civic activities. Figure 18.7 shows slope analysis map. The central part is relatively flat and will be ideal for central business activities which support other industries. The west is relatively low-lying and is suitable for preserving green spaces; this area also includes Malabar botanical garden. The southern side is flat land, which is currently coconut farm. Due to the presence of Malampuzha River, this part will be suitable for tourism, in which the place can be demarcated for very low-level human activity and maintain the site with its real beauty. The eastern side of central portion has a quarry, filled with water, which can be utilised as an area for water sports. Eastern part of the bypass road has vast coconut plantations and is relatively flat. Transportation of coconut is expensive since the volume of the shell is very high compared to the small volume of the central edible portion. Hence, eastern side of the road would be a good place for coconut-based industries. Proximity to the highway would make it easy to collect coconut from the nearby area as well. Also, part of this area can be used for transport hubs so that large trucks do not have to pass through the inner city to transfer their load.

Further various aspects of buildings were analysed. For example, buildings that can be demolished if required were identified through a logical query on the GIS database which has layers representing age, present structural condition, height, roof type, economic class, etc. The logic used here was as follows: buildings older than 20 years, having low height with tile roof, and in low and medium economic group are suitable for demolition, as owners of these buildings will find it more profitable to exchange these structures for higher return offered by the Smart City.
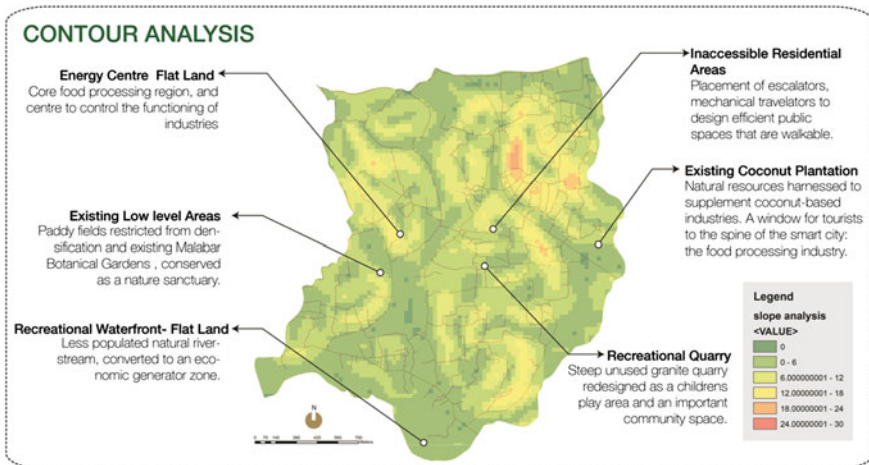
Fig. 18.7 Slope analysis

Such identified structures are shown in Fig. 18.8. However, efforts are made during the design formulation to minimise demolition of existing assets as much as possible. Traffic, water resources, ground water availability, etc., were analysed, and all such analysis were concluded with SWOT analysis for each Smart City buildings blocks and an overall SWOT for the whole city, which is presented in Fig. 18.9.

The strength of the selected area includes its existing food processing industries, existing plantations, existing cooperative banks, good road connectivity, the presence of schools and colleges, and abundant water resources. Weaknesses are the undulating terrain, accessibility to residential area, water scarcity in places with high elevation, and stagnation of river. Opportunities are easily available land with very sparse construction with a high connectivity, people with high educational qualifications who are prepared to accept smart technologies, presence of many houses which are good examples of traditional Kerala architecture, and untapped tourism potential in terms of natural features and as industrial tourism. Threats are pollution of the river, environmental degradation due to industrial activity, possible contamination of environment due to high-yield agriculture, expected migration due to the economic activity, and potential socio-economic conflicts due to migration.

18.11.4 Proposed Zonal Plan

The Umami site which extends to 5.4 km^2 area, as per 2011 census, accommodates about 55,000 people. The gross residential density of the site is about 101 persons per hectare (PPH). The Smart City development demands a high residential density (refer for density as per Smart City standard). Umami was planned to accommodate more than 100,000 people which will bring the gross density close to 200 PPH. The net density at residential locations needs to go as high as 300 PPH to give space for industries and open spaces.

18.11.4.1 Location of Food Processing Units

The proposed Smart City works around food processing industry, while tourism industry takes a minor role. There will be other supporting industries such as IT, advertising, banking, and commerce. The spatial requirement of various food processing industries was studied to arrive at the area to be allocated for the industrial purpose.

Food processing industries were classified into four spatial clusters based on their nature of the activity. This included a central hub, processing centre 1, processing centre 2, and processing centre 3. Central hub consists of industries that deal with higher-level products such as bakery, ethnic food cooking, and finishing-level activities such as packaging, distribution logistics. This zone is centrally located, has high connectivity to the transport network, and has dedicated corridors for goods movement. Figure 18.10 shows location of these processing centres.
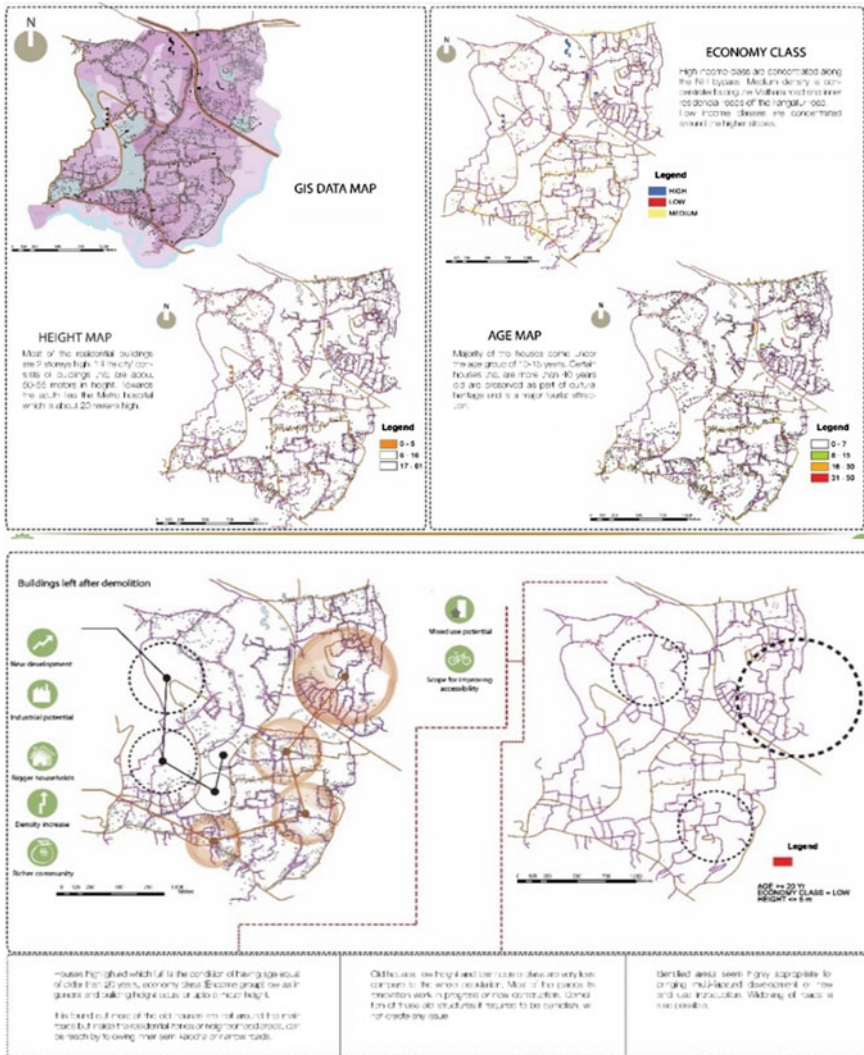
Fig. 18.8 Potential buildings for demolition

Processing centre 1 which deals with dairy products is located in the centre, taking advantage of the existing milk producers in this area. This part of the landscape has coconut plantations, which allows farming activity in the same land. Processing zone 2 has soil that is suitable for crops such as cashew and spices. This location also has discarded quarry which can be used for fish farming. Processing zone 3 grows coconut, banana, plantain, and cocoa. These zones accommodate facilities required to process the respective crops collected from the surrounding

Fig. 18.9 SWOT analysis

regions. The second level of processing of these products are done at locations are close to the central hub. Figure 18.11 shows the specialisation of these food processing zones.

18.11.4.2 Locating Tourism Activities

The tourism industry of Umami is oriented more towards showcasing its proficiency in food production. This can include showcasing of homely grown agricultural products, the superior technology used for production, and the smart environment. Few projects identified for this purpose are houseboats in Malampuzha River, which will expose the natural beauty of plantations on both shores, herbal gardens, tree houses near the botanical garden, and recreational facilities around discarded quarry.

18.11.4.3 Location of Transport Hubs

There are two main hybrid transit hubs, located along two major roads. Both of them handle public transport as well as goods, but the one located along NH bypass is specialised in dealing with raw materials, while the one located near the Mathara Road is specialised in handling finished products. This specialisation will be handy as the nature of transport of raw materials and finished goods is different. Raw
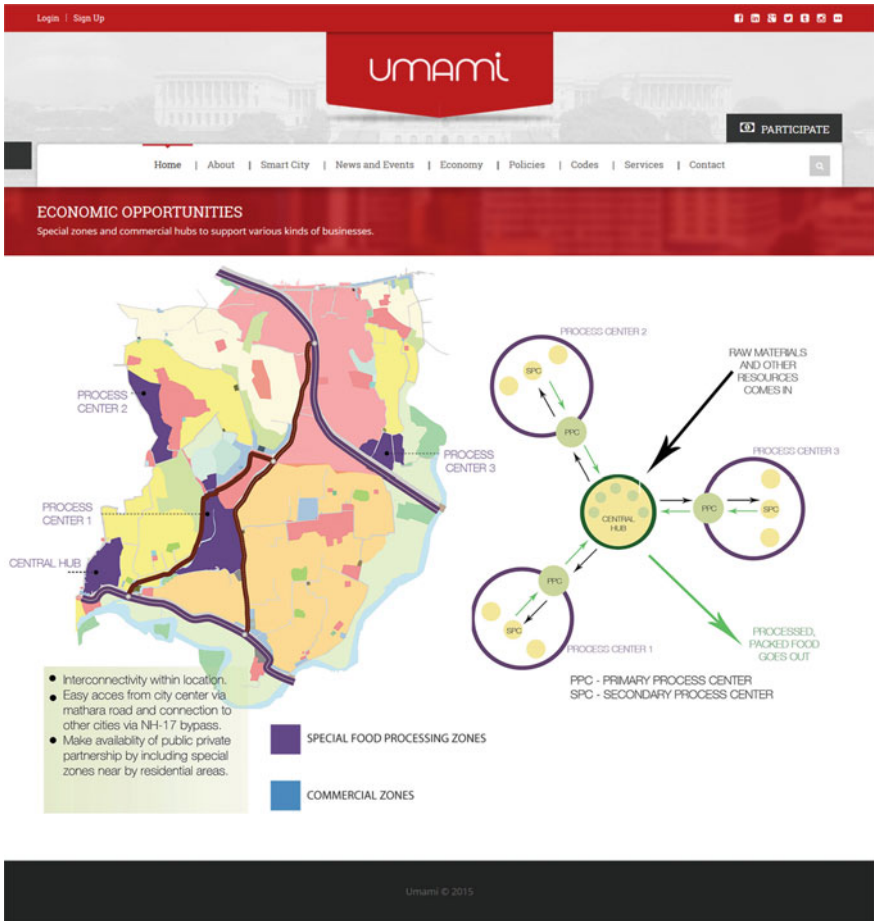
Fig. 18.10 Special food processing zones and commercial zones

materials are processed in large volume using heavy trucks, and generally the movement is slow, while the finished products are handled with smaller vehicles and are to be handled with care as the value of the products is high and has to be transported quickly.

In addition to the major transit hubs, there are a series of secondary hubs with varying size. These are meant to facilitate the efficient movement of goods and products from even smaller-sized units. A vendor who wants to send quickly even a single packet of cooked food will be able to find a fast means of transport to the airport if they book it with a transport company, who operates these hubs.
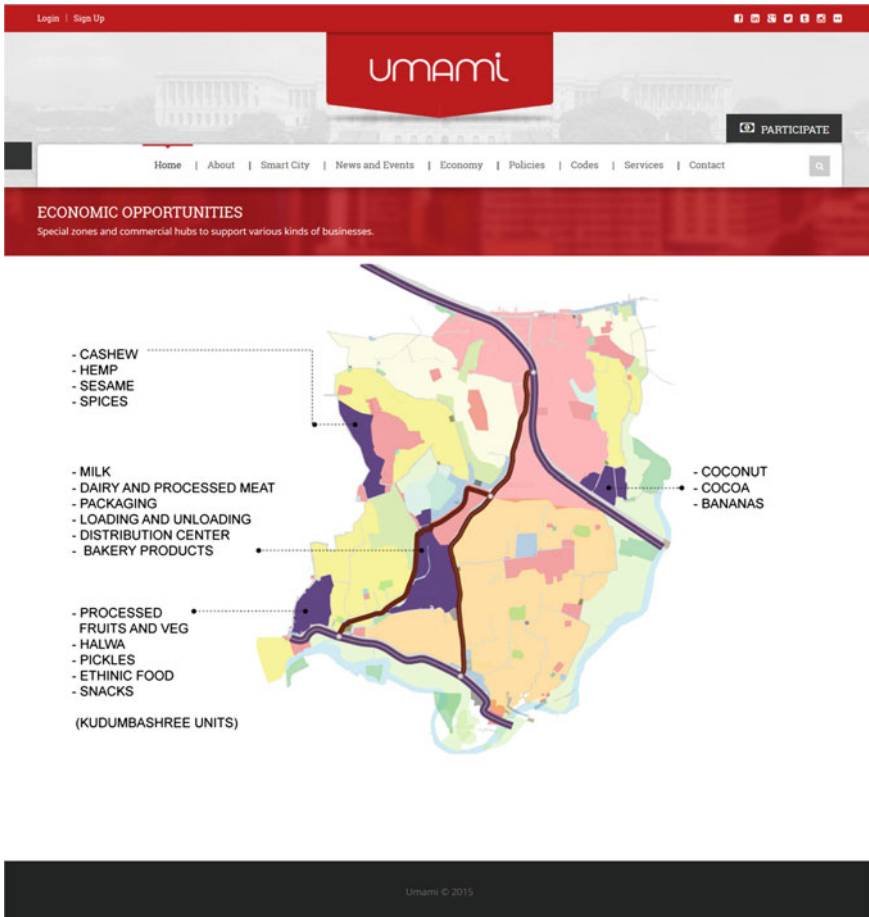
Fig. 18.11 Special food processing zones and their products

18.11.4.4   Residential Space

The residential area was delineated after allotting space for industries, commercial and open spaces, etc. The general policy adopted was to retain as many existing houses as possible. Houses were mapped with their age, structural longevity, kind of superstructure, etc., to aid in demarcating buildings to be demolished. Few buildings were demarcated for demolition irrespective of their condition, as their retention was affecting the alignment of infrastructure.

Fig. 18.12 Transect zones. *Source* Smart code version 10, 2010, DPZ and Company: downloaded from www.bettercities.net on 23 December 2015

18.11.5 Transects

The concept of transect was used in ecological studies. Duany [27] proposed a system of transects for urban design. Transects are employed in FBC to capture the environmental characteristics of the existing landscape continuum of perfectly natural to the city core. This helps to orient the regulations which govern building process in this land to maintain the same ecological relationship [6]. In Umami, two levels of transects were used. '*Tn*' (*n* denoting the transect number) represents the macro-transect with respect to the mother city, and '*tn*' accounts for the micro-transect which captures transect variation within the proposed Smart City. A similar approach was used in our previous work on FBC for public realm [2]. Transects vary from T0 to T6, where T0 represents perfectly natural landscape and T6 represents CBD, which is largely human made. Graphics prepared by A. Duany to explain the concept is given in Fig. 18.12. The proposed land for Umami belongs to macro-transect T3. The area was further divided into six micro-transects and a special food processing zone. This special zone was introduced considering the industrial character of buildings that are going to occupy this place. A graphical representation of the transect zones followed in Umami is given in Fig. 18.13.

18.11.6 Regulation Plan

Public realms are identified within the transects, which identify the most important public spaces that are to be regulated to give meaning full experience to the public. The regulation plan defines polygons around the public realm, which encircle the places that public will be experiencing. The extent of the polygons depends on the extent of built space visible from the given public realm. The regulation plan limits the application of HFBC to land within this polygon. Though it is ideal to include the whole land under Form-Based Coding, we can see that it is not necessary.
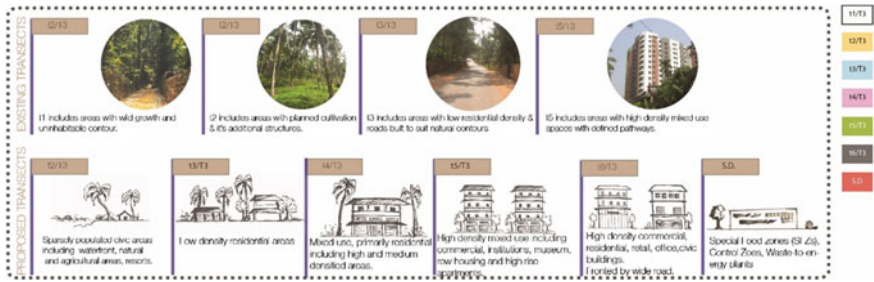
Fig. 18.13 Transect zones in Umami

Transects, which represent the ecological character, are overlaid with the public space polygons. This may create a number of polygons. These polygons are called regulation polygons, and they represent a unique combination of ecological character and a public realm. In other words, we can say that a regulation polygon will have a uniform character throughout. Hence, these polygons will have specific components of HFBC for the Smart City, which are applicable to sub-regions within the city.

In Umami, polygons A to G were identified in this manner. Each polygon has a unique character. Polygons A and B are the entry areas to the city, and it should have a welcoming design. These two polygons should have wide roads since most of the traffic will be going through this place. Polygons C and D has high-density residential spaces and commercial spaces. This will form the major shopping street. Polygon E is medium-density residential with school and college. Polygons G and F are also entry points to the city, and this also comprises of wholesale trade centres and retail shops (Fig. 18.14).

18.11.7   Web-Based Urban Management

Management of the Smart City is done through the web-based governance platform. Primary functions of the management that are concerned with urban design are (1) management of the building permission and (2) maintenance of public spaces and responding to requests for design changes. Both these functions are web based. The urban management web also performs as a platform for the interaction between various business entities involved in urban management and design process. A detailed discussion of these functions can be found in [2, 9]. Other functions such as budgeting and annual planning may be done taking [28, 29] as example cases. Figures 18.15 and 18.16 illustrate the maintenance process and building permission process, respectively. A mobile application was also developed to facilitate the smart governance process. This application enables a user to raise maintenance requests for public spaces with a geographical reference. The back-end process accumulates such
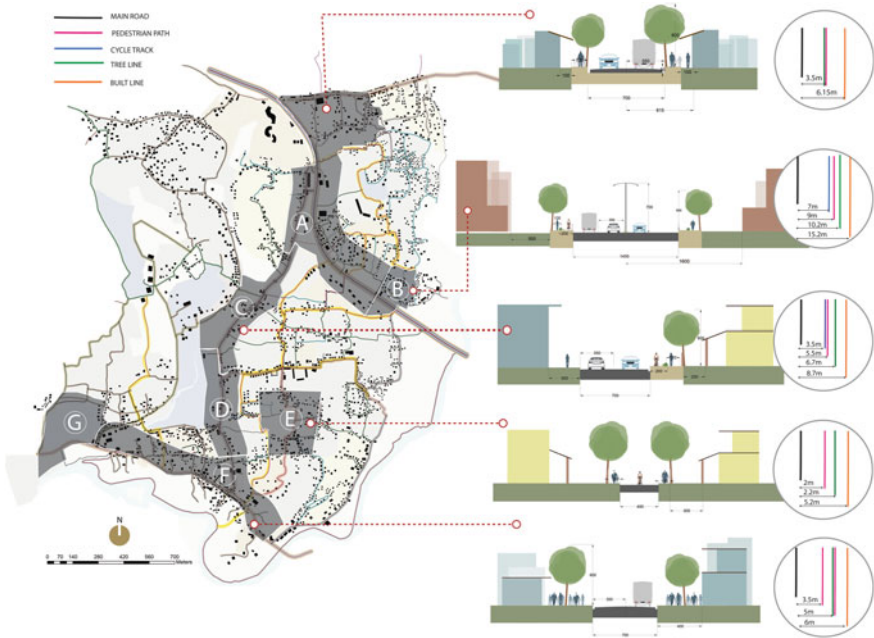
Fig. 18.14 Regulation plan
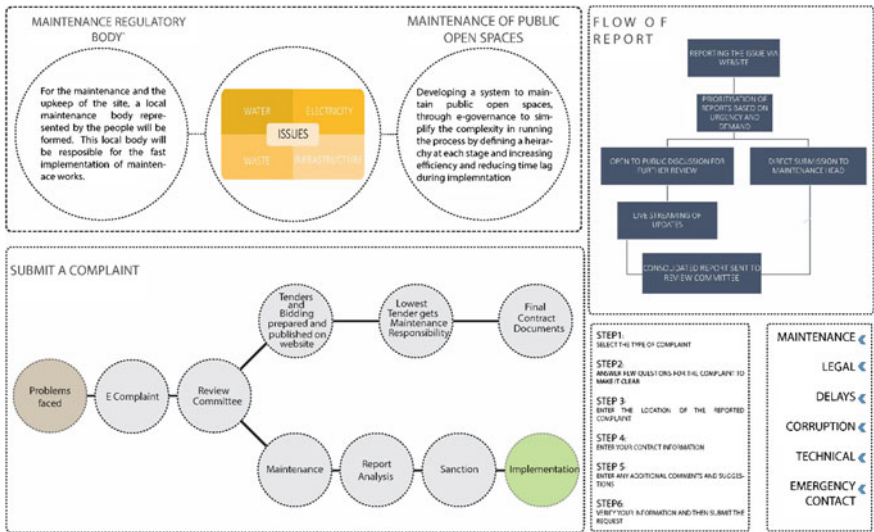
Fig. 18.15 Complaints and design suggestions management process
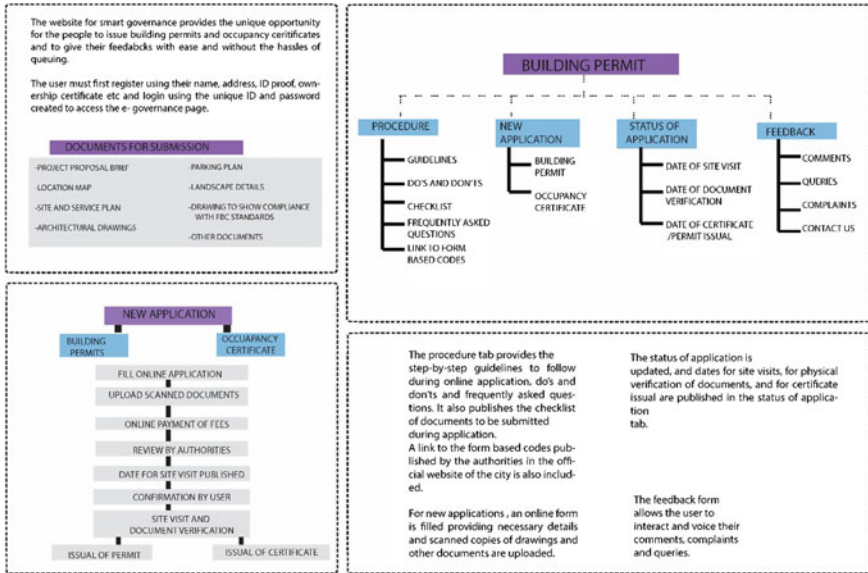
Fig. 18.16 Building permit process
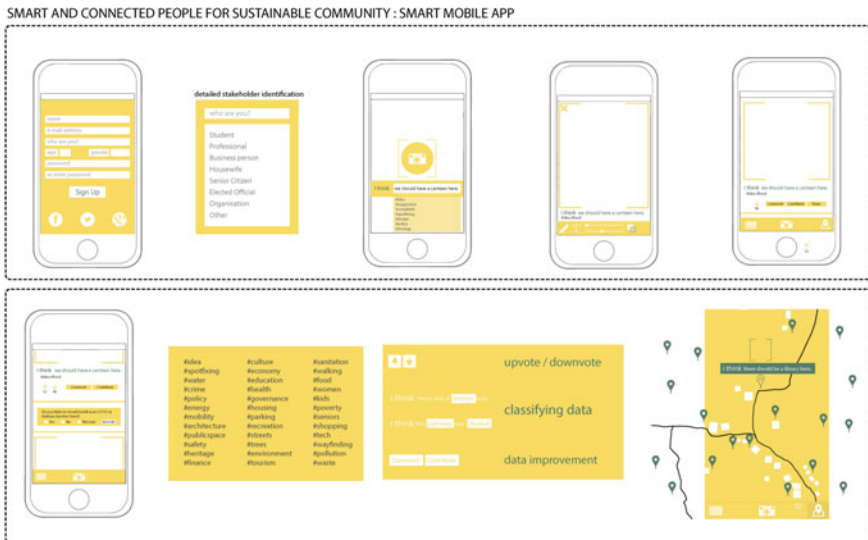
Fig. 18.17 Mobile app to facilitate smart governance of Umami

requests and groups them according to the location, and type of maintenance required. A filtering of duplicate requests generated by many citizens about the same complaint is performed before sending it to the respective contractors to rectify the issue. Illustration of the mobile application is given in Fig. 18.17.

18.12 Smart Mobility

The major objective of Smart Mobility in a Smart City is to provide quick and quality transportation for people and goods to any part of the world. Also, it should provide a convenient and healthy transportation within. Here it is important to note that the city is concerned with the movement of people and goods, but not just vehicles. The city needs to be more walkable and bicycle-friendly.

18.12.1 Smart Mobility of Goods

In Umami, quick transport of goods to the airport is a major concern as the city is expected to have a significant clientele in the Middle East and the food needs to be served hot at these destinations. This kind of quick transit is possible with dedicated transport lines, but that is not a possibility here as road widening or land acquisition is tough in Kerala due to the dense development and improper land management tools practised as discussed in Chap. 17. Hence, the next option is to mobilise goods in bulk from Umami to airport as per the flight timings with the least footprint on the road. ICT will help in organising this. The transportation companies will be able to choose a right vehicle as per the volume of goods to be transported. They may dynamically collaborate with other transportation companies to efficiently manage a suitable vehicle if the volume to be transported is less. Data mining algorithms will be able to find trends in the booking volume and better prepare for the right transportation choice. For example, the big data mining algorithms can find the expected volume of traffic, by analysing all orders received in the Smart City and finding the number of received orders, origin location of the order, and expected delivery time. The system can also look for the available resources to transport the expected volume and suggest a suitable mode. It is even possible to manage the city traffic at junctions to facilitate movement of this high-speed cargo (Fig. 18.18).

Umami has segregated certain roads majorly for movement of goods. They are further classified into three types as per the mode of transit allowed as given in Table 18.3. Further routes for these trucks were identified according to their locations as presented in Fig. 18.19. Movement of raw materials and finished products was also studied to suggest better transport option as given in Fig. 18.20.

18.12.2 Smart Mobility of People

Umami targets to have an efficient transportation of individuals from the Smart City to other important places such as the airport, Calicut City, and other nearby cities. It proposes a healthy and convenient transportation of public within the city. It recognises that the city is meant for people and not for vehicles.
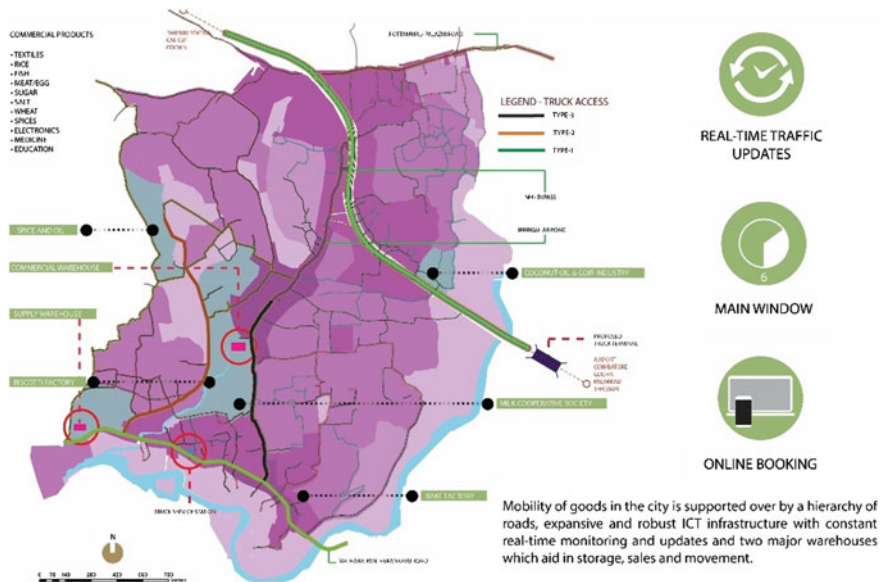
Fig. 18.18 Types of routes for goods transport

Table 18.3 Types of roads and truck access

Truck access	Type of trucks allowed
Type 1	All types of trucks can access Haulage (Cap-30 Tons)—highest capacity to Delivery vans (Cap-1 Ton)—lowest capacity
Type 2	Delivery vans (Cap-1 Ton) Rigid trucks (Cap-5 Tons)
Type 3	Delivery vans (Cap-1 ton), Rigid trucks (Cap-5 Tons)) Tankers (Cap-2000L)

18.12.2.1   Smart Connectivity for Outside Destinations

Calicut City is proposed to have a light metro connecting the airport and other important destinations. Unfortunately, Umami is not linked to the proposed light metro. However, people from Umami travelling to the airport will be able to use the last leg of light metro for about four kilometres after reaching Ramanattukara by road. Calicut is also proposed to revamp its forgotten waterways which were well-connected modes of transport before motor vehicles came.
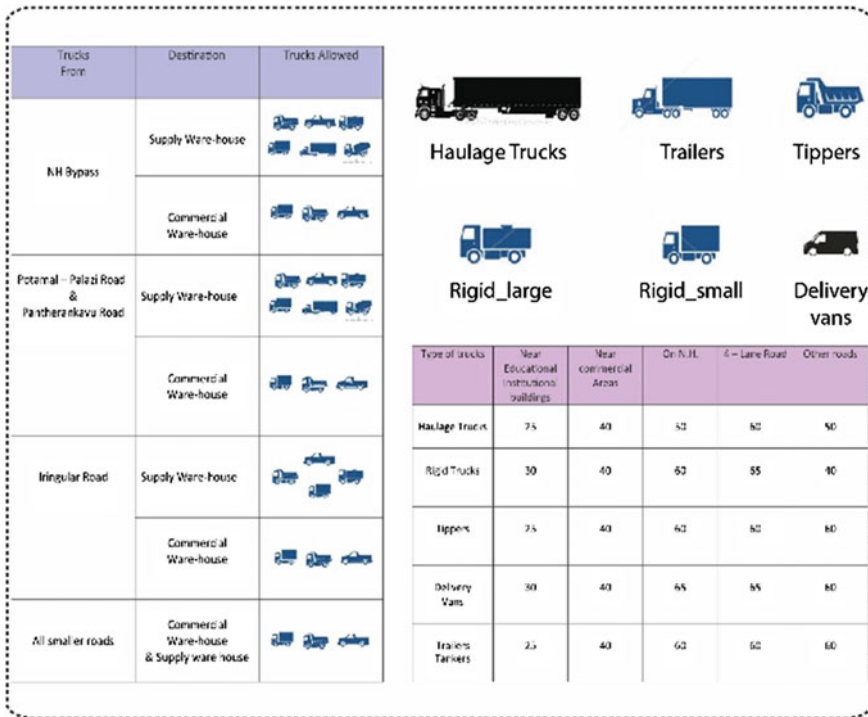
Fig. 18.19 Suggested routes for trucks

In Umami, as in the case of transport of goods, the only possible way to manage quick traffic to outside destinations is to reduce the number of vehicles going to the roads. With the use of ICT and mobile access to ICT, it is possible for an individual to express his/her desire to travel to a destination and leave the rest of it to the intelligent travel planning systems. The ICT-enabled travel planning systems can quickly sort number of people willing to travel to a given destination and their origins within the city and propose a quick mode of traffic which may include having one leg of the trip in battery-operated vehicle or walk, another leg in a pooled car with other people, and yet another leg in light metro. All these options may be worked out by the system and will be presented to the user with to choose from. Once the user accepts a proposed solution, the system can arrange the booking and ensure the connectivity at each of these mode changes. It can also monitor the movement of each of these modes and can alter the modes in case of failure of any of these modes. Umami proposes to have four micro-multimodal transit hubs for facilitating this traffic interchanges. These transit hubs need not be huge, but instead they are designated places where these interchanges can happen. Figure 18.21 shows locations of these micro-multimodal transit hubs.

REGULATED MOVEMENT

RAW MATERIALS	IMPORT NODES	TRANSPORTED VIA
Cocoa, Spices, Cashew	Wayanad	NH connectivity
Meat products, Milk	Cochin	NH connectivity
Vegetables	Coimbatore	Railway, NH
Cashew, Fruits	Calicut	NH connectivity
Rice and other groceries	Palakkad	NH connectivity
Fish	Beypore	NH connectivity

EXPORT NODES	TRANSPORTED VIA	FINAL GOODS
Cochin	Airport, Harbor, NH, Railway	All processed goods are transported to these nodes.
Bangalore	Airport, Railway	
Coimbatore	Airport, NH, Railway	
Calicut	Airport , Harbor	
Thrissur	NH connectivity	
Beypore	NH connectivity	

Fig. 18.20 Regulated movement of raw materials and finished products

18.12.2.2 Smart Mobility of People Within the City

Umami is designed to allow people to smartly use the right mode of traffic for commuting within the city. It recognises that mobility of citizens is a primary concern than the movement of vehicles. Hence, the city is planned to make walking and cycling as the easiest mode of transport within the city. This is achieved by respecting the existing interconnected lanes, and inspiring from that.

The strategy adopted is to limit the motorable roads to the periphery of the large residential areas and having a system of diagonal pathway made out of existing lanes for pedestrian as well as bicycle movement. This gets connected to the diagonal pathway of the next residential cluster. This pathway is further emphasised by placing commercial and public amenity centres along. All the parking spaces are moved to the periphery, and only emergency parking is provided within the residential area. Cul-de-sacs connect the parking places and residences. Hence, people will find it easier to walk or bicycle to the destinations rather than walking to the parking centre and going all around the residential blocks to reach the same destination. Umami being a place with 6 months of rain, enough shading is given along these walking corridors to protect people from the rain.

Bicycles are expected to be the preferred mode of traffic for people. A network of cycle rental centres is planned all over Umami as shown in Fig. 18.22. The cycle rentals are nearly automated with automatic locks dispensing the cycles with OTP (one-time password) sent to the user's mobile device and billed until the user disposes the cycle at another location. Only human intervention is required to redistribute the cycles from place to place, as per the demand estimated by the ICT-enabled intelligent management system. Demand may be predicted on a real time based on an algorithm similar to the one used to predict intra-day trip generation by Bimal [30]. The undulating geography of Umami is not in favour of cycling, and this is a major reason for the low popularity of cycles presently. Battery-assisted cycles are an obvious solution, but are rejected due to its
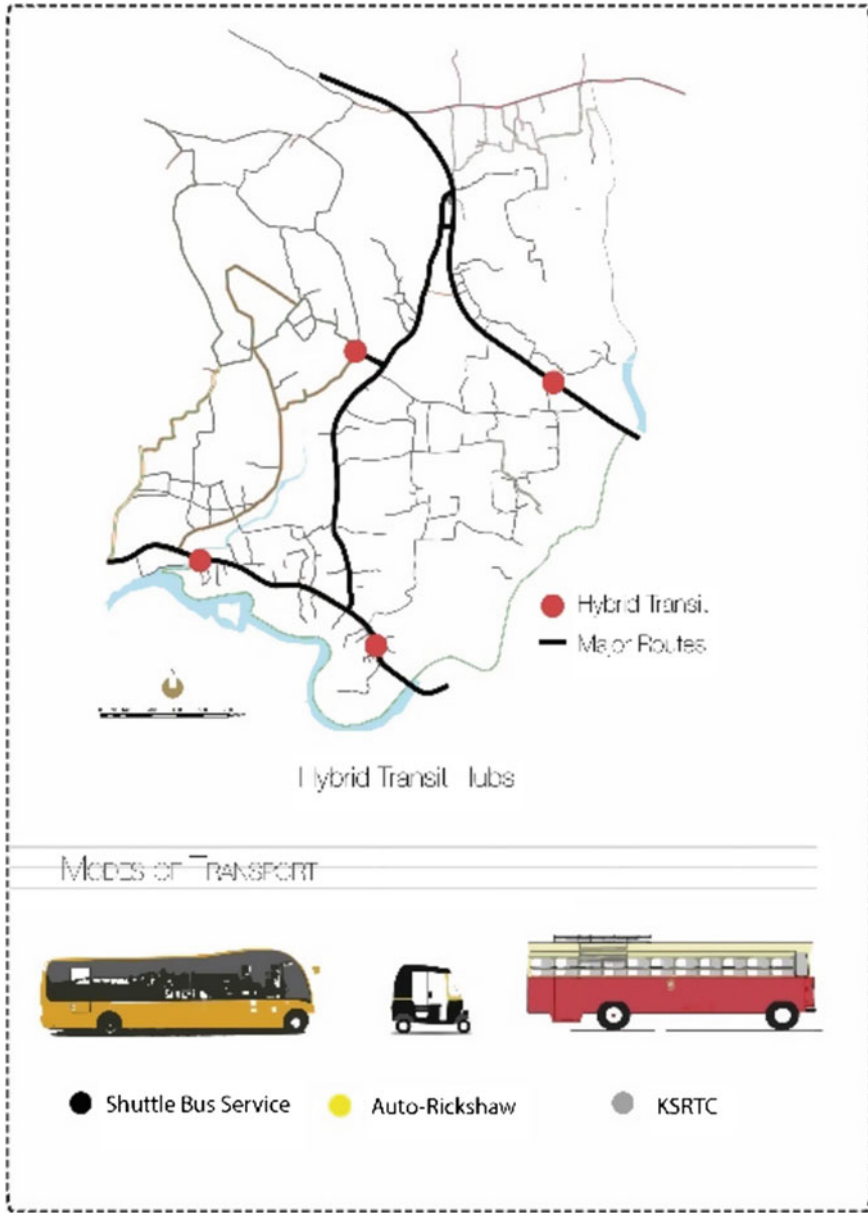
Fig. 18.21 Micro-multimodal transit hubs locations in Umami

operational difficulties as a rental system. Bicycle lifts as given in Fig. 18.23 were selected. This system provides the necessary assistance to climb the slope. A slope analysis was performed with the digital elevation model to identify places which are hard to climb by a cyclist.
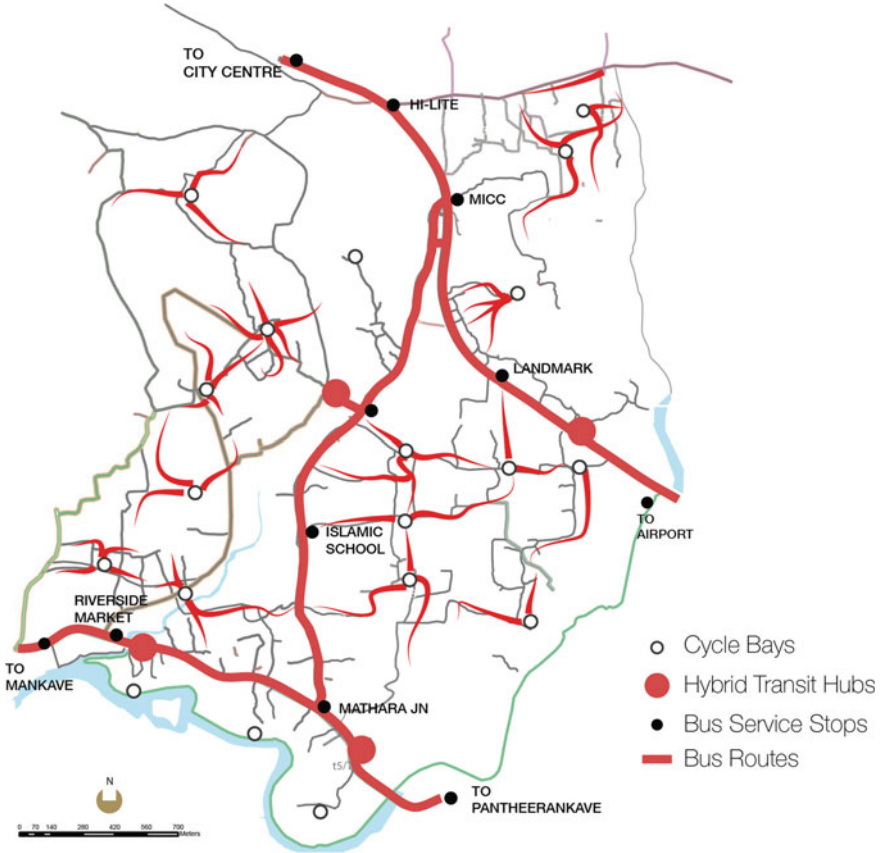
Fig. 18.22 Cycle bays, bus routes, and hybrid transit hubs

Smart People should have access to every place in Umami, despite any physical disabilities. Pedestrian pathways were laid with tactile directions and warnings for visually challenged people. Wheelchair access is provided for all paths and buildings. An illustration of few selected proposals is given in Fig. 18.24.

Traffic movement within the city is automatically managed by ICT-enabled the system. A dynamic prediction system as discussed in [30–32] can be used to estimate the number of people willing to travel at a given time, their preferred mode, and destinations. Such techniques, calibrated over a period of time, will provide a precise account of travel pattern at a given time. This information can be used to manage the traffic pattern in an efficient manner.

Fig. 18.23 Bicycle lift. *Source* http://lh3.ggpht.com. Accessed on 08 December 2016

18.13 Smart Living

Smart living standard is intended to improve the quality of living of citizens. From the urban design point of view, the quality of living is influenced by the appearance and utility of public open spaces, visual appearance, and harmony of built forms, architectural detailing, natural and manmade landscape, and the mental picture of the city created through its visual images and signage. Overview of these standards is given in Fig. 18.25. As explained in Sect. 18.8 and Table 18.2, all these standards are developed for each regulation polygon separately in order to keep the diversity of these spaces intact.

18.13.1 Public Space Standards

The design of streets and public spaces is implemented through public space standards. Public space standards ensure that the streets develop as per the overall plan, ensuring the harmony among other components making up the public realm. In polygon C, the major public space other than streets is a food court and a food museum. Figure 18.26 gives a part of public space standards for this facility. The detailing of public open spaces may be done through landscape standards.
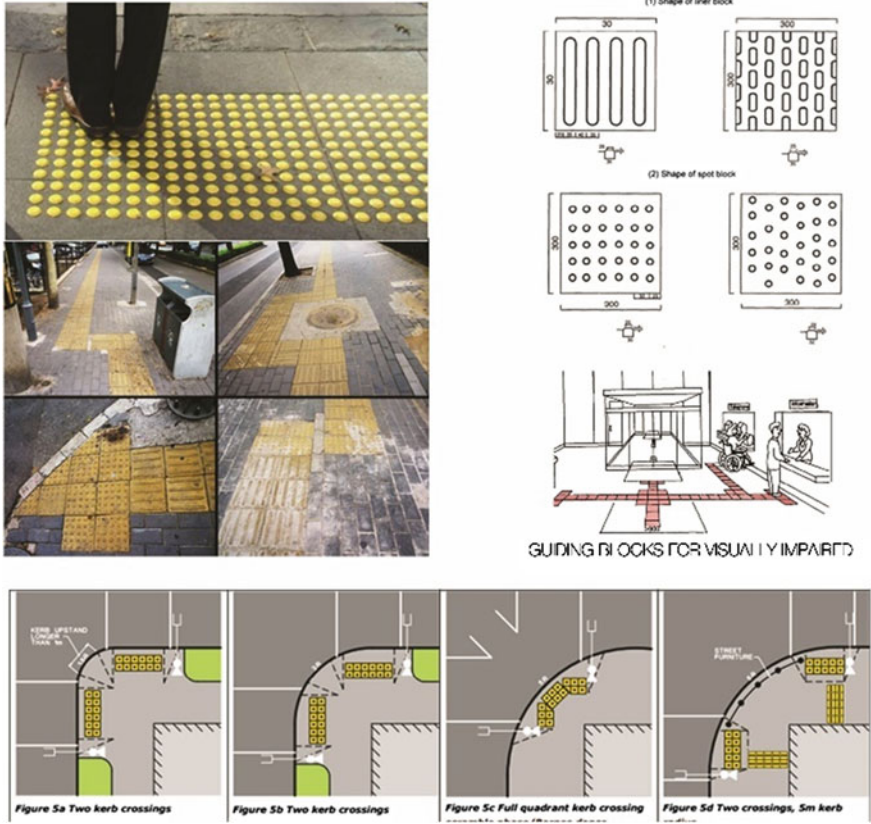
Fig. 18.24 Smart Mobility for differently abled

18.13.2 Built Form Standard

Figure 18.27 shows built form standards and architectural standards derived for polygon A. Polygon A works as the gateway to Umami, and hence, it should present an image of the lifestyle of Umami and also should have a welcoming feel. There will be tall buildings in this polygon, matching with the current style of buildings along the bypass road. The built form standard requires a setback of 8 m in this area, to allow a large open space in front of the tall buildings, so that these tall buildings will create a less intimidating feel for people walking on the street.

PUBLIC SPACE STANDARDS

Built form standards include the Coverage, FAR number of storeys, orientation , height , setbacks roof angle, etc standards for each public realm.

BUILT FORM STANDARDS

It describes the style, dimensions, colour, materilas used for various architectural elements in each public realm such as roof form, walls, handrails, fenestrations, plinth.

ARCHITECTURAL STANDARDS

It includes the variety, height, canopy of trees, shrubs and grass, street furniture used in each public realm depending on the function.

LANDSCAPE STANDARDS

It includes smart signage for all information for tourists, and pedestrians necessary for way-finding, samrt maps and electronic bill boards and smart maps.

SIGNAGE STANADARDS

It describes the standards for open spaces, recreational areas, play grounds, parks and parking spaces in each public realm.

Fig. 18.25 Smart living standards—overview

18.13.3 Architectural Standard

Architectural standards provide details of the buildings. There is a variety of architectural elements used in buildings. In traditional buildings, these elements are evolved from the culture, local climate, etc. In traditional Kerala buildings, there are plenty of such elements carved out of wood. Architectural standards intend to regulate few most essential elements in order to achieve a pleasing, harmonious experience of public space. For example, an essential part of traditional Kerala

Fig. 18.26 Public space
standard for polygon C

PUBLIC SPACE STANDARDS

Areas along the bypass have been identified as a
public realm with the characteristic of 2 storey build-
ings on either sides of the road and gradually increas-
ing in height further away from it.Food museum is the
main highlight in this polygon.

Food court is provided near the food museum. This is
located here to expose the culture of Calicut.

Open exhibition space is provided such that small
food stalls can be incorporated within it and programs
such as Food Festival can be conducted.

PLAN OF FOOD MUSEUM   PLAN OF OPEN FOOD COURT

building is its sloping roof which is inclined between 30° and 45°. 30° is generally
used for private buildings like houses, while 45° is used for the building which is
meant for the public. This feature, along with the configuration of entry, pillars, etc.,
gives a special appearance to public buildings. In polygon A, architectural standards
as shown in Fig. 18.27 regulate the roof, windows, door sizes, handrails, and
sunshades. It is possible to regulate every element of the building through FBC
framework, but in a Smart City, the buildings need to be unique and should not look
monotonous. Hence, enough freedom is given to the designers to achieve variety by
proper use of other elements. In this polygon, a colour palette was also suggested
which allows the architect to choose a suitable colour for individual elements.
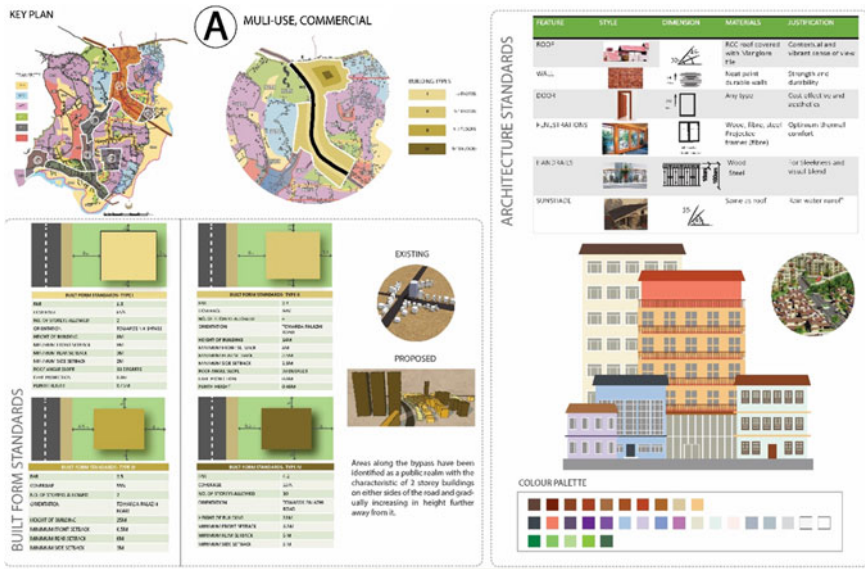
Fig. 18.27 Polygon A—built form and architectural standards

18.13.4 Landscape Standards

Landscape standards regulate the types of plants, street furniture, lamp posts, etc., used in the public realm. These are regulated to achieve a distinct character for the public spaces and to make them harmonious to other elements of the public realm. In Umami, the landscape is planned in connection with the signage plan for the whole city. The colour and texture of plants used for each zone are unique and contribute to the mental image of a place. The selection of plants also considers the usage characteristics of public spaces. Streets which run east–west should have a dense foliage on the southern side to provide sufficient shading for the streets during daytime. In polygon A, which is the entry point to the Smart City, Banyan trees with wide circular platforms are proposed, in order to invoke the traditional meeting place. This will form the major shopping street. Polygon E is medium-density residential with school and college. Polygons G and F are also entry points to the city, and this also comprises of wholesale trade centers and retail shops. Figure 18.28 shows the landscape standard specification for public realms, A, B and C.

The hard paving is selected for footpaths considering the need for water drainage and soil recharge. Street furniture is chosen in compliance with the signage concept. Each zone has its own set of furniture, which helps to identify the location. Figure 18.29 shows an example.
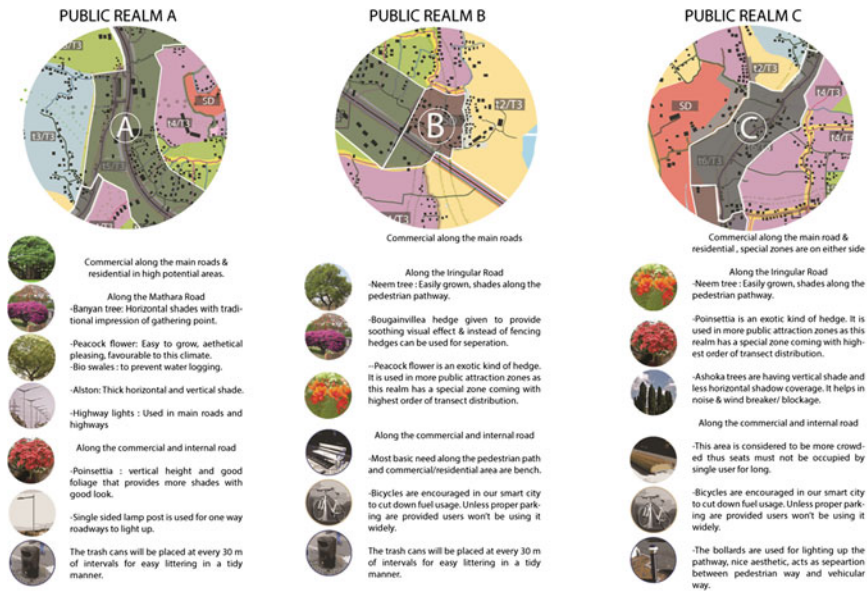
Fig. 18.28 Landscape standards

18.13.5 Signage Standards

Signage design concept of Umami has 3 major points. They are (a) creating a mental imagery, (b) seamless integration, and (c) rule of three. They are shown in Fig. 18.31. Major transport lines in Umami divide it into five sectors. People moving through these sectors should be able to distinguish these sectors easily. Each of these sectors is given a unique colour as a theme colour as shown in Fig. 18.30. Each of these sectors is assigned with unique symbol also. These colours and symbols are used for all signage in the corresponding sector. Landscape standards for these sectors also propose to use a number of plants that are matching these colours. Hence, people moving around Umami will be able to identify their current location by looking at the colour scheme of plants, buildings, or signage. Figure 18.32 gives an overlook of the signage scheme. Seamless integration is achieved among various methods of wayfinding. People with a smartphone and good map-reading skills will be able to find a way within Umami by using any mapping applications such as Google Maps. Umami also provides a multipurpose mobile app for its citizens and visitors. If a user of this app needs to do wayfinding within Umami, he/she can log a mapping request, and as he moves to a junction, and goes near a smart pole, the smart pole will show the road he should follow to

Single sided lamp post is used for one way roadways to light up.	Public Space lamp, used in public open areas like plazas. Type of lighting is diffused scattered.	Highway lights. Used in main roads and highways where divider is present and 2 way roads are running parallely.	Designer set lamp. It is used in all those places where aesthetical detailing are intricately done.	Park light lamps. placed usually along the pathway in a park. It is to provide scattered light with good amount on the path too.
Coverage = 1 lane	Coverage = 3-4m rad.	Coverage = 2- 8 lanes	Coverage = 4-5 m	Coverage = 2-3m
Height = 6-7m	Height = 3-4m	Hieght = 10m	Height = 2.5 - 3.5 m	Height = 3m

Steel furniture is an ideal wood alternative for park furniture.Care must be given to the choice of the size, composition, and coating of the seating members. Smaller, lighter colored steel slats hold less heat.

Wood is used primarily for park benches, tables, and decking. It is one of the hardest park materials to substitute. White oak is satisfactory for bench slats only if it is to be painted.

Wood is used for park benches, tables, and decking. It can be used in less personal usages. The adjacent seats are oppositely facing to each other.

These seats are usually placed in moderate traffic areas with slow paced movements. Material can be wooden, fibre plastic or even metal. Welcomes the public to spend comparitively more time.

Cycle stands with vertical support to avoid overcrowding and falling on each other.

Individual cycle support for keeping the cycles parked in a propoer order. These are foldable which when not in use can be kept down and it won't be blocking any space.

Bollards are used for the lighting at lower level near to the road side. It helps in litting up the pathway and makes it very clearly visible, which welcomes to walk on.

Trash Cans are also a part of landscaping in an urban context. The first step for beutification is to keep the area tidy. People can see these cans and will not litter around anywhere, which adds up to landscaping.

Fig. 18.29 Landscape standards for street furniture

reach his destination as shown in Fig. 18.33. Also, users can use smart screens placed at important points to find ways. Rule of three [33, 34] is followed as the general principle in reading or conveying address. The address has three components, the first part being the colour, name, or symbol of a sector, second being the street name, and third being the building number.

Fig. 18.30 Signage standard—sectors

18.14 Smart Environment

Umami values its environment as their major asset. The city has a scenic river, farm lands, and paddy fields. The city is planned to utilise these resources with care. Proposal for the utilisation of these resources is mentioned in previous sections. Smart environment standards propose standards for minimising problems caused by this utilisation. It deals production and efficient use of energy, management of waste, management of water supply, drainage and storm water drainage, etc.
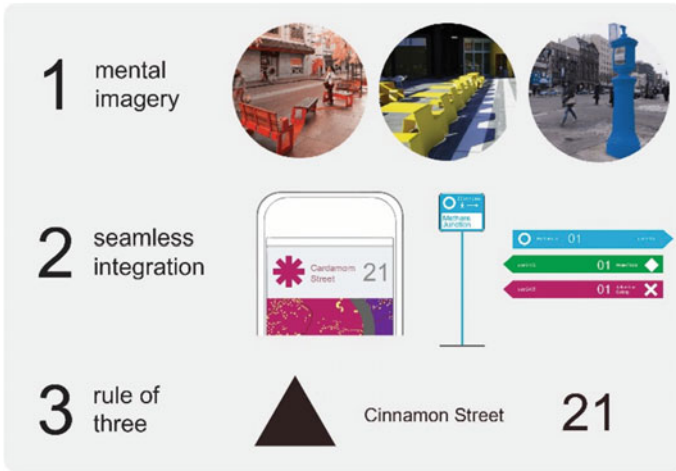
Fig. 18.31 Concepts in wayfinding

Fig. 18.32 Signage scheme overlook

Fig. 18.33 Seamless integration in wayfinding

18.14.1 Green Standard

Green standard comprehends a group of sub-standards dealing with different natural resources and specifies a suitable set for each geographical zone. This is required as the geography and land use proposal are not uniform throughout the city, and hence, the strategy to deal with resources and waste management is also different in different zones. Figure 18.34 shows the zones and their applicable bylaws. There are 8 model bylaws connected to the green standard. They deal with open green space, solar power utilisation, rainwater harvesting, on-site water treatment and reuse, waste segregation, and green buildings. Figure 18.35 presents these 8 bylaws and their justification.

IS-D : Industrial Developing
CB-D : Community Business Developing
MU-X : Mixed use Re-Developing
MXR-D : Mixed use Residential Developing
ER-E : Mixed use Residential Developing
HR-D : Mixed use Residential Developing
HR-X : Mixed use Residential Developing
HZ-E : Mixed use Residential Developing

Model byelaws 1, 3,4,5,6,8,9 and 10 should be considered while designing the indusrtrial, commercial residential and mix-use buildings.

Model byelaw 11 Local agricultural produce

Fig. 18.34 Application zones of green model bylaws

18.14.2 Waste Management

Having a food processing centre as the core, Umami is expected to produce a large volume of biodegradable waste. Since it aspires to be a zero waste city, the generated waste has to be processed within the city. Different options for this were considered. These options such as composting, waste-to-energy conversion through pyrolysis, gasification and incineration were considered. Landfilling was not considered as an option since it is not sustainable in a state like Kerala, where the population density throughout the state is very high. The city produces about 100 tonnes of waste every day, and about 70 % of it is biodegradable waste. Fifteen per cent is recyclable, and this can be collected and send to the recycling plants. There are many small-scale plastic recycling industries in and around Calicut, which can be augmented to take up this volume of waste. E-waste is not easy to process and requires specialised processes to separate heavy metals, etc., from the waste. Such plants can survive only with a critical volume of waste. Currently, Calicut sends its e-waste to Bangalore for processing. Umami can also follow this viable option. Seventy per cent biodegradable waste can be used within Umami for power generation as well as for agricultural processes. Households are encouraged to treat their own share of biodegradable waste with biogas plant or pipe composting. Community-level biogas plants are provided where high-density residential development is planned.

MODEL BYELAW 1: GREEN SPACE

All residential/ commercial/ institutional/ industrial plots above 500m2 should have 10% of site area as green open space. The space would have to be left green whole life time of building.

> provides habitat for landscape, foliage and vegetation.

> mitigattes urban heat island effect.

> provide human connection with outdoor and nature.

ZONAL MAP

Site area > 500m2

CB-D 07

HR-X 04

green open space (10 % of site area)

MODEL BYELAW 3: SOLAR WATER HEATING

For alll residential/ commercial/ institutional/industrial plots should install solar water heater which will provide 50% of domestic use.

> energy saving, peak load use reduction, environmental benefits and attractive payback period.

> prevents 1.5tonnes of CO2 emmission per year (ministry of renewable energy data).

MODEL BYELAW 4: RAIN WATER HARVESTING

All new buildings to provide rainwater harvesting system to capture atleast "one-day rainfall" runoff water.

> Reduces municipal water usage.

> improves ground water recharge.

MODEL BYELAW 5: ON SITE WASTE WATER TREATMENT AND RE-USE

For residential plots of more than 200m2 and for non residential plots of more than 2000m2, the following should be made:
> Use low flow water fixtures in minimizing water consumption.
> Have an On-site waste water recycling treatment system to handle 100% waste water, to the quality standards suitable for reuse, as prescribed on PCB.
> Use treated wastw water for at least 50% of total required for landscaping, flushing, and

> Conservation of water is ensured.

> Helps in avoiding water pollution.

> Reduces usage of potable water.

MODEL BYELAW 6: WASTE SEGGREGATION

All buildings to provide seperate coloured bins to collect dry wastes and wet wastes(organic) as applicable. Alocate dedicated soace for a centralised facility to divert the collected waste before transferring for recyclingdisposal. provide seperate bins for wastes like batteries, E-waste, Lamps, Medical waste etc. as applicable at centralised facility.

> Provides opportunity to reuse or recycle waste materials.

> Swachh Bharath Abhiyan.

> avoid waste bieng sent to landfill sites.

> avoid pollution.

MODEL BYELAW 8: GREEN BUILDINGS

New buildings of Residential/ Institutional/Commercial/Industrial with built-up area more than 2000sq.m shall be developed as green buildings.

> reduce environmental impacts.

Fig. 18.35 Model bylaws

Calculations show that, with all these measures, about 60 % of the biodegradable waste can be processed at the source itself, and the remaining along with certain other non-biodegradable wastes can be used in waste-to-energy plant. About 38 tonnes of waste will be available daily for conversion to energy. This volume is not sufficient for the successful functioning of waste-to-energy plant. Hence, the proposed plant can also serve the mother city and can generate power for the Smart City. The waste-to-energy plant is proposed in the north-east corner of the city to facilitate easy import of waste from the city without affecting remaining part of the city. The predominant wind flow in Kerala is from south-west to north-east. The location of waste-to-energy plant allows removal of smoke away from the Smart City.

18.14.3 Water, Storm Water, and Wastewater Management

As per the calculations using the standards recommended by National Building Code of India (NBC), Umami requires 18.2 Million litres of water per day. Umami has a perineal river on its border and abundant groundwater replenished by the river. However, being resource-cautious, Umami would like to utilise the storm water as a primary water resource. With the average rainfall of 3000 mm/year, rooftops of Umami can supply about 2.4 million litres of the total 18.2 million litres required per day. The run-off water naturally recharges the soil and provides water to the wells throughout the year. However, due to urban development, the net permeable surface will reduce and will create increased run-off. Various strategies are adopted to minimise run-off. Green standards specify a minimum 10 % of site area to be retained as green, permeable surface for allowing percolation of water. The stretches of road which run through the low-lying area can be constructed over underground storage tanks to retain run-off water to be used later in the year as shown in Fig. 18.36. These road stretches would anyway require strengthening because of the loose soil.

The water supply and storm water management will be done through an SCADA-based system, which monitors the yield of natural sources, and reserves of storm water collection, and matches it with the estimated requirements. The management system will also monitor the quality of water supplied at various locations and will make the necessary adjustments to the treatment process and pump systems.

Wastewater treatment is proposed at two stages. The industries need to treat their liquid waste to remove any dissolved chemicals and biological materials. Second-stage processing to purify this to potable quality is done by treatment plant located at the southern side adjacent to the coconut plantation and the river. The treated water may be used for the agricultural purpose in these plantations. Sensors

Fig. 18.36 Storm water detention tanks under selected stretches of road

monitoring the waste discharge will generate warnings when pollutants exceed the acceptable limit at various stages of wastewater treatment. The source of pollutants can be easily localised and rectified by this process. The local government may also charge industries a 'pollution charge' as per the discharged pollution in order to encourage them to treat the wastewater at the site itself.

18.14.4 Solar Power

The estimated power requirement of Umami is 12 MW per day. Being located close to the equator, the site receives sunlight during most seasons of the year, except June–August period. Assuming 70 % utilisation of rooftops of buildings in Umami for photovoltaic power generation, the city can generate 14 MW power. Combining it with 1 MW produced by the waste-to-energy plant and 0.72 MW power generated by biogas power plants at various localities, Umami can produce 15.72 MW per day and can be energy surplus. This will make electricity generation in Umami an important business. However, such a distributed system of power generation and connecting that to grid proposes certain technological challenges. These issues need to be monitored in real time by control systems.

18.15 Conclusion

E-Smart City design is the spatial design through electronic means such as the web and smartphones, under the six components of Smart City discussed in the first chapter. The spatial components of all these six components are the subject matter of e-Design which interacts with people to constantly and continuously finding newer spatial solutions. The resulting spatial form is the space in which Smart City components function in a complex manner.

Urban form and urban design of a city will be highly linked in the future with the advance of the third industrial revolution. Cities will be able to market their heritage and ethnicity through products which reflect this uniqueness. In such a scenario, the urban design becomes crucial as it gives the face to the city, and this face is the most important part of the city branding. Continuous participation of the stakeholders in the urban design process using e-Design website is proposed in this study. A systematic approach for the same is proposed in this chapter, which uses a modified version of Hybrid Form-Based Code (HFBC) for this purpose. The chapter discussed in detail about adapting HFBC for elements of the Smart City. It also discussed various smart technologies required for the design and functioning of smart cities urban form.

The proposed framework can be applied to the urban design of smart cities anywhere. However, care should be taken to develop authentic solutions and details for individual problems. Cities are highly complex systems. Though great effort is put in structuring the process, we still feel that anomalies are still existing and further research is required in evolving a universally fair system. Also, the smart technologies are just evolving, and gradually those technologies will change the way cities are designed and managed. Hence, a continuous research to incorporate such changes is required.

Credits

This chapter is based on an academic project conducted with 43 students of 8th semester B.Arch. They were divided into three groups, and each was given the task of developing smart cities at three different locations identified around Calicut. The cities were proposed to have a smart industry at the core. The proposed industries for these three smart cities were fisheries, electronics, and food processing. All three groups came up with unique proposals for all three smart cities. Food processing group was selected for this chapter. We thank students in all three groups since each of them contributed to developing our understanding of the topic.

Team Members of Umami Smart City with food processing industry

Akshid Rajendran, Aneesurahman C.A., Apurva Divakaran V., Arjun Sunil C. M., Jeena Joseph, Jeena Mary Sajimon, Neenu Ali, Nizam M. A., Ritu Sara Thomas, Sujoy Biswas, Swapnil Sangeet Shrivastav, Swapnil Soni, Riyas Mohamed T., Robin Thomas.

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Chapter 19
E-Urban Land Management as Business for Umami

Suzana Jacob and T.M. Vinod Kumar

Abstract An organised and efficient e-land management ensures full participation of citizen and various governmental agencies in the activity of urban land management and can play a large role in making a smart economy. Umami is a 'smart city' created within Kozhikode with a smart economy that markets the foods of Kozhikode. The spatial location of Umami mainly comprises of a food processing zone and allied living areas. The idea of e-land management is practiced and found successful in many cities worldwide, but such an idea is conceptualised for the first time in Kerala through this chapter. Little management beyond acquisitions and few not so successful land pooling and readjustment are seen in Kozhikode. Master planning approach and lack of transparency and hence inefficiency and corruption are the cause of failed land management in the city. The Kerala Town and Country Planning Act 2016 is a welcome gesture to the unused potential of land markets in Kozhikode. Recognising the strengths of urban land, it welcomes a variety of land management practices found successful in other states of India, yet to be applied in Kerala. It is realised through the successful and failed land management cases in the history of the state that public participation and transparency are two buzzwords for a success story. E-land management through a website opens up the land market for the participation of citizen and ensures transparency in the process. Opening up of the land market implies that a website provides information and opportunity to all citizens to financially benefit by opting land management of their holdings. This is illustrated in this chapter by an exploratory study of the smart city of Umami in Kozhikode. Firstly, a zonal plan is prepared for Umami considering the principles and needs of a smart city. E-land management is the method to achieve that zonal plan. The various land management tools permitted in Kerala are identified and studied. Depending on the tools, areas are identified for each tool. The opportunity for public participation is created through the website. Monetary benefit of taking

S. Jacob (✉)
NIUA-CIDCO Smart City Lab, National Institute of Urban Affairs, New Delhi, India
e-mail: sona.suzana@gmail.com

T.M. Vinod Kumar
Department of Architecture, National Institute of Technology, Kozhikode, India
e-mail: tmvinod@gmail.com

part in e-land management is informed to the public, hence giving them the freedom to decide, but also in a way moulding public decision to the interest of the zonal plan. This ensures that no decision is forced on the public, but what public decides for them happens in a way the zonal plan expects and hence direct towards a smart economy. The objective of this chapter is to showcase the e-land management website which makes land management market-driven and successful, hence a process in a 'smart economy'.

Keywords E-Urban land management (E-ULM) · Town planning scheme (TPS) · Land acquisition · Transfer of development right (TDR) · Compaction policy · Share economy business model

19.1 Introduction

Urban land management (ULM) practice in Kozhikode followed land acquisition approach based on Land Acquisition Act 1894 and detailed town planning (DTP) scheme based on Malabar Town Planning Act 1920. Both these acts were a legacy of colonial rule in India. These have rendered ULM in Kozhikode to be largely unsuccessful. These affected only a very small part of Kozhikode Municipal Corporation with not much of impact on the overall spatial development of Kozhikode city. ULM not only in Kozhikode but also all over Kerala had been a tightly held Government of Kerala activity, prepared within the four walls of town planning office or office of revenue administration, with no emphasis on generation of high-quality and well-serviced urban area.

ULM policies that seek to control the urban land market by government in socialist era, prior to liberalisation in 1991, are no longer suited to India which is growing at rates exceeding 8 % for sustained periods and in which over 70 % of GDP is generated in its cities [1]. Old ULM policies had made housing expensive and unattainable to a large share of the population, and reinforced both chronic urban infrastructure shortages city-wide and squalid, precarious living conditions in urban slums [2]. In recent time world over, ULM opened itself to new ideas based on common property management practised in different parts of the world for centuries that make it more efficient, socially acceptable, democratic and economically productive. In this scenario, it is necessary to make ULM in India, an easy and open-to-all activity as a part of e-governance, resulting in a subset of E-ULM. This chapter explores these possibilities within the context of Smart Economy in Smart Cities, where an income flow shall take place to all the participating stakeholders under E-ULM. In E-ULM, all activities related to ULM are made public through the use of interactive Internet, with transparency of information and timely completion of regulatory input from government with graded penalty for slow progress as well as corruption. Ample opportunities are available to all stakeholders to generate income flows in a smart economy. This chapter through an exploratory empirical study of the smart city of Umami discussed in the

previous chapters explores further how E-ULM can bring about efficiency, transparency, accountability and ease of urban land management by opening up land markets and also generate smart economy income flows.

19.1.1 ULM in Kerala

Compared to a total 1.2 billion plus population of India, more than 377 million in 2011 constituting 31.16 % of the total population [3] are urban. India has a total urban area of only 77.37 lakh hectare (2001) which constitutes 2.52 % percentage of total land area where new-generation ULM is to be practised. A liberal urban land policy is not visible in Kerala, India, because it was thought that scarce urban land resources of Kerala require protection from unsustainable use, fulfilling ecological and economic goals that ensure an efficient urban structure and infrastructure. But, it is now realised that direct control and enforcement of land management are not only expensive but also inefficient. ULM should be open to entrepreneurs. Urban population in our cities encompass a wide range of people whose aspiration for their city differs so largely that plans from a single entity be it even the city or state government, is unacceptable and instead needs an activity with input from every individual in the society, especially those who inhabit the area. Opening land market through land management are these activities that trigger smart economy in land market.

The state of Kerala has a computer literacy of at least one person in 49 % of families when the national average is 22 %. The computer literacy programme of Kerala soon will achieve 100 % computer literacy of one person in every household under the most successful Akshaya Project, and Government is determined to declare Kerala the first fully computer literate state and the first fully digitised state. Also, 97 % of villages have an Internet cafe, even as the national average is 17 % [4]. In this scenario, a website which manages all activities in relation to urban land, land use, land development, land titling and land transactions is no longer difficult to perceive in cities of Kerala, but yet does not exist. Such websites though not comprehensive but addressing few land management activities are found to be very successful in other Indian states. 'Bhoomi' project in Karnataka is a success story of e-land titling. 'CARD' (Computer-Aided Administration of Registration Department), is an e-government project started by the state government of Andhra Pradesh for land registrations. In the light of these success stories, it is obvious that land management needs to be a market and ICT-driven activity, for the people and by the people of Kozhikode with a website that brings in transparency and equality in opportunities and can be used for land governance. It serves and caters to all sections of the society and will act as a single window for all land-related activities. With globalisation and liberalisation in urban land, every individual anywhere in the world is given an opportunity to develop and make money out of the business of urban land development strictly within the regulatory framework of urban land policy of Kerala. The government will function only as supervisor to direct the course of land development and will not retard progress of people-driven ULM.

This chapter also puts forward how all the stakeholders will financially benefit by opting for land management of their holdings. It allows stakeholders to prepare projects which they can finance and share profitability within government regulation. In short, this chapter brings about how land management can bring about a smart economy by opening up of land market. By opening up land markets, the overall objectives of the government are made public and private actions from all stakeholders in urban land are invited towards meeting of these objectives. It generates the 'economics in land', the stakeholders make money, and the government get the objectives met. The interesting part here is that every individual is notified and becomes a stakeholder when these activities take place through a website around their home.

19.1.2   ULM in Umami

The potential of land monetisation as a resource in urban economic development is largely unknown and unutilised in Kerala. The creation of Umami on the lines of Kerala Town and Country Planning Act 2016, the urban compaction policy of Kerala, put forward by State Urbanisation Report 2003 Kerala [5] and assimilated into the Perspective Plan for Kerala 2030, [6] requires opening land market through an E-ULM for implementation. The citizens of Umami gets the right of additional built-up over their land due to the higher density design as per the urban compaction policy which is also a policy of Indian smart cities as per Smart City Mission. This is the basis of generation of additional wealth to stakeholders. Stakeholders are government (who collect betterment levies and land taxes), landowners, private developers, venture capitalist, GIS specialist (who map the property), land titling specialist assigning ownership of reconstituted land after ULM and finally a knowledgeable entrepreneur with social engineering and town planning expertise who coordinates all activities with a profit which is transparent. The additional built up available at the citizens' disposal need to be managed intelligently so that urban land management leads to a smart economy.

This chapter is organised into three sections. Following this introduction, the first section speaks about existing urban land management in Kozhikode and examines the weakness and threat in the present technique through two case studies. The second section deals with the E-ULM and the website for E-ULM for Umami. The third part moves from zonal plan-based E-ULM of Umami to one sample site, Dritisaka site development plan, and explores 'Business Development Plan of Dritisaka for Smart economy'. The first two parts are based on the academic work carried out by VIIIth-semester students of 2014–2015 of Bachelor of Architecture in National Institute of Technology, Calicut, in the course of urban land management (ULM). The class assignments, which included detailed area surveys, GIS mapping, preparation of existing and proposed zonal map of three zones including Umami, preparation of an urban land policy for three smart towns proposed in Kozhikode, identifying areas to implement various land management tools, namely

Transfer of Development Rights (TDR), town planning schemes and land acquisition, form the content for these sections. While Prof. T.M. Vinod Kumar gave the lectures, guided the studio and class projects and shared knowledge on all land management mechanisms and their application existing in India, Suzana Jacob (Lecturer) conducted lectures on some complementary aspects of land management, namely land titling, supply and demand markets, and real estate. Based on the assignments done by the students, a mock-up of the Web interface for E-ULM was prepared which may be allied with the website for the urban design of the city that already discussed in Chap. 18. Three groups worked on three smart cities, and the best work that is Umami zone was selected for inclusion in this publication. The third part is based on first-semester lecture course and project assignment on urban land management under Prof. T.M. Vinod Kumar undertaken by students of master's degree in planning in National Institute of Technology, Calicut, and based on academic projects undertaken under the project design and guidance of Prof. T. M. Vinod Kumar after a studio exercise on site planning using GIS. One best out of five business development plans for urban land management of postgraduate students based on GIS-based site planning was selected for this chapter. The assignments led to the business development plan for Dritisaka. Additionally, this chapter studies existing practice of urban land management in Kozhikode, its strengths, weaknesses and opportunities based on theory and field studies conducted by the authors. The theoretical study was based on the literature survey on ULM available for Kozhikode, the State Urbanisation Report 2003 of Kerala, Town and Country Planning Act 2016 of Kerala, Perspective Plan for Kerala 2030 and the 73rd and 74th constitutional amendment of Indian Constitution as adopted by Government of Kerala and other relevant documents. Field study included interviews with Mr. A. Jayan (Secretary, Calicut Development Authority) and Prof. M.G.S. Narayanan (Historian and activist, Kozhikode). Their hands-on experiences in ULM in Kozhikode are used to identify the weakness of existing land management practice and form the basis for the need of an E-ULM and business development plan in Umami. This chapter elaborates the interviews and the observations from them.

19.2 Urban Land Management Framework in Kozhikode

Soon after the economic liberalisation began in India in the 1990s [7], India enabled a legislation for local self-governance [8] enacting the 73rd and 74th constitutional amendments of 1992. Urban land, in Indian federal democracy, then became mainly a subject for the states. It gave execution and financial power and authority to the local bodies on urban land and municipal functions. Since then, urban local bodies (ULB's) in districts of Kerala have been independently taking decisions for urban development and land management. In the city of Kozhikode, this function earlier was that of the responsibility of Calicut Development Authority (CDA) and prior to that of Town and Country Planning Department of Kerala Government. However, Kozhikode Municipal Corporation (KMC) does not have a full-fledged Town

Planning Department who can do the ULM activities as a continuation of the predecessors and hence neglected.

The first legislation on town planning in India was the Bombay Town planning Act of 1919 during the pre-independence period, and the second was the Madras Town Planning Act of 1920. Both these were based on earlier acts in the UK—the British Town Planning Act. There is great significance of Madras Town Planning Act of 1920 in Kozhikode as the ULM in Kozhikode was guided by this act later entitled Malabar Town Planning Act 1920. The act provided basically for making the master plan and the detail town planning schemes (ULM) under the legislations.

Till date, there have been two approaches to manage urban development of Kerala. In the first approach, the public planning authorities and developmental agencies acquire land and then replan them in an appropriate manner. This is referred to as the 'land acquisition' method [9]. In the second approach, instead of acquiring land, it resorted to 'pool together land' of a group of adjacent owners and then plan the area by reshaping every land parcel in a manner that it is given a regular shape and proper access, and in the process, a portion of land parcel is appropriated to provide for roads, infrastructure and public amenities [10]. This is referred to as the 'land adjustment and pooling' method also known as town planning scheme [10–12]. In Kozhikode, the above two approaches exist, and sadly the city has witnessed little urban land management beyond very limited land acquisitions. Land acquisition is expensive, time-consuming and not the most desired method of urban land development. The second approach—town planning schemes—is very few in numbers and is also not performing well in Kozhikode.

The Malabar Town Planning Act 1920 guided master plans in Kozhikode [13]. Master plan as a tool for development of cities has often been criticised for being restrictive and ineffective in terms of process, content, implementation and monitoring programmes [14]. From time to time, court cases delay implementation of master plan provisions since court decisions require clear-cut representation which is present only in zonal plans and not in master plans, and such legally binding zonal plan at required scale does not exist in Kerala. It is in this scenario that a system of zonal plans is proposed as elaborated in the previous chapter. While master plan is revised once in 20 years, zonal plans can be revised once in 5 years making spatial plans more flexible and open to changes in circumstances such as newer policies and recent changes in ecological features. It is important that zonal plan for any area be prepared by people living in the respective localities with the general help of professional planners such that planner orchestrates five-year zonal plans with great amount of input by local people and based on geographic information system (GIS). Also, while master plan is prepared generally in 1:10,000 scales, zonal plan is prepared at 1:2000, site plan at 1:1000 to 1:500 and infrastructure plan at 1:200 to 1:100. Many of the important elements of zonal plan can never be represented in a map by master plan which creates problems for judiciary to resolve disputes. These details are most important for urban development; Kerala Master Plan practice does not give any importance to these details, and no zonal plan exists in Kerala in 1:2000 scale. A scale 1:1000 for zonal plan is acceptable since it shows more details bringing clarity of the work to the implementation

bodies, while smaller scales of master plan fail to give guidance often resulting in land use not intended in the master plan.

Urban land is a key bottleneck in the process of implementing economic development strategy in Kerala. If "smart city" is to be implemented in Kozhikode, we have to find ways and means to overcome this land issue, and this chapter focuses on that. Increasing urban economic development has increased the many alternative uses of land, such as for housing, industry, commerce, infrastructure and other economic activities, but the supply of serviced urban land has stood stagnant in Kerala. Kerala faces this trade-off even more acutely than the rest of India, given its settlement pattern and geographic features. Settlement pattern of Kerala is characterised by scattered settlement and comparatively higher state population density. When almost all other parts of India have nucleated built-up area in a settlement surrounded by rural hinder land, Kerala is characterised by dwellings made in individual plots, scattered all over the state including hills. This makes the population distribution more or less even over the entire state [5].

19.2.1 The Kerala Town and Country Planning Act 2016 [15]

The Kerala Town and Country Planning Act 2016 is a welcome gesture to manage urban land efficiently. Until this act, no unified legislation existed for the state. The legislations prior to this act were very old and obsolete. Town Planning Act 1108 ME (Travancore—Cochin area), Madras Town Planning Act 1920 (Malabar area) and Town and Country Planning Act 1120 ME (Travancore area), which are inherited from preunified Kerala, were the legislations in practice in the state. The act of 2016 takes a large leap ahead welcoming a more organised and efficient framework for urban land development. The act proposes a State Town and Country Planning Board, District Planning Committee, Metropolitan Planning Committee and also a Joint Planning Committee. Not only does the act lists the responsibilities to each of the committee, but also puts forward various land management tools for Kerala. The Kerala Town and Country Planning Act 2016 specifically deals with town planning scheme (TPS) and hence a major part of urban land management. It is this act that forms the basis for land management methods discussed in this chapter.

19.2.2 State Urbanisation Report 2012 (SUR)

The State Urbanisation Report, titled 'A study on the scattered human settlement pattern of Kerala and its development issues' released by Department of Town and Country Planning, studies the unique human settlement pattern of the state, its

capabilities and implications. Comparing with the other parts of India, Kerala is distinguished with comparatively low population density in urban areas and relatively high population density in rural areas [5]. Kerala has undergone highest level of urbanisation (47.71 %) during 2011, with an increase of 83.2 % over the previous decade [3]. Analysis shows that areal reclassification of adjacent rural area as urban by census norms and shift in the occupational structure towards non-agricultural economic activities is the reason for this level of urbanisation. Thus, the present urbanisation of Kerala is an urban spread rather than the result of the major structural changes in the economy of the state historically triggered by industrialisation [5]. The report envisages a compact urban form and visualises urban areas as instrument for the development of rural hinterland, besides being engines of development. A strategy of developing urban clusters in 2021 and urban corridors in 2031 is recommended in the report to refine the urban profile as a part of a regulated spatial structure defined through spatio-economic plans. Through these spatio-economic plans, a compact urban structure is to be developed. This idea is applied in Kozhikode through Umami.

19.2.3 The Kerala Perspective Plan 2030 (KPP)

The Kerala Perspective Plan 2030 is a comprehensive multisectoral plan, but as far as spatial planning is concerned, it is extrapolated from SUR 2012 and advocates urban compaction. It says that 'the aim of town planning in Kerala should be to achieve compact urban form' [6]. Growth of urban agglomerations in Kerala shows emergence of urban corridors. Some urban agglomerations (UAs) get merged to evolve urban corridor. For example, Census 2011 shows Vatakara UA has merged with Kozhikode UA with a total urban population of above 2 million. Considering the unique feature of a rural–urban continuum in Kerala, a strategy for urban development that will not focus on urban development alone rather aligning itself on a holistic rural–urban approach of developing a 'Kerala State Spatial Strategy' within the framework of the Perspective Plan 2030 report is envisaged. In such a set-up, Metropolitan Planning Committees are to be formed in Kerala at least in and around minimum 7 million plus urban agglomeration (UA) in the states supported by able and proactive politico-administrative structure. The State Spatial Strategy will safeguard areas of state interest and provide guidelines aimed at maximising the efficiency of human settlement system and other productive efforts and enhancing rural urban complementarities. Four elements are mentioned in this strategy [6].

1. Identify across the state education and health hubs, state industrial and manufacturing zones, eco-industrial parks, tourism zones, agricultural and allied activity zones (agri-zones, dairy zones and forests), food processing centres and cold chains, traditional industry zones and villages, and special economic zones.

2. Develop these zones into compact integrated townships and compact human settlements [6].
3. Link them with trade and transport corridors.
4. Initiate a programme for upgrading infrastructure and services within the existing urban centres and existing intercity networks to improve the quality of both rural and urban areas.

Number 2—'Develop these zones into compact integrated townships and compact human settlements' [6]—is what is exactly attempted in Umami, and E-ULM for the same on the lines of the Kerala Town and Country Planning Act 2016 is carried out in a website. A Web-based ULM upholds transparency and accountability. Also, it gives equality of opportunity to everyone. It is designed to support the policy of participatory planning in Umami advocated in Indian Constitution.

Before understanding E-ULM Umami, it is necessary to know the need for an E-ULM and its benefits over traditional urban land management. The authors have carried out a case study research method for establishing the weaknesses and threats of existing land management practices and recommend replacing in future by E-ULM. As mentioned earlier, there have been mainly two approaches of urban land development in Kozhikode: land acquisitions and town planning schemes. One case study of land acquisition and town planning scheme is taken up and studied.

19.3 Case Studies of Urban Land Management in Kozhikode

19.3.1 Land Acquisition

19.3.1.1 Land Acquisition Acts in India

The land acquisition process in India has been highly arbitrary. It was based on Land Acquisition Act 1894, formulated by British which gave more importance to colonial rulers than the landowners. The act had inadequate provisions for scientific valuation of land and no provision for rehabilitation of those affected by such acquisitions. The Land Acquisition, Rehabilitation and Resettlement Act 2013 (LARR) was intended to correct these unjust practices. There are also a plethora of acts for different institutions such as industrial development authority, defence ministry and urban development authority to acquire land, and an attempt is made in new act to unify all acquisition under one law. Finality of this act is an unfinished business by Indian parliament. However, in trying to correct the past injustices to landowners, the act went to the opposite extreme. Implementation proved to be complex with usual and most 'notorious red tape of Indian make' and expensive and very time-consuming with consequent reduction in rate of successful completion of land acquisition for public purpose. This is unacceptable for smart cities.

In this scenario, an ordinance was passed in 2014 with a further amendment bill in 2015. The ordinance and amendment exempt several type of development projects from mandatory social impact assessment and also from getting approval from 80 % displaced people which the 2013 act mandates. The long jam in parliament on this modification made Union Government to decide that states decide in their legislation what they want, and hence, it is an unfinished agenda of Union Government.

19.3.1.2 Land Acquisition in Kozhikode

Land acquisitions comprise the major part of land management in Kozhikode, and a case of land acquisition for widening of a major road in Kozhikode is studied.

19.3.1.3 Mananchira–Vellimadukunnu Land Acquisition

The proposal for road widening of one of the most important roads of Kozhikode—NH (national highway) 212—first appeared in master plan of Kozhikode 1981. The road identified for widening is an 8.4 km stretch from Mananchira to Vellimadukunnu (Fig. 19.1).

'Mananchira'—a square pond at the heart of the city—is one of the most important landmarks of Kozhikode. Vellimadukunnu is the eastern gateway, connecting Kozhikode with economically important places such as Wayanad hills famous for spice cultivation and tourism in Kerala, and Mysore and Bangalore which are two growth poles in Karnataka. In ancient times, connectivity of Wayanad with Kozhikode had triggered international spice trades and international contacts with Kozhikode. This national highway widening project was identified for the implementation under Kozhikode City Road Improvement Project in 2007 after 26 years of the proposal. Then, the road stood at first priority among the roads identified for improvement in Kerala, but as time passed, it dropped to second, then sixth and at the end, out of the list as per the political and administrative whims and fancies. At this stage, the residential association with the Malaparamba (a stretch along the road close to Vellimadukunnu) and Vellimadukunnu road involved and joined after patiently waiting for the government to act for last 26 years to sort out the most important issue of traffic bottleneck in Kozhikode. They felt that priority of roads to be developed was highly irrational and motivated by other dubious considerations of favouritism and corruption.

The NH 212 still is only a two-lane road. In spite of all these facts given above, the widening of the road is still considered low priority by Government of Kerala and district administration. Today, every vehicle is forced to spend at least 10–20 min at the signal stopping three to four times at traffic signal to cross the bypass to enter the city at Malaparamba and further experience slow moving traffic causing delay and pollution all around. There is no similar road intersection in Kerala. The areas through which the narrow road passes are residential areas, seats of city
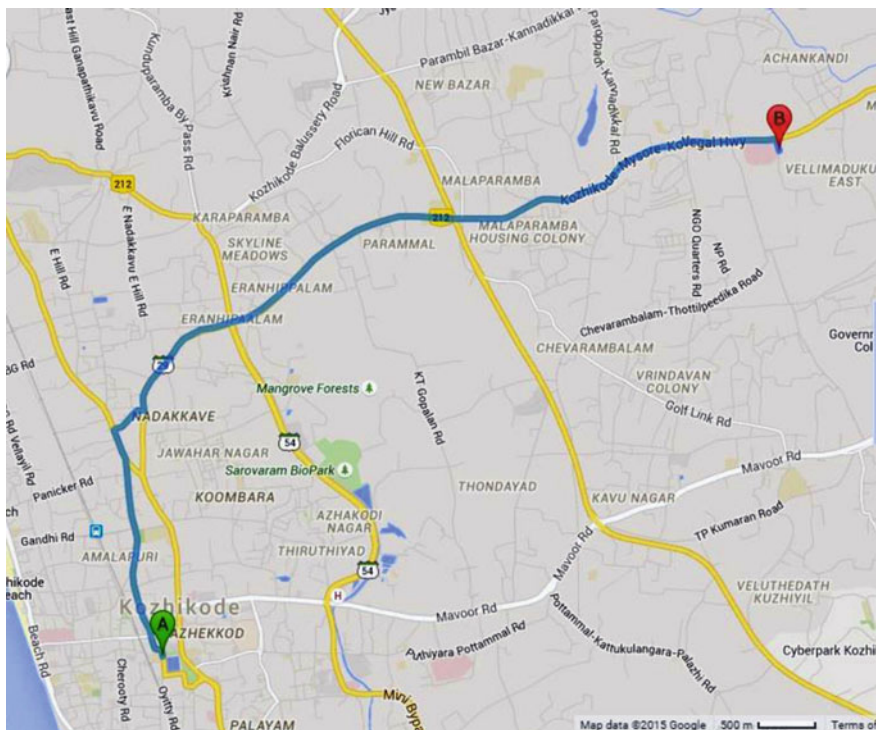
Fig. 19.1   The road from Mananchira to Vellimadukunnu

administration, schools and colleges and also connect to institution of national importance such as Indian Institute of Management, Kozhikode, and National Institute of Technology, Calicut, Spices Research Institute, Centre for Water Resources and Development Management, Government Law College, important private hospitals and many others. The Health of the inhabitants and road users all along the 8.4 km is at stake for last 3 decades. The voice of the residents association to the tardiness in the implementation of the project triggered the city administration and soon detailed survey and identification of land to be acquired was done and Detailed Project Report (DPR) prepared, but the project stood stand still at this stage. Today, even after 31 years, the acquisition has not begun. This case study is an attempt to understand how land acquisitions fail in the Kozhikode and rest of Kerala. To better understand the position, timeline of activity is tabulated below.

19.3.1.4 Timeline of Project

Year	Event
1981	The widening of Mananchira–Vellimadukunnu road was initially proposed in the statutory second Kozhikode Master Plan prepared by the Calicut Development Authority in the year 1981
2003	The first official announcement on the development of Mananchira–Vellimadukunnu road was notified in the 2003–2004 budget speech by K. Sankaranarayanan and allocated ₹20 cr in the budget for the widening and maintenance after 23 years
2006	Just before the assembly election, PWD conducted the survey and they marked the land for widening the road after 26 years
2008	State Govt. took decision to widen the road, and announcement of ₹52 cr was sanctioned in the 2008–2009 budgets by the Finance Minister Dr. Thomas Issac. A Govt. order GO (RT) 1523/2008/PWD for land acquisition was also passed on 8th August 2008 after 28 years
2009	Vision Malaparamba Action Committee was formed under famous historian Dr. M.G. S. Narayanan, working President Mathew Kattikkana and general secretary M. P. Vasudevan. It is a group of all resident association with the area, cultural groups, all political parties, social workers etc.
2011	Notification as per section 4(1), Land Acquisition Act 1894 was issued on 28th November 2011 after 31 years
2013	Draft declaration as per section 6, Land Acquisition Act 1894 was issued on 20th April 2013 and 13th May 2013 after 33 years
2013	Public Work Minister Ibrahim Kunju guaranteed that the land acquisition will complete within 1 year and widening work will complete within 2 years, and he instructed the collector to act
2013	Collector prepared the basic value report for land acquisition and instructed tehasildar/local authority to start the land acquisition process
2014	Just before Lok Sabha elections, chief minister informed that notification for granting ₹100 Crore (cr) for land acquisition was issued after 34 years
2014	Dr. M.G.S. Narayanan led collectorate march on 5th July 2014. Because of this strike, a meeting was called by chief minister. In that meeting, they decided to first acquire the 2.82 acre government land. It was decided that the land should be acquired before August 31st under the guidance of collector after 34 years
2015	Dr. M.G.S. Narayanan piloted another collectorate march and hunger strike on 11th February 2015 against government delays. Because of that, cabinet decided to grant ₹25 cr for the acquisition of land. The land cost was calculated by the District Purchase Committee at Rs. 12–21 lakh per cent and was approved by the State empowered society. 560 property owners had participated in the DLPC meetings for fixing the value of the land, but only 385 persons had agreed to part with the land for rates fixed after 35 years
2015	First instalment of ₹25 cr was received by the district collector on 31st March 2015 and called for a meeting to decide the starting point of the land acquisition using the granted ₹25 cr which was later used for the demolition of shops in the Malaparamba region after 35 years
2015	The draft declaration for land acquisition expired as per judicial provision
2015	Landowners filed a writ petition in High Court (HC) to end the development work of the road since the draft declaration expired saying that available width is sufficient. HC

(continued)

Year	Event
	rejected the petition. The public work ministry included the Mananchira–Vellimadukunnu road widening in the district flagship infrastructure programmes which is a megaproject of ₹3311 cr for developing roads in the state
2015	In the tender distribution programme of other 6 roads PWD minister announced 412 cr for this road. 40 shopkeepers handed over the key to district authority and demolition works had been started at Malaparamba junction. The notification under section 4(1) of the Land Acquisition Act also expired after 35 years

19.3.1.5   Fund Allocation

The road widening was proposed in the master plan (1981) and the official announcement was made in the 2003–2004 budget speech by K. Sankaranarayanan by allocating ₹20 cr, but the fund was not released thereafter. Again in 2008–2009 budget speech, Dr. Thomas Issac announced ₹52 cr for the land acquisition and this fund was also not released either. In 2014, just before the Lok Sabha elections, Chief Minister Oomman Chandy announced ₹100 cr for the land acquisition, but again the fund was not released and the Vision Malaparamba Action Committee conducted strikes demanding to release the promised ₹100 cr, but in vain.

A. Pradeep Kumar, M.L.A. of Kozhikode north, questioned about the delay regarding the release of fund in the assembly, and CM answered with a technical reason that no joint account is formed in between finance department and works department due to which the files are pending with the finance department. In February 2015, the cabinet granted ₹25 cr and the amount were released on 31st March 2015. Chief secretary Jiji Thomson announced ₹25 cr as a second instalment but not released yet. The principle hindrance to the project is that most of the buildings along the entire stretch are rented to various traders. The buildings are very old, and the announcement of road widening project in the master plan had halted any development, or for that matter, even repair and no changes or modifications are permitted to the existing buildings as per the land-use regulations since last 35 years. The locality is in a pitiable condition and an eye sore of the city. Therefore, landowners have rented/leased at a very meagre rent. The tenants, who are mostly small traders, are not willing to relocate as their livelihood is dependent on their linkage with the locality. Even when the owner sees monetary as well as developmental benefit in surrendering the land, the tenants are not willing to leave, and the project is stalled under political pressure. In addition to the small traders, several large businessmen who are tenants are also against the acquisition process, since they have made considerable investment and the acquisition does not offer compensation or rehabilitation to the tenants. Even though the majority of landowners and residents of the locality stands for acquisition and land acquisitions act permits compulsory acquisition for the unwilling, here it is not happening

because of the vested interest of the politicians and government administrators. The influence of the traders and the businessmen on the politicians and bureaucrats was identified the reason for the stagnant stage of the project, defeating its natural priority for the city. While local residents are keen on the project, government administration and politicians are not.

The conflict of opinion among landowners and traders would not have been a difficult task to address if the government had made deliberate attempts or at the least if government and bureaucracy did not become a hindrance to the process. The District Collector of Kozhikode—Ms. Latha went to heights of distorting the minutes of meetings with the chief minister (CM) to help interested parties who opposed road widening; as reported in newspapers. It was later found that she is a corrupt person and seriously involved in criminal police cases. Latha was later transferred due to media and public pressure, but disappointingly with a promotion which establishes the fact that corruption is accepted in Kerala Government and corrupt officials are often rewarded for acting against public interest. This incident confirmed that there exists an unholy alliance between politicians and government officers, and aim of E-ULM is to break the backbone of such alliance through transparency. Though the next collector started off well, as the threats by the revenue divisional officer (RDO) led staff of the collector to offer no support for the acquisition, the project was shelved again. If the government will was strong, it would not have been a difficult task in managing a corrupt bureaucracy, but incidents such as the chief minister's (CM) hollow assuring words while CM's cabinet was opposing the project makes it clear how the public was taken for a ride by the government. It is most surprising that even threats to the activists who are in favour of the project and incidents of missing files of Detailed Project Report (DPR) could not evoke the government response unless media built the pressure. Rather, the government took steps to transfer administrative officials who were pro-project. It requires mentioning here that the anti-project administration kept their hold to the large stretch of land belonging to government departments rather than surrendering it and serving an example for the private landowners to follow.

Now, after all these, presently the project is listed under the flagship programme 2015. CM has allowed 100 cr in supplementary budget in February 2015 and rest in March 2015. An estimate of 450 cr is kept for land acquisition alone. It is the unending efforts by the action committee and good media coverage that has brought the project to this level. All credit of obtaining this goes to the people of Kozhikode and news media and not administrators and elected politicians.

In Prof. M.G.S. Narayanans' own words 'A very important lesson I have learned by being part of the action committee is that, not only this project, but implementation of any development project will happen only through constant public pressure'. Public pressure was built in this project using print and television media. It is the lack of transparency in our present systems that are being an advantage to the corrupt. Further, administrative services in Kerala suffers from high administrative expenses due to overstaffing with low outcome of the overstaffed administrators and even when opportunity to punish erring district collector came up, no punishment was given which, if done, would have been an opportunity to

marginally reduce such expenses in favour of outcome and teach the corrupt. They utilise the opaqueness in traditional land management to their advantage, and the public never get to know where the delay is or who the one failing in their duty is. Hence, the most important character we need to add into our land management practice is transparency and high involvement of all stakeholders and probably reduce the role of government as mere regulator and not obstructionist. E-ULM is all about transparency for public involvement, and if it is combined with transparency of governance in a time-bound action, with heavy penalty for delayed regulatory action as per legislation to bureaucrats, then it will eliminate corruption from Kerala.

This is one of the many thousands of examples in the state of Kerala where joint venture of interested party, politicians and administrators try to defeat the urgent needs, aspirations and wishes of people and priority of the town as articulated by government-sanctioned statutory master plan of Kozhikode. A recent example is the sanctioning of light metro in Kozhikode which is ably reported in print and visual TV media of Kerala; but vested interest group seems to show they are thick skinned. This leads us to believe that urban land management shall be made more transparent using ICT and made a people's movement than it can be manipulated by vested interest of politician–administrator joint venture with prime motive of rent-seeking. A website for all land-related activities makes ULM an open activity. It ensures that the step-by-step progress and interests of all stakeholders at every stage are made public on the website. This exposes the defaulters with computer-generated time stamp and serves justice to the public, hence taking away corruption and malpractice in land management. Stringent punishment for delayed responses by regulator administrators will make the system useful for smart cities. Like polluter pay for pollution, government administrator with regulatory power who delays the projects that results in escalation of cost shall be fined for financial loss incurred and corruption shall also result in confiscation of property of corrupt officials with loss accounted for and not transfer with promotion as happened in this case study. A fine of few thousand rupees per day of delay to all officers concerned can help in land management a great deal. This will make the overstaffed administration to work harder and be afraid of corruption. Then, Malaparamba road will not be delayed from 1981 to 2015 but yet remain not executed. These require amendment of constitutions and passing of legislations which will have great support from voters.

19.3.2   Detailed Town Planning Scheme

19.3.2.1   DTP Scheme in India

Detailed town planning scheme (DTP) of Kerala is a term referring to land pooling and reconstitution (LPR). Strong landowner opposition to forcible land acquisition, politico-administrative inaction, corruption and inefficiency combined with

extremely limited fiscal capacity made the urban local bodies (ULBs) to introduce newer mechanisms for land development.

Used extensively internationally, LPR can trace its roots to Holland and Germany in the 1890s. It quickly spread across the globe including Europe (e.g. Sweden, Finland, France and Belgium), Asia (e.g. Japan, South Korea, Thailand, Indonesia, India and Nepal), the Middle East (e.g. Israel, Lebanon and Palestine) and Australia [16]. In India, the Bombay Town Planning Act of 1915 allowed [16] the use of LPR in the form of town planning schemes (TPSs) in the erstwhile Bombay Presidency. TPS was widely and successfully used in Maharashtra and Gujarat in the first half of the twentieth century [6]. However, its use declined when the Maharashtra Regional and Town Planning Act 1966 shifted the focus for the implementation of the city master plan from TPS to detailed development plans (DPs) [16]. The mechanism is proved in these states as an effective alternative to land acquisition under the Land Acquisition Act (LAA) 1894 as it is more equitable and self-financing and enables planned urban expansion. The success of TPS in other states pushed Kerala to try a hand at TPS. TPS in Kerala bears small differences from TPS in Maharashtra and Gujarat. The first and the most successful case of TPS is the plot reconstitution in Trissur.

19.3.2.2 DTP Schemes in Kozhikode

Several TP schemes are attempted in Kozhikode. Among some 30–40 schemes, all of them were not successful and became just paper documents. Out of the active 14 TPS in Kozhikode, TPS for sector 9 in ward no. 5 is stated to be the most successful by Mr. A. Jayan, Secretary, Calicut Development Authority. The Scheme is elaborated below.

Detailed town planning (DTP) scheme No. 8 and 9 for Sector 9 and 10 of Ward 5 of Kozhikode are taken as case studies to explain the response to DTP in Kozhikode and study its characteristics. This DTP scheme area is located in the eastern part of Kozhikode city. This ward is predominantly residential with commercial use along the major roads. The scheme was prepared by the Department of Town Planning and published by Calicut Development Authority in the year 1987. The DTP scheme falls within the jurisdiction of Calicut Municipal Corporation. The Mavoor Road stretched from Arayidathu Bridge marks the boundary to the south. The state highway 29 is in the north. The western boundary is NH 17, and the state highway 54 marks the eastern limits. Large areas are vacant and include mostly wet and water-logged area. A total area of the DTP scheme is 115 ha, and it has 653 land parcels.

The case study is interesting because in this single DTP scheme, land acquisition, land pooling by development authorities, land pooling by landowners, etc., are done for road widening, providing public utilities, industry as well as commercial development. A good mix of variety of land management tools with considerable public participation is witnessed in this DTP scheme (Table 19.1).

Table 19.1 The proposed land-use analysis of DTP Scheme Ward 5 Kozhikode

Name of use	Area (ha)	Percentage (%)
1. Residential	82.28	71.47
2. Commercial	7.77	6.72
3. Industry	2.18	1.90
4. Public and semi-public	5.28	4.59
5. Parks and open spaces	1.88	1.64
6. Transport and communication	9.93	8.63
7. Agricultural resources	5.40	4.69
8. Hazardous use	0.41	0.36
Total	115.13	100.00

Source Town Planning Scheme Report Ward 5, Calicut Development Authority 1987

A comparison between the map of the proposed land use and Google map with a site visit gives the following observations (Fig. 19.2).

Comparing the DTP scheme with the present land use in the ward reveals that the plan has been implemented to a great extent. Out of 21 cases identified for new roads and widening of existing roads, 17 are fully implemented and the rest 4 have seen partial implementation. Also, cases of 14 reservations were made under the
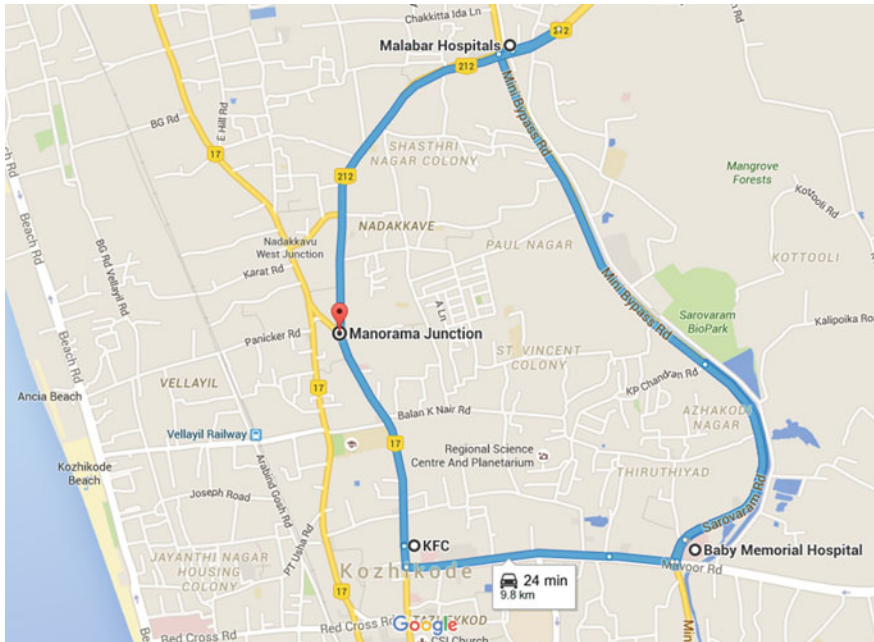
Fig. 19.2 Ward 5, Calicut Development Authority

scheme for various purposes such as commercial, public and semi-public use, industrial use and agricultural reservation. All 14 reservations are now developed for the same land use as proposed. In western part of the ward, when the land acquisition for road widening consumed so much time, the landowners themselves pooled their land and chalked out the widened road as per the DTP scheme prepared. The scheme was successful in reclamation of large pacts of water-logged land, which is now one of the highly priced residential lands in the city.

Though not like the TPS of Gujarat, where at every step public consultation is done and the final plan is truly a people's plan for their land, this particular government department drafted DTP scheme in Calicut was able to satisfy the landowners while also keeping the city's perspective for land development upfront. Presently, the land-use analysis of Ward 5 may seem unsustainable with over 70 % land residential and very little land for commercial, public and semi-public uses and open spaces. It has to be understood that at the period when this scheme was sanctioned, i.e. in 1987, the approach towards urban planning was a purely master planning approach with no zonal plan revisions once in every five years to achieve desirable urban compaction and solve emerging ecological issues through people's participation.

A take way from this case study is that DTP schemes were successful to a limited extend in upholding the aspiration of the citizens for their land while also not wavering for the city developer's perspective for the city.

19.3.3 Conclusions from Case Studies

It is estimated that 43 % of all stalled projects in India face land acquisition problems. In Kozhikode also, as compared to land acquisition proposed for the widening, the DTP scheme saw success for its interaction with the public, but it was not a people's DTP and quality of development is below planning standards. Andhra Pradesh C.M. Chandrababu Naidu has identified land pooling and reconstitution for development of Amaravati the state capital—the largest greenfield development ever in the country. In this technique, the landowners get back a percentage of their pooled land as ultra-expensive land, thereby offering profit to the landowner. It is a similar approach in Kozhikode that made public more a part of planning that contributed to success in DTP scheme in the city. Care was taken to minimise the land loss to the public. Consultation with the public was done before final approval of the DTP scheme. Expenses incurred to the development authority were minimal, since most of the task was taken up by the public themselves. Such a mechanism is absent in land acquisition. It makes land acquisition expensive and difficult to implement, and high corruption is a possibility. A land acquisition is a clear top-down method, while a DTP scheme does have the dynamics of bottom-up method. Both are necessary for a judicial planning of any smart city if refined out of experiences. The significance of land management and effective dissemination of land management tools in Umami is discussed further in the following sections.

19.4 Umami

19.4.1 Study Area

Umami is one of three brownfield smart city zones NIT-C urban design students took up as class project. It is a part of Kozhikode in Olavanna Panchayat within Kozhikode Planning area. The proposed smart city is of 540 ha covering 23 % of the 23.43 km^2 panchayat. In 2015, the projected population in the whole panchayat is 87,482 based on Census 2011 and as per the present growth rate. Considering the demographic profile in the panchayat, an average household size of 4.5 is adopted. The present population, in study area, is only 20,163, i.e. a population density of 38 person/ha. The benchmark density proposed by Smart City Mission of India is 175 persons/ha. Hence, the density in the study area is much lower than desired by Smart City Mission benchmark in India. The existing land-use map of Umami presented in Chap. 18 (Fig. 18.8) shows how unsustainable the land-use distribution is.

Close to 70 % of land is used for residential purpose and only a meagre 0.15 % for industrial and 0.9 % for commercial purpose. As elaborated in the previous chapters, Umami is developed as a zone of food processing in Kozhikode city. A food processing-centred smart city needs more land reservation for industry, and Umami offers potential by its vast coconut plantations and other agricultural cultivable land which can accommodate food processing industry without unsustainable interventions to the land. Large lengths of land along the water body in the study area which can be developed as blue-green corridor also can accommodate allied urban agriculture for food processing.

The Smart City Mission of India, which is a project of Government of India to develop 100 smart cities in India, has come up with a self-assessment form as a part of criteria for the selection of first 20 cities eligible for funding in the first year of the mission [17]. The self-assessment is done on the basis of the following 24 parameters: citizen participation, identity and culture, economy and employment, education, health, mixed use, compact, public open spaces, housing and inclusiveness, transport, walkable, IT connectivity, intelligent government services, energy supply, energy source, water supply, water management, wastewater management, air quality, energy efficiency, underground electric wiring, sanitation, waste management, and safety and security. With the understanding that these are parameters for a city whole and Umami happens to be a small study area as compared to a city whole, still if we take a look at the present status of each of these parameters in Umami, it is observed that Umami performs well in most of the parameters. This qualifies Umami as a location with potential to be a smart city.

Among the areas in which Umami falls backward, economy and employment turn out to be an important one. In an area set-up such as Umami, where local markets are prevalent, smart economy does not mean FDI or large-scale industries. As elaborated in the previous chapters, smart economy in Umami is one which augments the local resources, generates local employment for local traditional skill

and takes the city to international standards. The strength of Umami in terms of a food processing industry is already discussed in the previous chapters. For any urban activity, the first resource is land. Hence, land management in Umami becomes necessary to take the city forward in the direction of development.

19.4.2   Zonal Plan

As seen in the previous chapters, Umami is proposed with a density of 150–200 persons/ha for smart city infrastructure investment efficiency, which incidentally follows Smart City Mission guidelines along with state urbanisation report recommendations. This will accommodate more people who will be employed in food processing activities and other related urban functions in Umami such as food tourism, logistics and related industries. Not only the local inhabitant but also their relatives need to be invited to live in Umami to enhance the local cultural skill pool required to showcase internationally Malabar food, spices and Ayurveda health tourism. This density calls for a total number of 18,000 households in the study area. Considering present household density, a total of 13,519 more houses must be introduced in Umami for achieving a density of 150 persons/ha and 19,519 houses to achieve 200 persons/ha. Also, there is a need for larger areas for industry, commerce and open spaces. Hence, the residential land use of 68 % at present will have to be brought down for a land-use pattern desirable for a smart city. The following section elaborates on the rationale for the proposed zonal plan for Umami.

A smart city zone Umami requires the following:

(i)   Residential: a requirement of construction of 13,519 dwelling units (density of 150 persons/ha) in the study area at first sight may signify need for more land for residential purpose. The present density of 78 person/ha is unacceptable in a smart city as it signifies sprawl and inefficient utilisation of land. Hence, with a goal to reduce residential use of land to approximately half, i.e. near to 35 %, which falls in the range of permitted residential land uses in smart cities, the densities are checked and found to be within the acceptable range of near to 175 person/ha after the introduction of 13,519 dwelling units for the additional population. Currently, the dwelling units are low-rise plotted development which consumes a lot of land/person in the form of roads, backyards and front yards, land utilised for individual utilities such as septic tanks and individual wells. It is therefore concluded that the dwelling units will have to go vertical through introduction of medium rise and high density living. These types of group housing will not only accommodate the influx population but also permit efficient sharing of infrastructure.

(ii) Public and Semi-public spaces: the study area has little or no public and semi-public spaces. The absence of these makes the study area a type of

satellite residential settlement to the people working in other parts of Kozhikode. Such a pattern increases the need of travel and puts load on the transportation modes and roads. It is therefore required that the land use for public and semi-public spaces be increased.

(iii) Recreation, water and agriculture: a smart city is a place of international standards which give opportunities not only to live and work, but also to play as well. Therefore, recreation spaces must be increased proportionally to the growth in density. Attending to this goal of increasing recreation spaces with a consideration of the natural features in the study area, it is arrived at a decision to utilise the land adjacent to the water bodies, which is predominantly coconut plantations and other urban agricultural land to develop them into blue-green corridors. Blue-green corridors are corridors along water body which not only provide areas of recreation, but will also aid to preservation of water body from pollution and provide ecosystems for birds and animals, thus a move towards urban sustainability as well. The corridors will also allow carrying forward urban agriculture and animal grazing in a way closer to nature.

(iv) Commerce and Industry: the aim of Umami is a smart economy. Industry and commerce are the wheels for economic progress in an urban set-up. Umami is a food processing zone, which functions towards processing of the ethnic food of Kozhikode and marketing it across the globe through smart city–smart mobility. This will be the major industry in Umami, with allied industries for packaging, logistics, etc. It can be seen that all these are land-intensive industries. Obviously, commercial and industrial spaces must be increased extensively in the study area.

(v) Mixed uses/multifunctional use: in order to minimise travel, improve accessibility and achieve a compact development, it is necessary to have considerable amount of land devoted to multifunctional or mixed uses. Mixed use is an integration of two or more uses such as residential and commercial, commercial and institutional, and residential and recreation. Intermixing of commercial, recreation, institutional, etc., to residential reduces travel time and distance of residence. Such an urban fabric leads to compact form.

(vi) Transport and communication: the sprawl of dwelling units results in more roads to access them and promotes private modes of transportation. The percentage of roads in a smart city needs to be checked by substituting with cycle tracks and pleasant walk ways.

The large amount of land-use transformation as well as the addition of housing units requires that a well-organised land management process be designed for the smart city. Urbanisation policy of Kerala 2012 [5] has clearly identified that cities of Kerala stand a chance of long-term survival only through urban compaction. Urban compaction calls for higher density of living. Also, the smart city of Umami requires a larger benefit sharing mechanism to make the urban development in Umami economically viable. Kerala Town Planning Ordinance 2015 permits land

management practices, such as land pooling and readjustment and transfer of development rights for the first time, and allows for policy-making in the matter of urban land management. A zonal plan will be the guide to E-ULM in Umami (Fig. 19.3).

Land-use reservations for the proposed zonal plan are given in Table 19.2.

There will be introduction of additional dwelling units as many as 13,500 while reducing the residential land use from 367 to 119 ha. For that, it is required conservation-cum-demolishing strategy of dwelling units to bring down residential land use to 119 ha. While demolishing, care needs to be taken to demolish only obsolete unserviceable houses and houses that are in land identified for no development such as blue-green corridor and ecologically sensitive area. Also, houses in land identified for land-intensive developments such as stadium, high density living and public transportation routes may also be demolished. These demolished houses add to the number of additional housing required. For reconstruction purpose, based

PROPOSED LAND USE MAP

13% MULTI - FUNCTIONAL	03% COMMERCIAL	4.8% AGRICULTURAL WETLANDS	IS-D : Industrial Developing
12% RESIDENCE - LOW DENSITY	07% PUBLIC / SEMI-PUBLIC	0.9% SPECIAL ENERGY ZONE	CB-D : Community Business Developing
12% RESIDENCE - MEDIUM DENSITY	17% RECREATION	06% HYBRID TRANSIT HUB	MU-X : Mixed use Re-Developing
12% RESIDENCE - HIGH DENSITY	3.7% PARKS/ GARDENS	12% RAIN - WATER HARVESTING	MXR-D : Mixed use Residential Developing
12% SPECIAL FOOD PROCESSING ZONE	5.5% COCONUT PLANTATION	12% WATER BODY	ER-E : Mixed use Residential Developing
			HR-D : Mixed use Residential Developing
			HR-X : Mixed use Residential Developing
			HZ-E : Mixed use Residential Developing

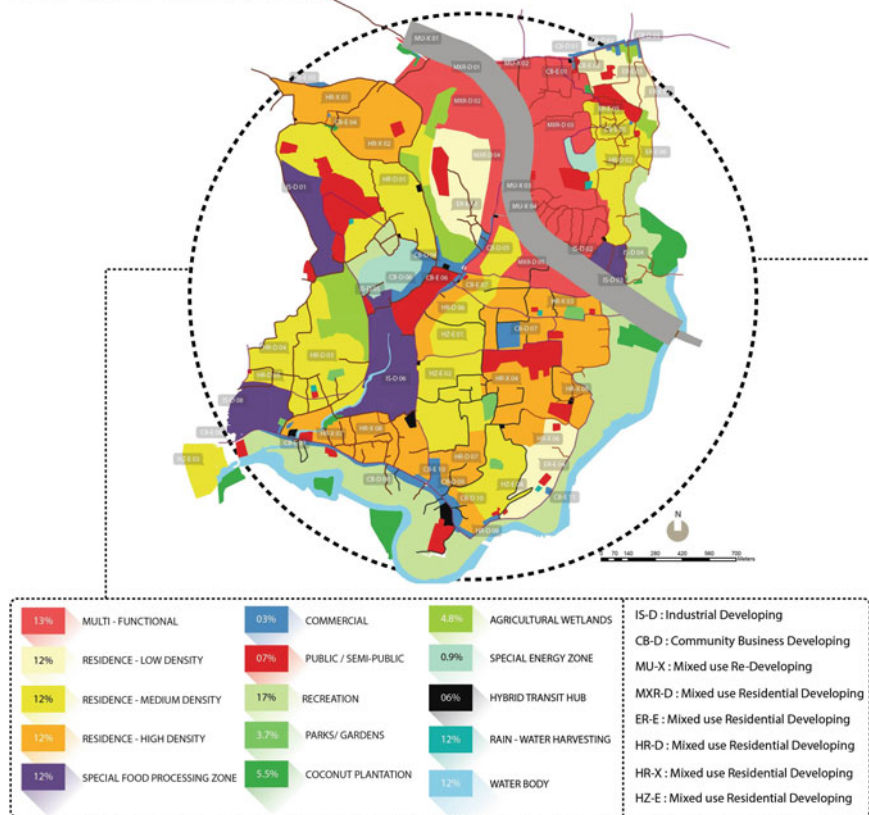**Fig. 19.3** Proposed zonal plan for Umami

Table 19.2 Land-use Umami zonal plan proposed

S. no.	Land use	Area (ha)	Percentage (%)
1	Residential high density	118.8	22
2	Residential medium density	43.2	8
3	Residential low density	43.2	8
4	Commercial	5.4	1
5	Industrial	64.8	12
6	Public and semi-public	32.4	6
7	Recreational	37.8	7
8	Transportation and communication	81	15
9	Agriculture and water bodies	27	5
10	Multifunctional	86.4	16
Total		540	100

Source 'Umami the Food Tourism Capital of Gods Own Country' (Brownfield Smart City development in Panthirankavu, Calicut), National Institute of Technology—Calicut 2014 (unpublished Urban Design Studio Report)

on the residential density fixed by the zonal plan, areas are categorised as low density, medium density and high density residential. Looking at the existing typologies of housing in Umami, high densities are almost non-existent. Therefore, new areas need to be identified for high density development. Medium densities will be achieved by building adjacent to and top of existing housing which are structurally strong. Lightweight and quick construction techniques using prefabricated gypsum boards, lightweight concrete, etc., will have to be carried out for structural stability. It has to be noted that areas for each—high, medium and low density—are regulated on basis of zonal plan which redistributes the permitted FAR of 4 throughout Umami in a way to achieve variations in urban form and space.

Housing is only one aspect of development. As the proposed zonal map suggests, large areas need to be developed for industrial purpose. Also, there is a need of land for recreation, which is non-existent in the study area. Multifunctional use, commercial use and agriculture and water bodies also add to the list.

As we can see, a large area requires be reconstituting and redeveloping. Since it is a brownfield development, it is important that how the land is reconstituted to different uses as there in no addition or reduction to the 540 ha.

19.5 Website E-ULM for Umami

The website for E-ULM shall be a part of the website for smart city of Umami discussed in the previous chapter. The website offers a mechanism for interaction and full participation of citizens and all stakeholders in land management in
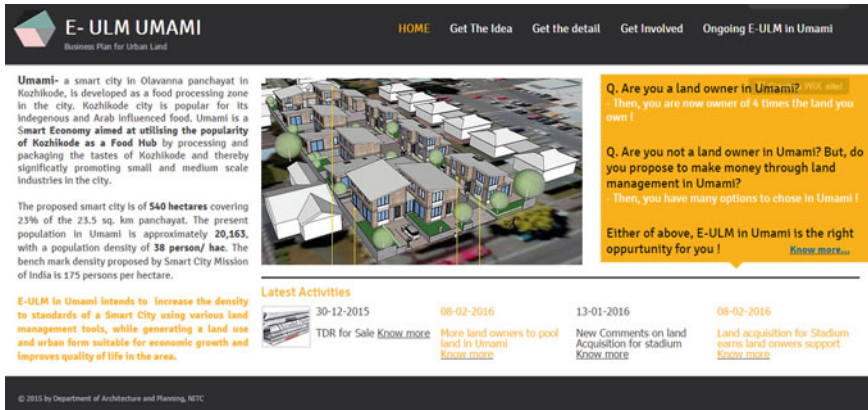
Fig. 19.4 Home page—E-ULM Umami: business plan for urban land

Umami. The online platform makes land management transparent to all concerned, ensure timely execution of government regulation and hence more responsible. It is designed to support the policy of participatory planning in Umami in which 74th constitutional amendment emphasises.

The E-ULM Web is implemented with a simple structure. The home page gives an option to know more about E-ULM without a login in the website. E-ULM or even land management for that matter, in Umami, is a new arena to citizens. Hence, it is required of the website to have tutorial in land management as well. The website is designed in a linear structure such that any citizen attempting to take part in E-ULM will not miss any step in the process. Also, any citizen unaware of the compaction policy in Kerala or the town planning ordinance can also gain an understanding and gain the maximum benefits arriving with densification with the expanse of information shared on the website.

The E-ULM Web on its home page gives a brief about the place under consideration and broad information on the possibility of E-ULM in Umami. The website is primarily categorised into four steps in four internal links termed—Get the Idea, Get the Detail, Get Involved and Ongoing E-ULM in Umami. Regular users can quickly navigate to the required section through the buttons on the home page, while the home page introduce and guide the whole process to the first-time visitor (Fig. 19.4).

The path followed by a first-time visitor to the website is traced as indicated in Fig. 19.5.

The four major pages accessed from the buttons on the home page as well as guided from home page are illustrated below.
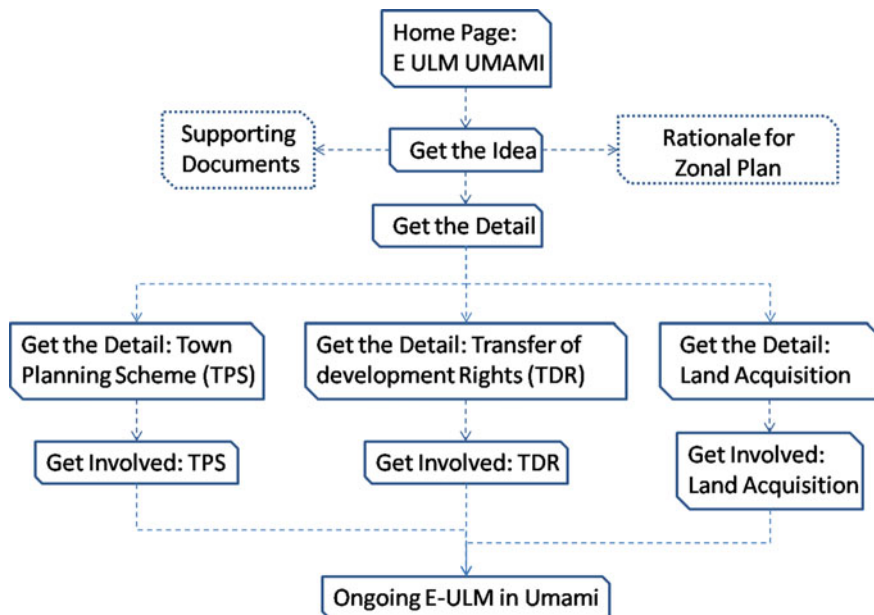
Fig. 19.5 Path followed by user

19.5.1   Get the Idea

There are several stages and methods of citizen engagement. The aim of this page is to 'Inform' citizens. This page gives detailed information on E-ULM and its scope in Umami. The background for the activity is set by stating relevant parts of State Urbanisation Report, Kerala Perspective Plan and Kerala Town and Country Planning Ordinance. The full documents of the same are also linked at suitable locations. Proposed zonal plan of Umami with the rationale for the land-use distribution is provided in the page to inform visitors the vision for the area (Fig. 19.6).

19.5.2   Get the Detail

The kind of transformation that occurs to land is not easily perceivable by citizens. Land acquisition, land pooling and transfer of development rights are the three prongs of land management in Umami.

This page further gives three links—town planning schemes, transfer of development right and land acquisition see Fig. 19.7.

Fig. 19.6 E-ULM Umami—Get the Idea

Fig. 19.7 Land management tools in Umami

19.5.2.1   Town Planning Schemes

As shown in the Fig. 19.8, various zones are found best suited for town planning schemes (TPS). The rationale for selecting these areas for TPS is elaborated in the section ahead. TPS is a land management tool which requires the landowners to come together to contribute land to avail shared benefits. With the increase in FAR in Umami, the existing G and G+1 structure will want to expand to avail the benefits. This opportunity is restricted in some land parcels, for many reasons, mainly as under:

(i)   In the case of interior plots, this opportunity is limited as the road width may not permit multiple floors.

(ii) In the case of smaller sized plots (2–5 cents), restrictions are imposed on building height.

The opportunity arriving with the increase in FAR can be gauged by these owners only by pooling their lands to widen access or increasing the land parcel size by removing boundary walls and connecting buildings through infill construction.

There is another category of land where TPS is deemed useful. In areas where there is no provision of open spaces, in congested living, lack of parking space etc., the owners can pool land to clear some land parcels and rehabilitate demolished buildings in situ, as close as possible to previous site, over existing buildings where FAR is lower level.

In TPS, each landowner contributes a part of their land parcel and avails proportional benefits in terms of infrastructure and utility, while the loss of land is immediate in TPS, and the benefits are not monetary and not immediate most of the time. Hence, the landowner will always need a good enough reason to contribute their land. Mostly, TPS is suitable for provision of infrastructure, such as playgrounds, parks, water tanks, and parking space, which is an assured benefit to reach all contributing landowners. The first-mentioned case, where land pooling is required to improve access and to increase plot size, is also a suitable scenario for TPS.

The page has a guiding button for first-time visitors to involve in E-ULM in Umami through TPS, which first leads to authentication through sign-in/sign-up and then to the actual process of involvement. The button is also provided from the home page which can be accessed by frequent users (Fig. 19.8).
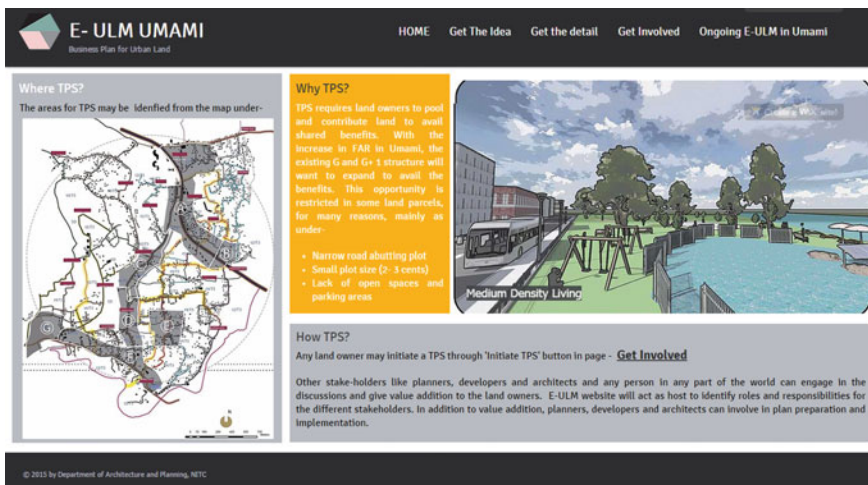
Fig. 19.8 Town planning scheme in Umami

19.5.2.2 Transfer of Development Right (TDR)

TDR is a tool introduced in Kerala for the first time through the Town and Country Planning Ordinance 2015. Umami has various land uses as indicated in the zonal plan. It is without argument that a higher FAR throughout the area applied as 3- to 4-storied buildings alone is not a desirable urban form. TDR is a tool to regulate FAR further, while not taking away the opportunity of the citizens. Certain areas for various reasons require maintaining G and G+1 structure. The remaining FAR of these parcels may be assigned as TDR, which may be used by the landowner in another zone permitting a larger FAR or sold. This tool grants opportunities to all landowners to fully augment the increase in FAR while complying with the zonal plan regulations. It resolves conflicts and quickens the development process. Two zones are required in depicting TDR—sending areas and receiving areas. Sending areas are those which need to maintain lower FAR or lower building height for various reasons. Receiving areas allow increase in FSI. Figure 19.9 shows the zones identified for applying TDR, the rationale for which is elaborated in the section under.

Sending areas are mostly areas that need to be maintained low to medium density. Interior areas with poor access, uphill area and ecologically sensitive area which are already occupied with low density are few examples. These areas either need to be decongested or maintained at lower density for inherent reasons. Receiving areas on the other hand are areas which can accommodate larger populations, viz. unoccupied land assigned for high density in zonal map and lands close to transit routes. These are selected to avail a benefit sharing of the best lands.
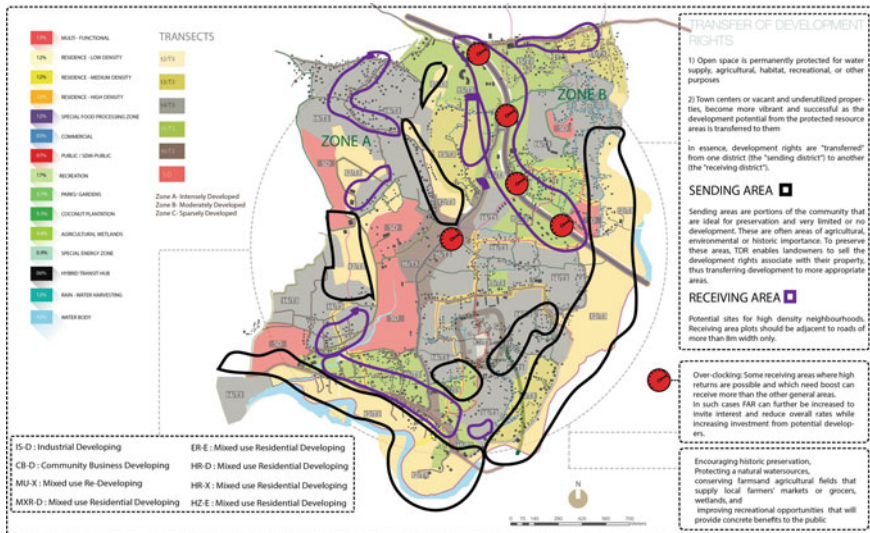
Fig. 19.9 TDR zones In Umami

Figure 19.10 shows the snapshot of the web page for details of TDR in Umami with an illustrative image of application of TDR, resulting in high-density development to preserve an ecologically sensitive area. TDRs may be put to sale and purchased globally. Areas permitting overclocking are assigned as TDR receiving areas.

The description is followed by a guiding button for first-time visitors to involve in E-ULM in Umami through TDR, which first leads to authentication through sign-in/sign-up and then to the actual process of involvement. The button is also provided from the home page which can be accessed by frequent users.

19.5.2.3 Land Acquisition

Land acquisition is the last option for land management in Umami. Certain private lands needs to be acquired for a greater public good. Land acquisition in Kozhikode is already discussed in previous sections. The website gives the zonal map layered with the zones earmarked for acquisition. Certain land-intensive developments such as sports stadium, ecologically sensitive zones, and land for food processing units of Umami require large parcels of land undistributed. Land compensations values, benefits of surrendering land for acquisition, etc., are shared along with the zones in the website.

Figure 19.11 shows the transformation of an area with land acquisition. The illustration is followed by a guiding button for first-time visitors to involve in E-ULM in Umami through land surrender for acquisition, which first leads to authentication through sign-in/sign-up and then to the actual process of involvement. The button is also provided from the home page which can be accessed by frequent users.
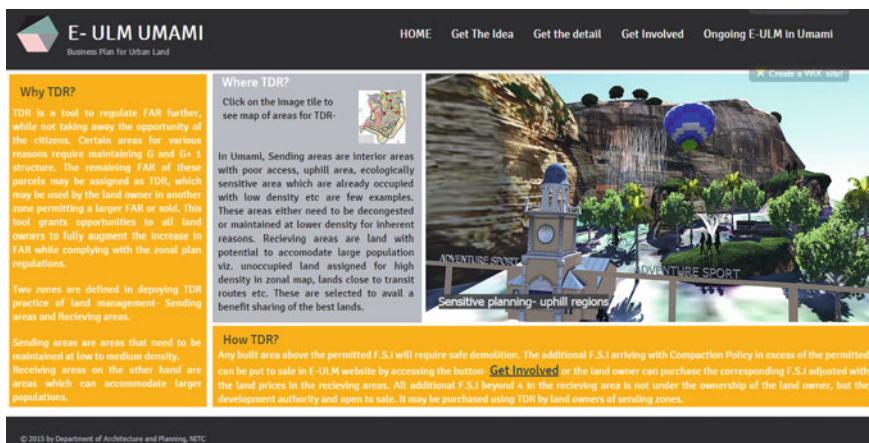

Fig. 19.10 TDR in Umami

19.5.3   Get Involved

This is third major button from the home page as well as guided from 'Get the Detail' under each sub-button. This page is the last step in the linear process of operation of the website, where the citizens and landowners can take part in the E-ULM process based on the information shared in the previous steps. To get involved in E-ULM, the site visitor is required to login with details. Once logged in, the visitor is offered three options—town planning schemes, transfer of development rights and land acquisition.

19.5.3.1   Town Planning Scheme (TPS)

TPS is a tool available for use by landowners alone, as it requires the willingness to pool land for common utilities which will consume a part of land. The zonal plan of Umami overlaid with the TPS zone provides information to the landowners if their land is eligible for reconstitution under TPS. A landowner may initiate a TPS or even take part in an ongoing TPS thorough the website. In either of the case, the submission form to take part in TPS requires the landowner to enter the details of the land parcel which includes ward no., survey no., area of land and dimensions. Verification is done based on the map, and the application is accepted or rejected based on the eligibility for TPS automatically. If accepted, the landowner can post the willingness online which will be treading on the website. More landowners may engage, and the landowners can interact through the website and arrive at plans. The plan can be submitted to the development authority online through the same page. Further processing of the plan, compliance with Development Control Regulations (DCRs) and zonal plan is further verified by the development authority. No objection certificates (NOCs) and commencement certificates (CCs) may be
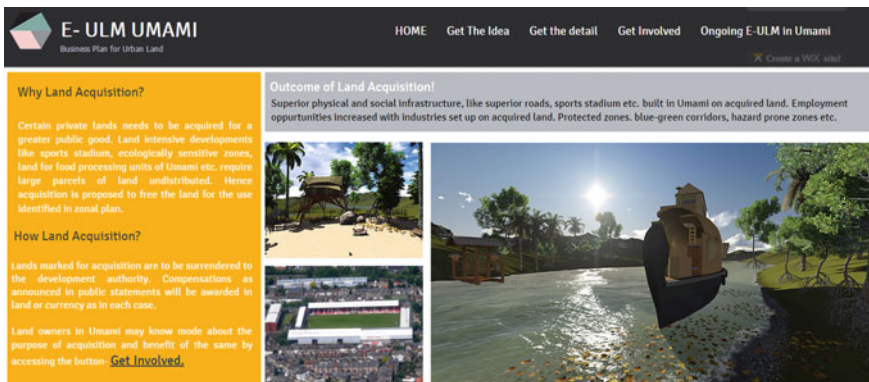
Fig. 19.11 Land acquisition in Umami
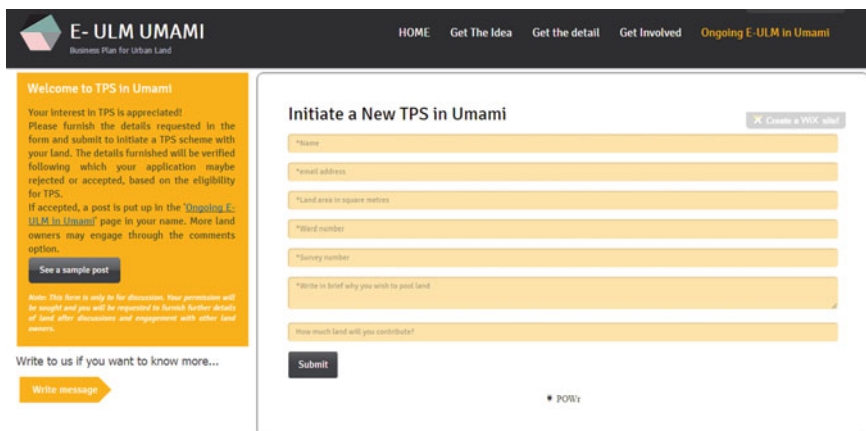
Fig. 19.12   Online form to engage in TPS in Umami

issued following this. The online form to engage in TPS in Umami is shown in Fig. 19.12.

19.5.3.2   Transfer of Development Right (TDR)

TDR as a land management tool in Umami may be used globally. TDRs can be purchased by anyone with a login in the Umami E-ULM website. As in the case of TPS, the zonal plan overlaid with TDR sending and receiving zones regulate the eligibility for TDR of any land parcel. Various options are available with TDR in Umami through the website. A landowner in TDR sending zone may put request for the excess built-up area as per the fixated FSI, in any of the receiving zone plots. The land prices are compared and equalised by the development authority, and a notice with built-up area with corresponding changes is reverted back to the landowner. The landowner can then chose to continue or to try any other plot. Landowners also have an option to put the excess built-up for sale in form of TDR. The website gives options for any site visitor with valid login and may put a request for purchase of TDR that is available for sale. The landowner may revert back, and transactions can be carried out with the development authority as an intermediary. Figure below illustrates online form to buy or sell TDR in Umami (Fig. 19.13).

19.5.3.3   Land Acquisition

Land acquisition is more like an information portal which allows the landowners to know the full benefits of land acquisition in their plots. It also helps to maintain a public forum where the landowners can engage with each other, compare compensation details and track the progress of the project. Significant issues of
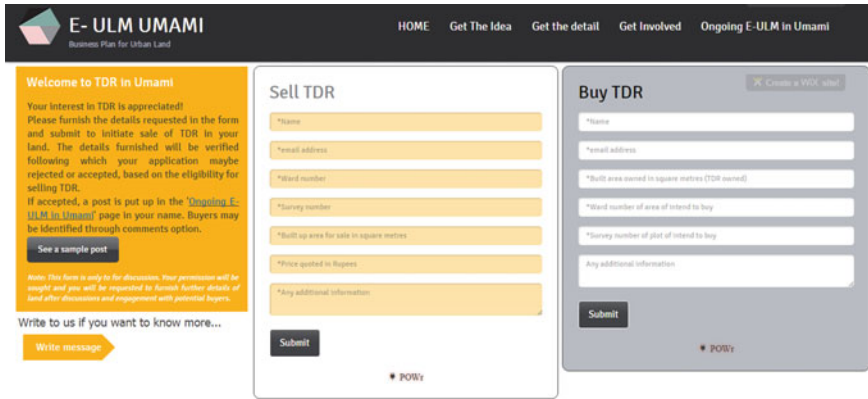
Fig. 19.13 Online form to buy or sell TDR

rehabilitation can be raised up at this forum and can serve as a one stop for all land acquisitions in Umami.

19.5.4   Ongoing E-ULM in Umami

Ongoing E-ULM is the culmination of the online activity of E-ULM in the website. Landowners and other stakeholders in Umami, after login, can engage in discussions and arrive at decisions in this online platform. Irrespective of the location of the stakeholder, everyone can contribute towards E-ULM in Umami through this interface. The conversations can go on as along as the stakeholders wish to. The website will be monitored by the development authority, and all queries will be addressed by responsible bodies. Figure below shows the interface. Each of the entries in the page is posted by the Web manager based on the submissions through the forms of TPS, TDR and other queries (Fig. 19.14).

Engagement of citizens in an ongoing land management in Umami is shown in the figure. Citizens and stakeholders can engage in the discussion under the overall monitoring of the development authority. Willingness for the development may be posted in the website, based on which the development authority will reach out for further verifications and action (Fig. 19.15).

19.5.5   The Way Ahead for E-ULM

The Web-based activity presently culminates in an engaging platform where irrespective of location, all individuals and businesses can engage to arrive at land management decisions in Umami. The website further needs to develop as also a

Fig. 19.14 Ongoing E-ULM in Umami

Fig. 19.15 An ongoing TPS in Umami

platform for transactions and issue of building permissions and monitored by the development authority. Observing the market trends, the website should enable timely updating and changes in zonal plan. E-ULM which becomes an open-to-all activity with the website is further enhanced as a transparent and market-driven activity with these developments. The mock-up website may be accessed by the readers at www.nikhilpawar2205.wix.com/umami.

19.6 Sharing Economy Business Model for Smart City Site Development

As an alternative to existing urban land management models given in the earlier part of the chapter, 'sharing economy business model' is also explored for urban land management of Umami. Sharing economy model, also known as share economy or collaborative consumption, refers to peer-to-peer-based sharing of access to goods and services (coordinated through community-based online services such as E-ULM) [34]. Sharing economy can take a variety of forms, including using information technology to provide individuals, corporations, non-profits and governments with information that enables the optimisation of resources [35] through the redistribution, sharing and reuse of excess capacity in goods and services [36]. A common premise is that when information about goods is shared in an online marketplace, the value of those goods may increase for the business, for individuals, for the community and for society in general [37]. The sharing economy can be defined as the economic model in which demand and supply are immediately in contact through an online platform as discussed in the Calicut study, in order for the supply side to directly provide developed site and built-up space with an underlying aim to improve the use of assets and to reduce the transaction costs. Sharing economy models attempt at better exploitation of assets. These assets are accounted for and protected in a transparent way such as venture capitalist fund and debt servicing, and landowners present value of land, entrepreneurs and developer contractor's fee, and profit. This can results in the reduction of the costs inherent to all economic transactions. This is commonly realised with the help of innovative web-based online platforms where transparency prevails which increases mutual trust. In this model, the sharing component is more a matter of access rather than of owning the goods. Essential features of sharing business model are as follows:

1. Individuals offering their own assets such as land by landowners and capital by venture capitalist, entrepreneur his expertise and domain specialists their expertise.
2. Sharing economy model is structured around a well-identified community, very often a clearly localised community, and a community entrepreneur—in this case, the Dritisaka site and all stakeholders.

3. A Web platform is used to connect all actors of site development such as E-ULM.
4. The improved use of assets is another crucial aspect of sharing economy model which transform the site to smart city site.
5. Trust is another common element to consider, and the sharing economy and smart cities often require a higher level of trust in respect of their traditional counterparts. Transparency in all business transaction in a website may ensure twin objectives of trust as well as social mobilisation by entrepreneur.
6. Last, but not least, and strictly related to trust, the data such as property-related data and household details' protection and its security are other delicate elements that affect both smart cities and the sharing economy. In both cases, data are used to offer targeted services to citizens/consumers and are at the core of the model itself.

19.6.1 Benefits of a Sharing Economy

By sharing assets, the benefits of a sharing economy are said to include the following:

1. Stronger communities [39].
2. Saving costs by borrowing.
3. Providing people with access to goods who cannot afford buying them
4. Increased independence, flexibility and self-reliance by decentralisation, the abolition of certain entry-barriers and self-organisation.
5. Increased participatory democracy.
6. Allows people to take idle capital and turn them into revenue sources.

The sections ahead will show how this model works.

19.6.2 The Site

Umami is a brownfield smart city of 5 km^2 site designed for Kozhikode, Kerala, India. Dritisaka is a residential zone in Umami zonal plan designated as HR-X, High Density Residential—Redeveloping Zone with a river front. The first exercise in sharing economy is comprehensive site design of the zone into a site plan at a scale 1:500, and then development of a business plan for venture capitalist, implemented by a person with expertise in urban land management, social engineering and project execution skill using venture capital funds called entrepreneur.

19.6.3 The Dritisaka Site Development

Umami is a smart city with smart environment, smart mobility and smart governance for smart living discussed in Chap. 18. The Smart City Mission of Government of India has specified benchmark [38] for smart cities which is used for the design of Dritisaka site development plan. What is not provided in the Smart City Benchmark statement is derived from Ministry of Urban development URDPFI guideline [39]. The project involves no major demolitions and no land acquisition, but involves the integrated development of smart city infrastructure, services, common amenities, dwelling units, commercial, industrial and recreational areas of smart city standards by land pooling and reconstitution achieving urban compaction required by the Umami zonal plan. Site plan of Dritisaka is evolved from site analysis to design, analysis based on detailed household and site features surveys, using GIS tools and remotely sensed maps.

Dritisaka is 8 km south from Kozhikode city, 3 km off the bypass road, and is near to major city landmarks such as the Hilite Mall, Apollo Cradle Hospital and Metro International Cardiac Centre. It is well connected to the city through public transport.

19.6.4 Goals

Social Goals

- The project would take utmost care not to dislocate any existing tenants or landlords from site by land acquisition and charter him in the path of prosperity in a smart city.
- The project is designed on the basis of the locals residing in the area and thrives on their tradition and culture and will tap its international economic potential.
- It allows for the passing of the property in the form of land/buildings to the next generation by existing owners after reconstitution.
- The project allows immigration of outsiders to this area as tenants or owners because of urban compaction, higher density and more number of dwelling houses in a desirable mix decided by stakeholders for envisaged and emerging economic opportunities within Umami.

Economic Goals

- The project aims at getting into the next level of economic development, the smart economy using the business model of sharing economy, moving from the conventional economy.

Financial Goals

- All the stakeholders including the entrepreneur, venture capitalists, developers, contractors, and existing and the prospective landowners shall be assured of return in the most transparent and just manner agreed by all emphasising the historical name of Calicut the city of truth.

Urban Development Goals

- The project aims at converting the site into a smart city site accomplishing the smart city benchmarks adopted by the Government of India along with following the URDPFI guidelines (revised).

19.6.5 DRITISAKA Site Plan

The site plan for the project was made by considering all the goals, strengths, weakness, opportunities and threats on the basis of various analyses carried out. The land use proposed for the 'Dritisaka' project is shown in Figs. 19.16, 19.17 and 19.18.

19.6.6 Project Phasing

The project will be completed in five phases over a period of 24 months. The project is phased such that the time lag is minimal. Also, the time for various marketing activities, such as prelaunch, launch and regular sales, was found out to make the impact of outflow the least (Fig. 19.19).
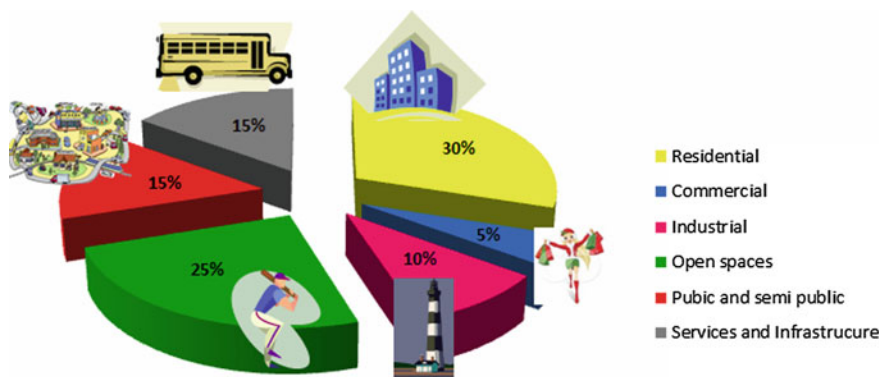
Fig. 19.16 Proposed land-use percentages for Dritisaka

Fig. 19.17 Site development plan Dritisaka

19.6.7 Cash Flow

The cash flow for the project was prepared taking into account the investment of various stakeholders. The total number of saleable dwelling units was calculated. All commercial and industrial spaces are also saleable. Out of the total 493 dwelling units built, 304 units are saleable (Table 19.3). This is calculated by deducting the number existing households and the number of units given to the participating landowners as compensation.

From the cash flow (Table 19.4), the project was found to be profitable if

1. 235 out of the 304 saleable units are sold.
2. 6100 sq ft out of 8800 sq ft commercial space is sold.
3. 12,700 sq ft out of 18,400 sq ft industrial space is sold.

The investment from the venture capitalist gradually decreases with the inflow from sales. The time when the inflow from sales has exceeded the outflow was found to be 13 months. The venture capitalist starts getting the return from the 13th month onwards. The interest rate is calculated for the capital invested for the first 13 months.

Fig. 19.18 Site development plan Dritisaka 2
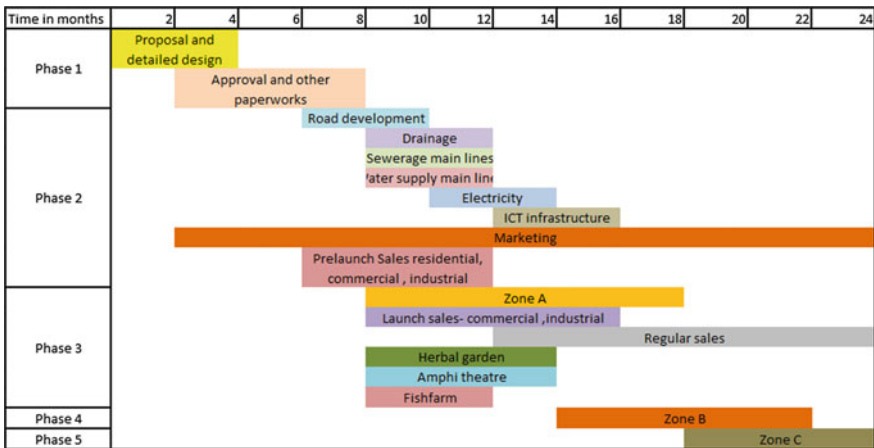
Fig. 19.19 Phasing of development of Dritisaka

Table 19.3 Saleable dwelling units

Sno.	Built up area(sq.ft)	Required no. of units	Exisiting no. of units	Units to be given as compensation	Saleable units	Total Inflow from sales
1	300	99	12	63	24	₹ 1,29,60,000
2	400	148	37	2	109	₹ 7,84,80,000
3	600	197	50	0	147	₹ 26,37,18,000
4	800	49	25	0	24	₹ 6,14,40,000
				TOTAL	304	₹ 41,65,98,000

Table 19.4 Cash flow

Phase	Months	Inflow	Outflow	Cumulative cash flow
I	1st to 4th	₹ -	₹ 2,00,000	
II	4th to 8th	₹ -	₹ 230,26,350	₹ -232,26,350
III	8th to 10th	₹ 552,00,000	₹ 361,77,250	₹ -42,03,600
IV	10th to 14th	₹ 1319,90,000	₹ 674,80,750	₹ 603,05,650
V	14th to 25th	₹ 1208,75,000	₹ 974,24,000	₹ 837,56,650
Total		₹ 3080,65,000	₹ 2243,08,350	

19.6.8 Market Analysis

In the Umami zonal plan, Dritisaka is zoned for mixed use development, to tap high increase in employment opportunities and the consequent demand for more dwelling units. At present, major high rise residential buildings, along with shopping malls and offices, are concentrated along the bypass road nearby. Traffic congestion, noise and air pollution, and overcrowding of the apartments are some of the major drawbacks of this area. These dwelling units are for high-income group (HIG) people, mainly the non-resident Indians. The options of affordable housing for other economic groups are very limited, and they tend to live in congested and poor conditions. This site development plan is an alternative for them with smart city standards.

The land price in the area is high (ranging from Rs. 70,000/ per cent (one hundredth part of an acre) in the interior areas to Rs. 1 lakh per cent on the road side areas, average being Rs. 80,000/-). It is still high when compared to the existing infrastructure, but is dictated by location. Since the land is abundant and readily

available, a sharing economy model for the development using monetisation of land pooling and plot reconstitution will help in reducing the total investment and difficulties associated with land acquisition, thereby increasing the profit. The profit goes up since the project involves urban compaction reaching much higher density as per smart city benchmark of Government of India.

A business sharing economy model in which built-up spaces with high quality of smart city infrastructure for land pooled is provided to the inhabitants after evaluating the value of their land pooled by one household to another in detail.

Low-rise high density group housing is ideal for the site and market needs in the area, since increase in the building height can increase the cost of services for vertical transportation. Rapid construction method, reducing construction time using prefabricated gypsum material roof and wall panel developed by Indian Institute of Technology (IIT) Chennai and marketed locally by Fertilizer And Chemical Travancore (FACT) will be used which will lower the construction cost by Rs. 1400 per sq ft. After providing due compensation for land pooled in a transparent manner with built-up space, auctioning of remaining built-up space can be done for the project prelaunch. The public response to the project can indirectly be measured from this.

Unique Selling Points

- All the benefits of a smart city;
- Reduce, recycle, reuse and recovery concept;
- Zero energy, zero discharge and zero garbage concepts;
- Ample parking facilities;
- Pedestrian and cycling tracks;
- High connectivity—multimodal transit hub;
- Uninterrupted water and power supply;
- River front recreation space;
- 25 % open spaces; and
- Healthy and classy way of life.

19.6.9   SWOT Analysis

The major stakeholders of the project are the existing landowners, prospective owners of houses and shops, entrepreneurs, venture capitalists, developer, contractors and the government regulator. SWOT analysis has been done for the major stakeholders, as this project aims at 'benefit for all by sharing economy model'.

Stakeholder 1—Landowners

Strength	Weakness	Opportunities	Threats
1. High development Potential of the area 2. Availability of land and house to develop 3. Open to Improvement and change	1. Lack of money to improve living conditions 2. Lack of coordination between different landowners 3. Poor infrastructure and services	1. Better living conditions. 2. Availability of common amenities, infrastructure and services 3. The works of unfinished houses can be completed and houses could be renovated 4. Vacant houses could be rented out or sold 5. Sense of safety and security especially for senior citizens 6. Employment opportunities	1. Fear of getting inadequate compensation 2. Fear of losing land through acquisition 3. Resistance to change due to lack of awareness 4. Social- and privacy-related issues due to mixing of people from different backgrounds

Stakeholder 2—Developer

Strength	Weakness	Opportunities	Threats
1. Technical and managerial skill to develop the area 2. Readily available machinery and manpower	1. Non-availability of affordable lands to develop 2. Shortage of liquid funds 3. High construction cost including labour and scarce building materials 4. Delay in project completion time, thereby increasing cost of construction 5. Low profit margin	1. No investment on land purchase 2. More F.A.R., thereby increasing profit 3. The area to be developed as smart city 4. Exemption from time-consuming building regulations, complete waiver of building plan approval fees and charges through E-ULM	1. Mobilise funds for developing infrastructure 2. Resistance from existing landowners 3. Labour strikes which is common in Kerala

Stakeholder 3—venture capitalist

Strength	Weakness	Opportunities	Threats
1. Availability of liquid funds 2. Innovative ideas	1. Risk involved with project is the first of its kind	1. The project is a smart city 2. High profit expected in auction of built-up space	1. Sensitivity to escalation of costs in built-up space

Stakeholder 4—government

Strength	Weakness	Opportunities	Threats
1. Regulatory body that give power to reconstitute land after land pooling 2. Fully transparent governance using e-design website e-governance module	1. Delay in approval process 2. Corruption 3. Lack of technically qualified people.	1. Augmented revenue generation by betterment levy 2. No investment for infrastructure and services 3. Positive publicity and credits earned without direct involvement	No threats

Stakeholder 5—entrepreneur

Strength	Weakness	Opportunities	Threats
1. Well versed in urban land management and sharing economy model 2. Managerial skill to coordinate 2. Social engineering skill 3. Skilled user and designer of e-design and E-ULM Web	1. No land owned 2. No Capital available 3. No plant and equipment to execute work	1. Ability to encash land management skill to reasonable return 2. Social engineering through project website and personal contacts	1. Inefficiency of regulator government 2. Ability to identify interested venture capitalist to fund 3. Lack of coordination among other stakeholders hindering the design and planning process 4. Building bye-laws delaying the project

Stakeholder 6—prospective owners of houses and shops

Strength	Weakness	Opportunities	Threats
1. Seeker of better city environment 2. Seeker of cost efficient solution 3. Seeker of benefits of Smart city infrastructure	1. Dependence on loans 2. May not be related to main economic activities of Umami	1. Use of renewable source of energy and recycling of water and waste 2. Use of organised open spaces for recreation	1. Escalation of EMI and price

19.6.10 Strategy

Urban land management models such as land acquisition and detailed town planning (DTP) schemes are not suited for smart city site development in Dritisaka. Apart from defects explained in the case studies, the Land Acquisition Act of 1894 does not treat government and citizen landowners and tenants with equal rights as per Indian Constitution and generates an impression of failed land development authority. Detailed town planning scheme based on Malabar Town and Country Planning Act 1920 is incapable of creating a site development as per Benchmark of Smart City Mission of India. Hence, a strategy for alternate Sharing Economy business model is presented below.

1. Strategy is evolved out of above SWOT analysis of stakeholders to effectively utilise the complementarity of stakeholders. Strength of one stakeholder is used to remove the weakness and fears of another when they work together for the business of site development. This requires effective and convincing communication with the stakeholders by the entrepreneur. E-ULM and e-design of site provide ICT-based opportunities for communication and training of stakeholders. Entrepreneur and venture capitalist hailing from any part of the world are key actors of the site development for Dritisaka.

2. Unlike DTP scheme, there will not be mixing of site planning with urban land management in a compromising way and it will be designed based on benchmark of smart cities envisaged by India Smart City Mission.

3. Dritisaka is designed to give a stream of income for its residents from envisaged primary and secondary employment opportunities as related to food processing and tourism in Umami as well as from urban land by rent or ownership. Site development is conceived as part and parcel of Smart City Economic Development where all stakeholders equally benefits, generating income flow to all of them as per their financial participation by cash or land.

4. No one is displaced by land acquisition from Dritisaka in Umami. Site development gives landowners relatives, sons and daughters opportunities to settle in this area since they are wanted in Umami and have important role in the heritage-based food and tourism-related activities in Umami. This is achieved by compensating the land lost to householders in land pooling by equivalent built-up space at present land value. This is possible because Dritisaka practices urban compaction as per States' Urbanisation Report.

5. Every stakeholder is financially compensated in an open and justifiable fashion as convinced by the entrepreneur (Table 19.4). The key person is the entrepreneur who communicate, motivate and integrate all stakeholders for site development works for a fee of 0.5–1 % of the total capital invested. Venture capitalist also get a fee of 1–2 % of capital according to the money he has invested, and debt servicing in terms of market interest lost during construction period is also paid to him. Landowners in Dritisaka lose a per cent of land owned for land pooling which will be computed based on present land value (Table 19.5), and they gets both direct and indirect compensation for the loss, direct compensation being the proportionate share of overall profit and indirect being the increment in the land value after development (Table 19.6). Similarly, the house owners lose part of their built-up space owned for the urban densification strategies such as splitting, combining and converting. The loss is computed based on the present sale price (Table 19.8), and he is compensated with additional built-up space which will enable him to augment his income by renting, sales or even passing on to his sons and daughters who are human resources with their capabilities to sustain the food processing and touristic activities in Umami (Table 19.7).

Table 19.5 Calculation of landholding value compensation

Land holding size (Before development) (cents)	Land to be given for public purpose (cents) 60%	Land holding size (after development) (cents)	Total no. of land owners	Total cents available for public land	Existing land holding value	Total land holding value after land pooling (with present land value)	Loss on land value after land pooling	%share of profit	Profit share per land owner	Total profit share for land owners
2	1.2	0.8	16	18.88	₹ 1,60,000.00	₹ 64,000.00	-₹ 96,000.00	2%	₹ 1,26,873	₹ 19,96,293
5	3	2	64	191.81	₹ 4,00,000.00	₹ 1,60,000.00	-₹ 2,40,000.00	19%	₹ 3,17,183	₹ 2,02,80,109
10	6	4	60	358.53	₹ 8,00,000.00	₹ 3,20,000.00	-₹ 4,80,000.00	36%	₹ 6,34,366	₹ 3,79,06,260
15	9	6	8	75.31	₹ 12,00,000.00	₹ 4,80,000.00	-₹ 7,20,000.00	8%	₹ 9,51,549	₹ 79,61,872
20	12	8	28	339.43	₹ 16,00,000.00	₹ 6,40,000.00	-₹ 9,60,000.00	34%	₹ 12,68,732	₹ 3,58,86,669
TOTAL			176	983.95					TOTAL	₹ 10,40,31,202

Table 19.6 Compensation of built-up area

BUILT UP AREA BEFORE DEVELOPMENT	BUILT UP AREA - LOST AFTER DEVELOPMENT (AVG, SQFT)	COMPENSATION IN TERMS OF BUILT UP AREA (SQ.FT)
300	0	0
600	300	50
900	525	300
1200	300	300
1800	900	400

Government acts only as regulator and collector of taxes and levies. Developer contractor gets his usual 10 % contract profit. Government is assisted by e-governance component of e-design and E-ULM discussed in last and this chapter. In fixing the housing mix for Dritisaka, Kerala Government housing policies of giving due weightage to low-income housing will be incorporated as well as Urban Land Compaction policies of Government of Kerala. After completion of construction of houses and all other facilities, built-up spaces are sold in e-auction using website of Umami designed to the highest bidder. The income received will be divided between venture capitalist and landowners proportional to capital they invested on site development in cash by venture capitalist and land by landowners. Dritisaka is a having high potential for rental housing and ownership housing since it is a high standard smart city layout and there exists employment opportunities within Umami or outside mainly from nearby two information technology parks being developed. It will be managed by residential association.

6. Strategies are worked out for participating landowners, for their land and built-up area separately. Approach of reconstitution of land is designed very rationally and in a transparent manner since all the existing households who are participating with their land and built-up area get a specified built-up area and proportionate profit in return for the same they part for common and public use and the process can be easily communicated by the entrepreneur. According to the land value distribution of Dritisaka, landowners, who are participating with

Table 19.7 Profit calculation

PROFIT CALCULATION	
Total Cost of Construction	₹ 16,82,31,263
Total Land development Cost	₹ 5,60,77,088
Overall Cost of Construction (incl. land development cost)	₹ 22,43,08,350
Inflow from saleable units (residential)	₹ 41,65,98,000
Inflow from saleable units (commercial)	₹ 3,08,00,000
Inflow from saleable units (industrial)	₹ 6,90,00,000
Overall inflow	₹ 51,63,98,000
Total profit	₹ 29,20,89,650
Venture Capitalist investment	₹ 13,00,00,000
Interest= @7% for one year	₹ 91,00,000
Total returns of venture capitalist	₹ 13,91,00,000
Remaining profit (To be shared among all stake holders)	₹ 15,29,89,650

the quantity of land, will be given a share of the overall profit proportionately apart from increment in the value of land held after pooling. The land value would increase to Rs. 2.5 lakhs per cent after development. The indirect compensation is calculated based on this (Table 19.9). The landowners who are participating with the quantity of built-up area will be given additional built-up area proportional to the value of built-up area lost (Table 19.6).

7. No resurvey of existing land is contemplated, and land area of titling document is taken as final for land pooling, thereby reducing time for implementation.

8. New land titling and registration after reconstitution of land are expected to be given by the government for free since norms of smart city and URDPFI are fulfilled and by this scheme are having a socially secure environment by having enough number of EWS and LIG houses and policy goals of SUR and Perspective Plan 2030. A GIS-based land record using total station is recommended.

9. Since all the amenities are nearby Dritisaka and the site is part of smart city Umami, a well-designed area in the Calicut city, marketability of built-up spaces will increase for rent or ownership. E-marketing developed for Umami will be used for marketing and payment receipt.

10. Due to the innovative and very rapid panel-based construction methods used in the construction, considerable saving in cost of construction is envisaged. This

Table 19.8 Profit share among stakeholders

Total profit to be shared among stakeholders			₹ 15,29,89,650
S no.	Stakeholders	Profit	Profit Share
1	Entrepreneur	0.5% of profit	₹ 7,58,448
2	Venture Capitalist	1% of profit	₹ 15,29,897
3	Developer contractor	10% of cost of construction)	₹ 1,68,23,126
4	Land owners	Remaining Shared proportionately	₹ 13,38,78,179

Table 19.9 Increased land value

Indirect Compensation- Increased Land value				
land holding size (Before development) (cents)	Land holding size (after development) (cents)	Total Land holding value before development (present land value)	Total land holding value after development (projected land value)	Profit on land value after development
2	0.8	₹ 1,60,000.00	₹ 2,00,000.00	₹ 40,000.00
5	2	₹ 4,00,000.00	₹ 5,00,000.00	₹ 1,00,000.00
10	4	₹ 8,00,000.00	₹ 10,00,000.00	₹ 2,00,000.00
15	6	₹ 12,00,000.00	₹ 15,00,000.00	₹ 3,00,000.00
20	8	₹ 16,00,000.00	₹ 20,00,000.00	₹ 4,00,000.00

solves the issue of scarce and non-available sand and building materials for construction and non-availability and high labour cost in Kerala.

19.7   Conclusion

Practice of ULM is observed as early as in the Egyptian civilisation, where land management included mandatory increase in number of floors in lands close to Nile River to have an equity sharing of good lands among as large population as possible [18]. From then to present days, many different understandings have developed on urban land by the large research fraternity in urban studies, but it all leads to a

common idea that urban land is scarce, always in demand, and this scarce resource needs to be used very efficiently so as to promote equity. In the context of India, this activity had been till recently restricted to building regulations, land-use planning and restrictions on building height and density which was supervised as well as regulated directly under the state or local government. E-ULM and sharing economy business model are recent trends in land management which ask for the devolution of authority and responsibility to the citizens, and are found to be successful globally. The environment in Kerala, India, is presently best suited to welcome these. With the Smart Cities Mission of India, Indian cities are no longer looking forward for sustenance but present ambitious goals of world-class infrastructure and quality of life. The Kerala Perspective Plan, through its 'Kerala State Spatial Strategy' proposes to identify 'hubs' across the state and develop them as compact settlements. It is in such a scenario that the Town and Country planning Act 2016 is passed, which propose town planning schemes in cities of Kerala, and for the first time propose transfer of development right as a tool for land development and management in Kerala. With the necessary legal support granted by the ordinance, cities of Kerala are exposed to large potentials of 'economics of land'. History has revealed that too much regulated and state-controlled land management has put the cities and citizens always at loss. A market-driven activity not only is sustainable, but also offers the benefit of belongingness to the citizens. E-ULM of Umami is such a market-driven activity which follows the institutional and legal framework of Kerala and supervised by the authorities through a zonal plan. The aim of E-ULM is to make processes transparent and accessible to all, and also generate a bottom-top planning system in which identification of issues as well their solutions, both are by the citizens. Sharing economy business model invites all citizens to contribute in terms of assets, skills, knowledge or data and makes shared profits. It is built on the concepts of community planning where the community is empowered and not dependent on the city or state authorities. With E-ULM and shared economy business model, the true activity of local self government as proposed by the 73rd and 74th constitutional amendment is revealed in the lives of people of Umami.

19.8   Credits

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Part VI
India-New Delhi

Chapter 20
Making Delhi a Smart City: Economic Buoyancy with Spatial Justice

Ashok Kumar and Pradip Kumar Sarkar

Abstract With the case of Delhi, the core argument of this chapter is that the Smart Cities Mission appears to present a disjuncture and a severance between the actually existing needs of Indian cities and citizens including the primary goal of creating wealth by embedding advanced technologies in the built environment without first addressing the basic city problems. Acceptance of New Delhi Municipal Council area as one of the selected 20 smart cities for central funding is puzzling because it further highlights the disjuncture between ground actuality and smart city policy utopia. In order to present these fissures, this chapter first presents five challenges of urbanization facing the city of Delhi. These are the challenges of infrastructure with a specific focus on sanitation, the challenge of mobility, the challenge of environment, the challenge of slums, and the challenge of governance. Separately, these challenges have been discussed, but this is the first attempt when urban development challenges are being discussed in the context of the Smart Cities Mission. These challenges are also selected because they form critical elements of the smart cities generally and the Smart Cities Mission in India particularly. Examining these challenges leads us to explore whether the smart cities, as conceived and currently being built by Indian and global corporate builders, could face up to the challenges presented by the Indian urbanization. The case of Delhi is appropriate within the smart city discourse because it is counted among the top performing metropolitan cities of the country. Core argument of the chapter is that narrowing down the disjuncture between experienced city realities and policy perceptions is useful even for economic growth, the prime public policy goal at the present moment.

Keywords Disjuncture · Urban development challenges · Spatial justice · Economic growth · Actually existing city

A. Kumar (✉)
Department of Physical Planning, School of Planning and Architecture (SPA D),
New Delhi, India
e-mail: dak_13april1962@yahoo.co.uk

P.K. Sarkar
Department of Transport Planning, School of Planning and Architecture (SPA D),
New Delhi, India
e-mail: sarkarpradip52@gmail.com

20.1   Cities as Nodes of Economic Growth

Development narratives after internationalization of the Indian economy have taken a decidedly 'urban turn,' where the city is regarded as the centerpiece of economic development along with social and cultural progress. Cities are shown to contribute nearly two-third of country's gross domestic product largely based on the service sector. Global capital and global financial institutions buttressed by local capital and financial institutions supported by market-friendly state policies make this crucial framing with attractive agenda of 'cities as engines of economic growth.' A clear and positive correlation is increasingly established between the rising levels of urbanization and economic growth. Economic growth without high levels of urbanization is shown to be an improbable proposition. For example, John M. Quigley presents evidence to show that 'cities are important facilitators of economic growth, increased productivity, and rising incomes in poor and rich nations alike. Policies to facilitate, not inhibit, urbanization are likely to improve economic conditions in developing countries' ([58: 116]; also see [75]). Further, cities are showcased as places of action for a diversity of people who expect to live better quality of life because major portion of economic growth takes place in urban areas. Creative classes are regarded as raison d'être of high economic growth as well as propellers and instruments' economic buoyancy of cities. In this view, only those cities will economically grow, which are able to attract and provide for world-class lifestyles, production, and consumption spaces and most importantly protect freedoms to innovate and create new ideas and services. Here, cultural diversity has to be protected and enriched rather than shunned [33: 38–39].

These scholarly arguments get further leg up from studies conducted by global think tanks. For instance, a recent study by the McKinsey Global Institute shows that since the last three decades, from 2002 to 2012, the Indian economy has grown the fastest. Economic growth from 2002 to 2012 has been 'the fastest … in independent India's economic history, as GDP grew at 7.7 % annually.' Household consumption also grew rapidly at 7 % per year in real terms, and fixed investment touched an all-time high of 35 % of GDP in the year 2011–2012. This study also points out that the share of the population below the official poverty line fell from 37 % in 2005 to 22 % in 2012—the fastest rate of poverty reduction India has achieved since economic reforms of the early 1990s. An impressive 137 million people rose above this threshold [6: 11]. These are impressive figures by any standards making state policy makers even more enthusiastic about framing market-enabling city policies. However, there are some scholars who argue that people can be taken out of poverty faster if governments spend a larger percent of their GDPs on basic services such as health and education [60].

To further support the argument of market-led economic growth, the McKinsey Global Institute and the World Bank also predict that most of the future economic growth in India will take place in towns and cities. In 2012, India had 54 metropolitan cities which together with their hinterlands (65 districts) accounted for 40 % of GDP and 45 % of consuming-class households. Hinterlands, in this

instance, refer to districts in which metropolitan cities are situated and stretch across. By 2025, India will have 69 metropolitan cities, and together with their hinterlands, they will account for 54 % of India's … GDP from 2012 to 2025 and 50 % of India's total income in the terminal year [6: 17–18]). The same report also underscores that 'just 49 clusters (183 districts) will drive about 77 % of India's incremental GDP from 2012 to 2025. Top ranked metropolitan districts constitute the nucleus of these clusters with the surrounding 'high potential' districts making the cluster a serviceable market' [6: 18]). 'The NCT of Delhi would be a market of 22 million residents by 2025, with a standard of living similar to Russia, Goa and Chandigarh on the other hand, in 2025, in purchasing parity terms will mirror Spain today' [6: 31].

Another fact that further supports the argument of 'cities are engines of economic growth' is that a majority of Indian population will live in cities in future. United Nations, for example, forecasts that the level of urbanization is certainly going to be higher in future than what it is today. It is estimated that 50 % of the Indian population will live in cities by 2050 [75: 22]. This implies that the future of India is most likely to be urban. Both majority population and large percent of wealth will get generated in cities. Another recent report published by the McKinsey Global Institute shows that nearly 600 million Indians would be living in cities by 2030, and cities would generate nearly 70 % of new jobs by 2030. Cities would also produce more than 70 % of India's gross domestic product. Therefore, cities would propel a fourfold increase in per capita income [52]. Most research studies carried out by think tanks like the McKinsey Global Institute show that the Indian cities not only will produce most of the economic wealth but also would house a large percentage of the consuming class. If a majority of the Indian population also begins to live in urban settlements, economic dominance from production as well as consumption perspectives in all probability will increase. Cities civilization will eclipse age-old rurality of India. At the present moment, consequences of increasing levels of urbanization are much clearer than consequences of fading rural economy and society over the next 50 years.

Think tanks aside, Government of India also believes that 'cities are engines of economic growth.' Based on [18] data, the Smart Cities Mission highlights that cities have contributed 63 % to the GDP of India. Government of India expects that by 2030, urban areas will be home to 40 % of India's population and these areas would contribute 75 % to India's gross domestic product [57: 5]. Government of India argues that economic growth therefore will decidedly happen in urban areas. If this is true, urban areas are required to be equipped with necessary infrastructure to facilitate the economic growth and well-being of city dwellers.

This dominant discourse of 'cities as engines of economic growth' has overshadowed another equally, if not more important, city reality of woefully inadequate or in some cases even non-provision of critical basic services such as water and sanitation, lack of decent housing and shelter, lack of affordable and safe mobility opportunities, scarce new employment opportunities in the formal sector, low wages, lack of safety of urban citizens, deteriorating environmental quality, and non-transparent and largely unaccountable city governments. All these factors have

become the root causes of social and economic inequalities, which certainly manifest themselves in city spaces such as slums and squatters, unauthorized colonies, pavement dwelling, and living in empty drainage pipes. These inequalities perpetuate poverty and in the formalization of livelihoods as the McKinsey Global Institute's report itself shows that 270 million people (22 % of the total population) remain below official poverty line of 1.25 dollar a day [43: 11]. Urban poverty, homelessness, unemployment, lack of basic social and physical infrastructure, lack of mobility, unclean environment, etc., remain central problems of the Indian city. In this chapter, among other things, we would like to examine how far public policies like the Smart Cities Mission tend to focus on these problems.

Indian policy makers are well aware of the significance of the Indian city in so far as economic growth of the country is concerned. Starting in the year 2008 and traveling through a number of European and Asian countries, the smart city has recently arrived in India, becoming quite a fascination for the Indian political and business classes and neoliberal intellectuals. Now christened the Smart Cities Mission, the smart city idea quickly took the center stage during the 2014 general elections in India when the presently ruling political party made it an integral part of its election manifesto as well as the development discourse. With opposition political parties failing to present any credible new alternative urban vision, the smart city imagination got accepted and adopted as a policy instrument central to city planning and physical development in India. Expectedly, the business classes lapped up the Smart Cities Mission as a huge business opportunity whereby urbanization is directly being used as a site for accumulation of wealth. The Smart Cities Mission in India appears to be deployed as an innovation by the state and capitalist classes to invest in the city for endlessly creating surplus value through built form. However, the spread of smart city discourse is uneven and limited to large existing cities and new developments. Small and medium towns and cities appear to be untouched by the Smart Cities Mission. Increasingly, it is becoming clear that cities in India are no longer purely perceived as places to live, work, educate, and entertainment, and they are simultaneously envisioned as commodities to be innovatively conceived, produced, packaged, and marketed before being sold in the marketplace like any other commodity. Involvement and commitment of the private global companies in partnership with local investors in this endeavor clearly show that a decisive step has been taken by the state and capital whereby cities have become the primary arenas of accumulation of surplus value. High surplus value will arise largely out of integration of a complex of high technology and the city's built environment. This policy framing and expected policy outcome easily fit the earlier discourse of the city as an engine of economic growth.

In June 2015, the *Smart Cities Mission Transform-Nation* was launched from Delhi by the Indian Prime Minister. Under the Smart Cities Mission, Government of India pledged to create one hundred smart cities by 2020 by way of regenerating existing areas through retrofitting, redevelopment, and pan-city application of certain smart solutions to existing infrastructure and also by developing new areas or greenfields [57: 5–8]. For this Mission, comprehensive city planning and development is a long-term goal and cities are advised to work toward this end in an

incremental manner. What is to be done presently is to build foundations for achieving that long-term goal by creating what is termed as the 'layers of smartness' with a focus on 'sustainable and inclusive development.' However, simultaneously, the Smart Cities Mission document clearly notes that 'the purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology especially technology that leads to Smart outcomes' [58: 6]. Smart city objectives of inclusivity, sustainability, and improved quality of life through accelerated economic growth are laudable but problematic at the same time because these are not prioritized giving few clues about how far economic growth will take priority over inclusivity and equitable distribution of material resources created under the Smart Cities Mission. As the policy document stands today, the emphasis appears to be placed on economic growth at the cost of inclusivity and sustainability as I will discuss below. If this is found to be true, the Smart Cities Mission could end up achieving 'exclusionary urbanization' whereby people are more prone to displacements and evictions, and the primary questions about urban poverty and unemployment, adequate shelter, access to basic infrastructure and services, and clean environment remain unaddressed. Smart City Solutions further mask the contradictions of the Smart Cities Mission. Smart City Solutions include six aspects—e-governance and citizen services, waste management, water management, energy management, urban mobility, and others involving telemedicine—may not touch the lives of the urban poor as they do not have access to smart technologies and even if they have, they cannot afford such solutions.

With the case of Delhi, the core argument of this chapter is that the Smart Cities Mission appears to present a disjuncture and a severance between the actually existing needs of Indian cities and citizens including the primary goal of creating wealth by embedding advanced technologies in the built environment without first addressing the basic city problems. Acceptance of New Delhi Municipal Council area as one of the selected 20 smart cities for central funding is puzzling because it further highlights the disjuncture between ground actuality and policy utopia. In order to present these fissures, this chapter first presents five challenges of urbanization facing the city of Delhi. These are the challenges of infrastructure with a specific focus on sanitation, the challenge of mobility, the challenge of environment, the challenge of slums, and the challenge of governance. Separately, these challenges have been discussed, but this is the first attempt when urban development challenges are being discussed in the context of the Smart Cities Mission. These challenges are also selected because they form critical elements of the smart cities generally and the Smart Cities Mission in India particularly. Examining these challenges leads us to explore whether the smart cities, as conceived and currently being built by Indian and global corporate builders, could face up to the challenges presented by the Indian urbanization. The case of Delhi is appropriate within the smart city discourse because it is counted among the top performing metropolitan cities of the country. Core argument of the chapter is that narrowing down the disjuncture between experienced city realities and policy perceptions is useful even for economic growth, the prime public policy goal at the present moment.

Core argument of this chapter is that the Smart Cities Mission appears to present a disconnect between the actually existing city development and urbanization, and its primary goal of creating wealth by embedding technology in the built environment without first addressing the basic city problems. In this chapter, therefore, I will present comprehensively the three of challenges of urbanization facing Indian cities. These are the challenges of shelter, the challenge of infrastructure with a specific focus on sanitation, and the challenge of governance. Separately, these challenges have been discussed several times over. But this is the first attempt where these challenges are being discussed in the context of the Smart Cities Mission. After this critical analysis, I seek to explore whether the smart cities, as conceived and currently being built by the Indian and global corporate builders, could face up to the challenges presented by the Indian urbanization. This chapter ends with some concluding insights.

20.2 Defining the Smart City

Before moving to the five challenges of urbanization, it is imperative that a brief overview of the smart city idea is presented. Defining is not setting limits but showing a certain direction for future movement. This movement is political and shows certain ideology. Smart city movement is no exception. The smart city movement originates from an ideology of neoliberalization involving national and global corporations and their constellations. Free markets in a globalized environment play foundational role in defining and popularizing the smart city idea. Efficiency, productivity, and profitability remain central pillars of the Smart Cities Mission. A number of definitions of the smart city are in circulation. Academic journals, books, and the Internet are overloaded with such definitions. Several of these definitions overlap, but none of them appear to be clearly accepted and adopted by practitioners and scholars of urban studies. Private companies such as the IBM and CISCO and a number of think tanks have clearly placed greater emphasis on the technology-embedded urbanization and value creation through the marriage of technology and built environment by providing high-end cities. I delve into some of these definitions of the smart city in order to identify its salient features.

We begin with the often quoted and most representative definition of the smart city. In this definition, smart cities are envisaged as '… territories with a high capacity for learning and innovation, which is built into the creativity of their population, their institutions of knowledge production, and their digital infrastructure for communication' [45: 306]. As is quite apparent, Holland shows that smart cities house creative pool of talented workers and institutions embedded in information and communication infrastructure. The definition places high premium on human creativity and advanced technologies. In this view, smart cities are those

which are rich in human capital and information and communication technologies. Smart city economies are knowledge-producing economies. As shown in the creative class thesis, it is knowledge production that will steer economic growth in the future city [33].

Smart cities are based on six axes. 'These axes are: a smart economy; smart mobility; a smart environment; smart people; smart living; and, finally, smart governance…. In particular, the axes are based—respectively—on theories of regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and the participation of society members in cities' [17: 70]. Here, emphasis is placed on six axes to make a competitive city. Everything smart is put into the service of competitiveness and economic growth. Economic advantage is based on the integration of technology and built form. Few years earlier, the same authors presented a somewhat similar definition of the smart city. They argued that '… a smart city is a synthesis of hard infrastructure (or physical capital) with the availability and quality of knowledge communication and social infrastructure. The latter form of capital is decisive for urban competitiveness' [16: 45]. Here, the authors stressed that we should place a greater emphasis on the integration of physical and social infrastructure through technology to produce a competitive city. Knowledge production and ICT get linked up for producing the smart city.

A number of information and communication companies such as the IBM are heavily investing in the smart city projects. In an article titled 'Smarter, More Competitive Cities: Forward-thinking Cities are Investing in Insight Today,' the IBM underscores that the smart city is:

> Every step towards becoming a smarter city creates efficiency, and every bit of efficiency alleviates some of the strain on city budgets, freeing up time and resources to focus on driving economic development and prosperity. Developments in technology have fundamentally increased the value that cities can generate for their citizens, their city, and the planet. Let's build a Smarter Planet, city by city [47: 3].

The IBM concludes that by 'becoming a smarter city is a journey that requires a shift in thinking. Every step drives increased efficiency and every initiative that delivers return on investment can translate into another project. The resulting smarter city is one that attracts citizens and businesses by delivering on its potential as never before' [48: 4]. With relentless focus on efficiency, economic development, and economic prosperity, the IBM has even greater plans. The company does not stop at building smarter cities alone; it goes on to developing a smarter planet, and tomorrow, the IBM may think of developing a smarter universe. Globalization may get replaced with what I would like to call 'universe-lization,' referring to the development of free markets throughout the universe. The IBM also emphasizes on the economic development through technology to produce a competitive city through private enterprise (also see Table 20.1). After examining these definitions of a smart city, it is not difficult to arrive at some of the salient features of a smart city as given below:

Table 20.1 IBM and the smart city characteristics, 2009

Today…	What if a city could…	Already cities are…
People Cities have difficulty using all the information at their disposal Citizens face limited access to information about their health care, education, and housing needs	Reduce crime and react faster to public safety threats, by analyzing information in real time? Use better connections and advanced analytics to interpret vast amounts of data collected to improve health outcomes?	Putting in place a new public safety system in Chicago, allowing real-time video surveillance and faster more effective response to emergencies Giving doctors in Copenhagen instant access to patients' health records, achieving the highest satisfaction and the lowest error rates in the world
Transport Transporting people and goods is dogged by congestion, wasted hours, and wasted fuel	Eliminate congestion and generate sustainable new revenues, while integrating all transport modes with each other and the wider economy?	Bringing in a dynamically priced congestion charge for cars to enter Stockholm, reducing inner-city traffic by 25 % and emissions by 14 %, while boosting inner-city retail by 6 % and generating new revenue streams
Communication Many cities have yet to provide connectivity for citizens 'Going online' typically means at slow speeds and at a fixed location	Connect up all businesses, citizens, and systems with universally affordable high-speed connectivity?	Merging medical, business, residential, and government data systems into a so-called ubiquitous city in Songdo, Korea, giving citizens and business a range of new services, from automated recycling to universal smart cards for paying bills and accessing medical records
Water Half of all water generated is wasted, while water quality is uncertain	Analyze entire water ecosystems, from rivers and reservoirs to the pumps and pipes in our homes? Give individuals and businesses timely insight into their own water use, raising awareness, locating inefficiencies, and decreasing unnecessary demand?	Monitoring, managing, and forecasting water-based challenges, in Galway, Ireland, through an advanced sensor network and real-time data analysis, giving all stakeholders —from scientists to commercial fishing—up-to-date information
Business Businesses must deal with unnecessary administrative burdens in some areas, while regulation lags behind in others	Impose the highest standards on business activities, while improving business efficiency?	Boosting public sector productivity, while simplifying processes for business in Dubai through a single-window system that simplifies and integrates delivery and procedures across a range of almost 100 public services
Energy Insecure and unsustainable energy sources	Allow consumers to send price signals—and energy—back to the market, smoothing consumption and lowering usage?	Giving households access to live energy prices and adjust their use accordingly, as in a Seattle-based trial, reducing stress on the grid by up to 15 % and energy bills by 10 % on average .37

Source IBM Institute for Business Value [46: 10]

- Digital information and communication technology appears to form the core of a smart city project.
- Role of the private sector is central, and government is only an enabler in the smart city project.
- To become a smart city, a city must be competitive, efficient, and productive.
- To become competitive, a city should house a large number of creative and innovative people. Human capital is critical to the Smart Cities Mission.
- Integration of the various elements of a smart city through technology is another central aspect of a smart city.

To say that there is no consensus on the definition of a smart city is fallacious and motivated. Leaving a smart city undefined is useful for the business as it leaves the scope for greater human discretion. Certainly, it would also lead to greater elite capture and lower levels of citizen participation.

Smart could mean efficient and effective use of energy or resources. In this sense, all scientific discoveries promoting efficiency and effectiveness are smart. It reminds me of the basic idea of lever, where small amount of energy could result in the movement of a large object. Computational capacities of highly complex modern computers are another instance of efficiency and effectiveness. In both the instances, movement of a large object and processing of a large amount of data represent efficiency and effectiveness because society and scientist viewed that moving large objects and processing large amounts of data were not humanly possible even if huge costs and longer time were spent performing these tasks. Smart cities may be a new formulation that appeared globally in 2008.

But close cousins of smart cities have been around for some time now, for example, intelligent cities, virtual cities, digital cities, and information cities. These are 'all perspectives on the idea that ICT is central to the operation of the future city' [1]. Then, there are other theoretical perspectives, which closely resemble with the smart city idea. These are as follows:

- Creative Cities [30–32]: creative class or 'high Bohemians,'
- New Urbanism [15],
- Smart Growth [29]: compact, transit-oriented development, and mixed land use development,
- Information Cities [8–14]: the network society and productivity,
- Neoliberal City, Revanchist City, Entrepreneurial City [44, 68].

These are all perspectives on the idea that technology-centered economic growth through private sector is central to the operation of the future city. *Economic growth is the key objective, technology is the key driver, knowledge production is the key resource, and high-quality lifestyle is the key promise.* When these four key ideas collapse together, the smart city emerges like a phoenix from the rubble. Our core argument is that there is nothing wrong with these ideas if the state has mitigated the five challenges of urbanization for the entire population in a city. Without transcending these urban challenges, achieving economic growth will remain

unsustainable, uncertain, and unpredictable because producing, attracting, and retaining highly skilled knowledge workers responsible for bulk of creativity and innovation will become extremely difficult in a city, for example, in a city where 10 % population has to defecate in the open and where potable water is not available to a large percent of the population.

20.3   The Five Challenges of Urbanization in Delhi

20.3.1   The Challenge of Urban Infrastructure: Sanitation Focus

Everyday experience of the Indian city depends on who is describing that experience. There is no doubt that a slum dwellers' experience is fine-grained and closer to city realities than a person from an elite group who experiences the city after a lot of filtration made possible by accumulated wealth. One group of citizens experience lack of almost all the things needed for a good life, while the other side seeks improvements on the acquired and inherited endowments and faster economic growth. Beyond differences in the way public interests are perceived by different social classes, overall the Indian cities and towns face a number of serious urban challenges. First of these urban challenges includes housing for the masses and not only for the middle- and upper-income classes as it is accepted today. For example, the Delhi Development Authority has failed in its attempt to provide housing for the low-income groups as the development authority has been able to complete 'less than 10 % of low-income projects' [22] after [35: 511]. Sanitation, particularly 'sanitation deprivation,' is another big challenge that the Indian cities face. The third major challenge is that of mobility, mobility of all income classes. Affordable, safe, and environmentally friendly modes of transportation are crucial to the making of smart cities. Related to mobility are the environmental concerns, which are getting aggravated by each passing day as pollution levels soar. Before becoming smart cities, development authorities, municipalities, and state governments need to face up to these challenges aggressively.

As shown above, urban India is important to the Indian economy, society, polity, and the environment in multiple ways. For instance, nearly 600 million Indians would be living in cities by 2030. Cities would generate nearly 70 % of new jobs by 2030. Cities would produce more than 70 % of India's gross domestic product. Most important of all, cities would propel a fourfold increase in per capita income [52]. Urbanization and economic advancement will become synonymous reinforcing and contradicting each other or masking each other's limitations. While cities and towns present momentous opportunity for future economic growth, they also pose several foundational challenges due to lack of critical urban infrastructure including inadequate provision and maintenance of infrastructure, lack of finances

for investment in infrastructure, uneven development and low quality of infrastructure, and governance of infrastructure.

Infrastructure in Indian urban settlements is inadequate in comparison with the needs of the citizens, which is a well-known fact. Some people remain out of the orbit of decent infrastructure throughout their lives. As the Census of India showed, 17.24 % or 65 million population of the country lived in slums in 2011. This represents not only injustice of global proportions; it also does not help in the reproduction of highly skilled labor power essential for creating economic wealth today and in the future. It is not only the urban poor but also the middle classes struggle for securing access to basic infrastructure in towns and cities. Struggle to access basic infrastructure has become critical in small and medium towns in comparison with large metropolitan cities, particularly in relation to urban sanitation as sewerage systems are either not laid out or only provided for a small percent of population and area. According to the Census of India, although 81 % households have access to latrine facilities of some kind or the other, only 33 % urban households are connected with modern sewerage system. The most disconcerting aspect of sanitation deprivation is that 9.9 million urban households in India still defecate in the open [18].

According to the [18], nearly 13 % of urban households resort to open defecation and another 8 % use shared toilet facilities. It is disappointing to see that India has over 47 % of the world's population practicing open defecation [54]. In smaller cities, 22 % households practice open defecation. In parts of the megacities like Mumbai, the condition is much worse. For example, in Dharavi, there is only 1 toilet for every 900 persons and people are compelled to start a movement called the *Right to Pee*. Sanitation specifically poses serious risks to the safety and health of woman and the girl child. As a result, tensions and even violent clashes between middle-class aspirations for a clean and orderly city and bodily needs of the urban poor with no access to toilets repeatedly manifest themselves in parks, playgrounds, and other public open spaces [2, 3]. Urban India with global aspirations simply cannot afford open defecation in its cities and towns. At the core, the smartness of the Indian city is connected with access of all households to basic sanitation facilities.

Major obstacle to providing adequate urban infrastructure of good quality requires huge amounts of financial resources. Several prominent committees have made estimates about investments in urban infrastructure. Committees led by Rakesh Mohan and Isher Judge Ahluwalia are well known for their excellent work on urban infrastructure financing. According to the Twelfth Five-Year Plan: 2012–2017, Rs. 108,168 crores is required just to provide potable water in urban areas. Another Rs. 50,780 crores is needed for laying out sewerage systems and treatment of sewage. Urban transport requires an outlay of Rs. 100,000 crores for 20 years [62]. The final report of the Working Group on Financing Urban Infrastructure has noted that investment in the urban sector for building critical infrastructure in the next 20 years from 2012–2013 to 2031–2032 is projected at Rs. 39,20,000 crores. Out of the total projected investment, 44 % is to be invested on urban roads and 11.5 on mass transit and putting together investments in the transport sector would

exceed the half mark of all investments in the urban sector. Another 14.39 % investment is required to be made in water supply and sewerage. In other words, water supply, sewerage, solid waste management, storm water drains, urban roads, urban transport, street lighting, and traffic support infrastructure would amount to Rs. 31 lakh crores out of Rs. 39 lakh crores over the 20-year period. This means nearly 80 % of all investments in the city infrastructure would be made in the above-mentioned 8 core urban sectors as per the Twelfth Five-Year Plan's Steering Committee on Urban Development and Management [61: 9–10]. Most committees on infrastructure finance are unanimous about enhancing spending on urban infrastructure as percent of the GDP. Chaired by Isher Judge Ahluwalia, the High-Powered Expert Committee (HPEC) for estimating the investment requirements for urban infrastructure services proposes to increase investment in urban infrastructure from 0.7 % of GDP in 2011–2012 to 1.1 % by 2031–2032 [56: XXI]. Agreeing with the HPEC report, the McKinsey Global Institute in its report titled 'Infrastructure Productivity: How to save $1 trillion a year' argues that an increase in infrastructure investment of 1 % of GDP would 'translate into an additional 3.4 million direct and indirect jobs in India…' [53: 4].

Inadequate investment in infrastructure has two immediate consequences. First, the majority of urban poor living in slums and unauthorized colonies suffer from sever lack of critical services such as water, sanitation, education, and health causing ill health and income deprivation. Second, inadequate infrastructure negatively impacts India's economic growth by reducing India's gross domestic product by 1–2 % annually. Inadequate sanitation alone costs India a staggering Rs. 2.4 trillions or over 6 % of the GDP [55]. Social and spatial inequality of infrastructure becomes a barrier in the reproduction of highly skilled labor power and becomes a major hindrance to achieving spatial justice for the urban poor.

The second challenge is urban governance. Governance of infrastructure, in the first instance, critically depends on the capacity of urban local bodies to raise taxes after effective delivery. In India, urban local bodies largely depend on grants from government. Over the decades, municipalities have been regarded agencies responsible for provision and maintenance of services. Political leaders in the municipalities have not taken upon themselves the responsibility of steering city development as a whole. Dependence upon the state and central government funds could reduce if urban local bodies are allowed to look for generating additional funds through exclusive taxes and levies. Although 74th amendment to the Constitution of India has facilitated decentralized urban local government throughout the country, political devolution with executive powers in the hands of elected representatives has not yet truly happened. Urban local bodies still implement policies framed at central and state levels and do not really make policies, a critical element of any autonomous urban local government. Financial dependence of three municipalities on Government of Delhi and resulting conflict between Delhi government and the municipalities highlights this point well. A good beginning has been made by the decentralization of urban local government throughout the country, but attempts are required to be made to make these bodies autonomous with clear leadership roles assigned to locally elected politicians.

A system of directly elected mayors entitled to appointing groups of professionals is required for efficiently running cities and towns.

The third and most important challenge of urban infrastructure is the use of appropriate technologies for the provision and maintenance of physical infrastructure, more particularly sanitation. The use of technology becomes even more important if people responsible for providing certain kind of infrastructure such as sanitation are treated badly by the society as a result of their involvement in these activities. Here, a major problem should be highlighted: the dreadful social practice of manual scavenging. Manual scavenging in Indian cities is still being practiced. There are about 13 lakh manual scavengers in India according to Vimal Thorat as quoted in The Indian Express of October 8, 2013; Delhi alone had 14,479 scavengers in 2013, and Delhi also had over 10,000 dry latrines in 2013. Indian Railways engages manual scavengers on its 14,300 trains transporting 25 million passengers across its 65,000 km of tracks. Human shit goes straight to railway tracks and 172,000 open discharge toilets [66: 35–36]. This inhuman and degrading social practice can be easily stopped by the use of appropriate sanitation technologies. The colonial rulers deployed humans for collection and transportation of human excreta from large cities like Delhi because they found it cheaper [62]. To be a candidate for a smart city would include complete elimination of manual scavenging and honorable resettlement and rehabilitation of those involved in this inhuman social practice.

Urban infrastructure is not only about pipes, bricks, and mortar, even when we acknowledge its materiality, it is visibly important as use value as well as exchange value. Understanding of the politics, sociology, and economics of infrastructure is equally significant. Economics of infrastructure is being given its due place by placing greater emphasis on financing of infrastructure. However, sociology of infrastructure is largely ignored without critically making it part of sanitation policies in planning. Polity and economy of the Indian cities is largely controlled by the middle classes. How it is then the middle classes complain about the absence and quality of urban infrastructure?

Centralized and inefficient sewage treatment facility in cities coupled with lack of connectivity to sewer lines in major parts of cities is one of the main causes of water pollution, which leads to dumping of untreated or partially treated sewage in surface water sources. Unregulated and illegal groundwater extraction further reduces the depth of groundwater table. Dumping of solid wastes (inclusive of wastes generated during religious and social practices) and industrial effluents into water bodies is another cause for concern. Flow of untreated storm water into rivers also leads to water pollution as this water carries with it toxic chemicals swept off from built-up areas, pavements, and roads. This is a part of the environmental challenge because inappropriate sewerage system causes water pollution and land pollution as a significant part of the sewage never reaches sewage treatment plants.

Nearly 80 % of the sewage generated in India flows untreated into its rivers, lakes, and ponds, turning the water sources too polluted to use. Almost 40 % of the total sewage treatment capacity of the country exists in just two cities—Delhi and Mumbai. Water pollution is a multidimensional environmental challenge. First part

comprises of supply of adequate potable water and effective water supply network for treatment and distribution of water to residences, industries, commercial spaces, etc. Second part of water pollution is that used water has to be carefully and effectively disposed of through modern sewerage network. Third dimension of this challenge is dumping of untreated storm water into rivers, etc., again leading to pollution [25].

Another aspect of the urban infrastructure challenge is that India alone accounts for 48 % of population defecating in the open, whereas it has only 15 % of world's urban population [74]. This open defecation, a form of sanitation deprivation and a violation of a human right, has implications for public health, natural environment, education, safety of women and children, and economy of the city. In a recent study conducted by the Planning Commission in 2006, it was highlighted that around 60 % of the economic burden at the national level is due to lack of access to adequate water and sanitation facilities [37]. Critical importance of sanitation deprivation in the form of open defecation could not be overstressed. In this direction, Prime Minister of India has spearheaded a nationwide project called the Swachh Bharat Mission. Adequate funding for sanitation services under this project appears to be available. It is imperative for municipal bodies in Delhi to not only provide adequate number of toilets to the citizens, but also ensure that these are well maintained. The smart thing to do in a smart Delhi is to create an environment of 'smart maintenance' of all services being provided by the public as well as the private sector. Provision without proper maintenance would be wastage of public funds.

The same document also highlights the severity of the problem by estimating this economic burden to be equivalent to 6.4 % of annual gross domestic product of the nation. Furthermore, every year, around 15 million persons migrate to urban areas in search of employment and better standard of living [38]. However, majority of these immigrants are unable to afford decent housing in cities and end up squatting on public and private land. Being dubbed as encroachers or illegal occupants of public lands, they are often denied access to basic sanitation facilities. Even in situations where sanitation facilities exist, their quality is extremely bad compelling people to resort to open defecation. Although various policies exist at various levels of government, change in the scenario is rather insignificant.

According to the Census of India in Delhi, 10.5 % households did not have access to any form of latrine facilities within the premises. In other words, in Delhi, 1 in every 32 persons is defecating in the open and every second person defecating in the open is an urban poor, who has either inadequate access to basic sanitation or completely deprived of it. This shows that income poverty and lack of access to sanitation facilities are directly related and reinforce each other. Nonetheless, the extent of open defecation has been brought down in Delhi by more than 50 % from 22 % in 2001 to 10.5 households in 2011 [38]. But still Delhi cannot dream of becoming a world-class smart city where a significant section of its citizens defecates in the open. Here, three issues are central to sanitation deprivation—counting, location, and solution.

As far as counting is concerned, the problem of open defecation gets compounded further as the Census figures do not adequately address the real extent of households experiencing dreadful practice of open defecation. The Census figures account for only that fraction of population that does not have access to a latrine facility. It completely ignores those who despite having access to latrine facilities in the form of community toilets or mobile toilet vans, etc., are forced to defecate in the open because of the ill maintenance of such facilities as convincingly articulated by Burra et al. [9]; also see Fig. 20.1.

> The public toilet blocks are often in serious disrepair within three months of being constructed, leaving people with little or no alternative but to defecate in the open. The space around the public toilets often becomes heavily used for open defecation which, in turn, produces a very large health burden and contributes to high infant and child death rates. Toilet blocks also become places where household wastes are dumped, since communities often have no garbage collection. Women suffer most from having no accessible and safe toilet. To protect their modesty, they often wait until nightfall to defecate in the open—but this need to wait until dark also causes widespread gastric disorders [6: 12–13].

Second, it is a common belief that there exists a direct relationship between slum population and location of open defecation. But Delhi depicts a different story. For the past two decades of Census enumeration, figures show higher instances of open defecation in peripheral districts of Delhi, which include the South District along with southwest and northwest districts. This could be attributed to two main factors—availability of open space to defecate and lack of access to basic sanitation

Fig. 20.1 Municipality-built community toilet at Kathputli colony in Western Delhi. *Source* Kumar [55]

facilities. In the peripheral areas, ample open space accompanied with lack of access to any form of latrine facility, be it a public latrine or community latrine, encourages people to defecate in the open (see Fig. 20.2).

Third issue pertains to how planners and policy makers view the problem of open defecation in Delhi. Master Plan for Delhi enforced since 1962 and its two versions prepared in 1990 and 2007 appear to be oblivious of the fact of sanitation deprivation manifested in the form of open defecation. The word open defecation has not appeared in any version of the Master Plan for Delhi. To add to the problem of exclusion of open defecation from plan-making discourse, continuing emphasis of the government planners on extending sewerage network and augmenting its treatment capacity seems futile because large percent of sewage never reaches sewage treatment plans due to the centralized nature of the system and its ill maintenance.

Delhi generates estimated 3060 MLD of sewage, and the city has a total of 2700 MLD installed sewage treatment capacity. However, only 1546 MLD sewage
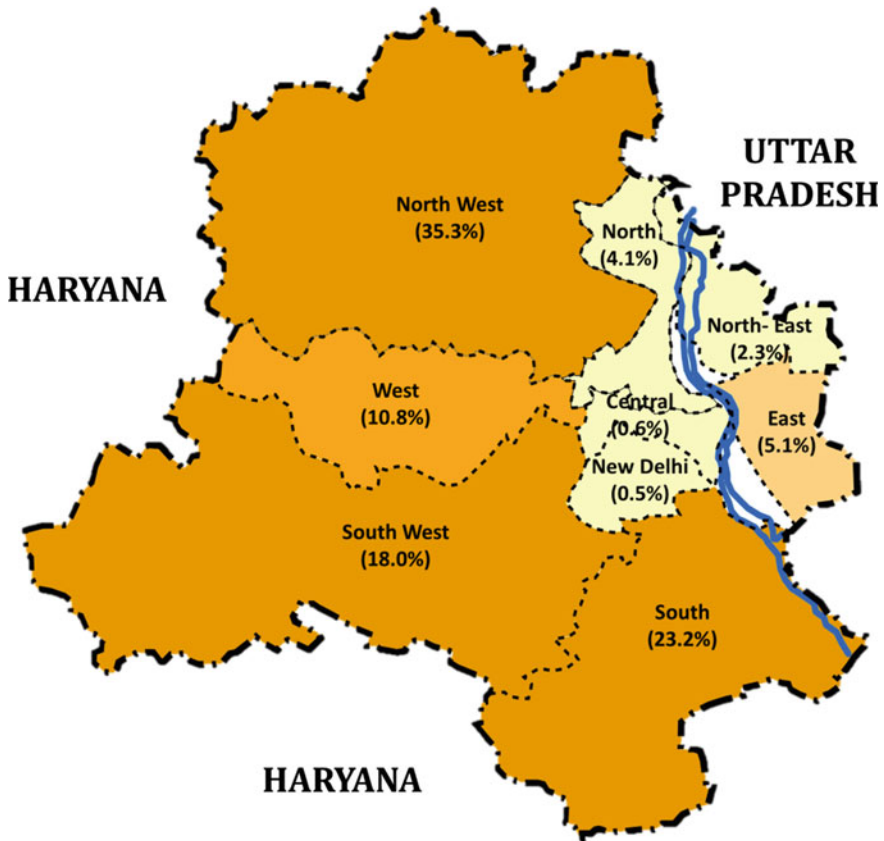
Fig. 20.2 District-wise distribution of percentage of households defecating in the open, 2011. *Source* Census of India [18]

gets treated at Delhi Jal Board's sewage treatment plants. This means only 57 % of the existing capacity is being utilized. Remaining sewage causes water and land pollution as it is directly goes to river Yamuna and also seeps into earth. Sometimes aging and broken pipes carrying wastewater also leak sewage, which mixes with potable water through broken and ill-maintained water pipes causing serious health threat to people.

Clean and healthy environment gets closely linked with access to sanitation. Access to sanitation is foundational for a healthy citizen and smart economy, and it is in this context that sanitation deprivation has to be completely eliminated. Swachh Delhi and smart Delhi are not two different things because smart Delhi is unimaginable without providing all Delhi residents with decent sanitation facilities.

As the 17 sustainable development goals have been ratified by the United Nations in its 70th General Assembly meeting held on September 25, 2015, it is worthwhile to stress that the world leaders have committed themselves to eradicating sanitation deprivation as the following goals and subgoals show [76: 18].

Goal 6: Ensure availability and sustainable management of water and sanitation for all.

6.1. By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

6.2. By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

6.3. By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.

6.4. By 2030, substantially increase water use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

6.5. By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

6.6. By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, and recycling and reuse technologies.

6.b Support and strengthen the participation of local communities in improving water and sanitation management.

Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable [76: 21].

20.3.2 The Environment Remonstrance

Environmental issues have become a common concern for people of Delhi; it is no longer a matter to be debated and determined by the experts. Common citizens talk about environmental derelictions in daily conversations. Effects of harmful gases and unhealthy fumes are regularly deliberated in coffee shops and malls alike. In the month of January 2016, environmental concerns came inside the drawing rooms of all vehicle-owning citizens when odd–even formula for driving cars was launched by Delhi government on a trial basis for 15 days. Under these circumstances, when Delhi is faced with environmental challenges of the worst kind, people of the city are beginning to participate in the public discourses on urban environment. However, air pollution remains the sole concern of public debates about environmental challenge, which is in fact much broader and deeper area of concern. The environmental challenge involves climate change, disturbing the natural environment, disturbing the natural drainage patterns, destruction of natural habitats of flora and fauna, etc., degradation of natural resources, degradation of land, degradation of air, and degradation of water resources (see Intergovernmental Panel on Climate Change and United Nations Framework Convention on Climate Change). Cities appear to be the main offenders. Although cities cover less than 2 % of the earth's surface, they consume 78 % of the world's energy and produce more than 60 % of all carbon dioxide and significant amounts of other greenhouse gas emissions, mainly through energy generation, vehicles, industry, and biomass use. For instance, inhaling Bangalore's or Delhi's air is equivalent to puffing 20 cigarettes in a day (see Table 20.2). Remonstrance by all stakeholders particularly by those who daily use city and its environment is the first step in tackling the environmental challenges.

In order to face up to and transcend the environmental challenge, comprehensive and land use planning could play a vital role, for example, developing and redeveloping cities in such a manner that natural drainage patterns are not disturbed or minimally disturbed. Filling up of lakes in Mumbai and Bengaluru is an example of blocking drainage systems and causing floods. Air, water, and land pollutions, particularly in the megacities, could be reduced to a significant level by promoting green technologies, green buildings, clean energy, and promotion of reliable, efficient, and affordable public transport systems. Since 2002, Delhi Metro has shown the way forward by offering environmentally sustainable, affordable, and safe mode of transport (see Table 20.3 for major cities).

Transportation is one of the main contributors to air pollution in urban India ([70]; also see Figs. 20.3 and 20.4). While the large number of polluting vehicles is the main reason for air pollution in Delhi, construction works and dust also contribute greatly to air pollution.

Post the Industrial Revolution, cities have been brought to limelight and considered as the main reason behind climate change. Cities are blamed for generating most of the world's greenhouse gases. Generation of these greenhouse gases is determined to some extent by the pattern of urban mobility, housing design and

Table 20.2 Air quality of metropolitan cities during 2009

Name of the city	SO$_2$	Air quality	NO$_2$	Air quality	PM10	Air quality
Agra	6	L	21	M	185	C
Ahmedabad	16	L	21	M	95	C
Allahabad	3	L	24	M	160	C
Amritsar	15	L	35	M	190	C
Bangalore	9	L	62	C	163	C
Bhopal	16	L	40	M	122	C
Chennai	7	L	18	L	115	H
Coimbatore	9	L	17	L	70	H
Dhanbad	6	–	29	M	164	C
Delhi	17	L	41	–	243	C
Faridabad	6	L	49	H	154	C
Hyderabad	15	L	23	M	80	H
Jaipur	5	L	22	M	151	C
Jabalpur	6	L	36	M	136	C
Jamshedpur	36	M	24	H	172	C
Indore	9	L	49	M	183	C
Kanpur	8	L	17	M	211	C
Kochi	4	L	31	M	40	M
Kolkata	11	L	12	M	126	C
Lucknow	8	L	68	H	194	C
Ludhiana	9	L	36	L	254	C
Madurai	10	L	37	M	42	M
Meerut	8	–	25	L	119	–
Mumbai	6	L	44	C	117	C
Nagpur	6	L	41	M	99	C
Nashik	23	L	30	M	89	H
Patna	5	L	29	M	146	C
Pune	23	L	37	–	82	H
Rajkot	11	L	40	H	105	C
Surat	19	L	15	M	91	C
Vadodara	16	L	26	M	86	H
Varanasi	17	L	30	M	123	C
Vijayawada	5	L	20	L	80	H
Visakhapatnam	13	L	14	M	97	C

Note L: low, M: moderate, H: high, C: critical * concentration exceeding NAAQS. Low, moderate, high, critical classification based on the pollution-level classification
Source Central Pollution Control Board [19: 90]

Table 20.3 Air quality index in major cities, 2015

City	Air quality index	Quality
Delhi	279	Poor
Pune	68	Good
Kolkata	65	Good
Mumbai	56	Good

Source SAFAR@MoES-IITM-IMD (as quoted in the Times of India, May 7, 2015)

Fig. 20.3 Traffic on Delhi's roads. *Source* http://www.mpg.de/5928050/global_air-pollution

distribution, organization of food and water systems, and a person's lifestyle [51]. With technological, industrial, and agricultural advancements, coupled with increase in population growth, growth of cities, increase in the number of vehicles on roads, growing energy consumption, evaporation of fuels from petrol pumps, and waste production, and lack of strict implementation of environmental laws and regulations have increased the discharge of pollutants into air as well as water, and soil has exacerbated this situation. Thus, it could be safely concluded that the cities are the main culprits causing climate change. Evidence keeps on mounting. For example, although cities cover less than 2 % of the earth's surface, they consume 78 % of the world's energy and produce more than 60 % of all carbon dioxide and significant amounts of other greenhouse gas emissions, mainly through energy generation, vehicles, industry, and biomass use [27].

Therefore, cities are also highly vulnerable to climate change. Not only large concentrations of population and economic activities in urban areas have serious implications for climate change, but also climate is bound to affect these

Fig. 20.4 Smog as an evidence of air pollution in urban India. *Source* http://www.mpg.de/5928050/global_air-pollution

populations. Increased precipitation has implications on cropping patterns and causes flooding. Urban floods have direct and indirect implications on economy and health of society at large. The most rainfall was recorded on 26 July when the city received 944 mm of rain in one day (37 in). The floods caused extensive damage to Mumbai and surrounding areas. Mumbai metropolitan area authorities reported 700 human casualties, 244,110 houses with total or partial damage, 97 collapsed school buildings, and 5667 damaged electricity transformers, together with losses to national highways and transportation systems (52 broken local trains, 41,000 taxicabs, 900 buses, 10,000 trucks). In addition to the direct impacts, the flood event had cascading effects at different scales. Informal settlements were one of the worst affected sections in the city [20: 342]. December 2015 Chennai floods have already killed nearly 300 persons, and there is a huge loss of property. Chennai Airport has been closed for days, and the Indian Railways could not operate its trains from Chennai as the railway station was under water. Clearly, environmental degradation has economic costs.

What are the driving forces of climate change? According to the Government of India [39] report on 'Statistics related to Climate Change-India' in India, unregulated and unplanned economic activities are the main driving forces behind human-induced climate change:

- Increase in the production of consumer goods and services with increase in purchasing power,
- Change in the production structure,
- Increased mobility,
- Increase in demand for all kinds of consumer goods, etc.,
- Change in land use patterns, decreasing green cover, increasing built-up area, deforestation, and land clearings are some of the main factors,
- Continued dependence on fossil fuels to meet ever-increasing demand for energy particularly for travel through private vehicles,
- India continues to depend upon coal, oil, and natural gases and derived products to meet country's energy needs for all its economic activities,
- The primary issue is the emission of carbon dioxide as a residual product resulting from the burning of these fossil fuels.

Increasing geographic size of cities due to urban sprawl and peripheral urban development around large cities has led to longer average trip lengths. For example, Delhi has an average trip length of over 11 km for all mode types, which causes additional use of fossil fuel-based energy through private modes of travel causing air pollution and fuel wastages.

Traditionally, cities in India got built in the form of mixed land uses with activity systems located alongside each other. In modern times, particularly since early 1900s when modern urban planning came into existence in India, cities have been planned by separation of land uses. Each area is used for a specific land use such as residential, industrial, commercial, public, and semi-public. This creates additional need for travel making mobility critical to city life. As shown here, principle reason for air pollution is vehicles in the city.

Increased conspicuous consumption in cities has also given rise to unsustainable developments such as malls and multiplexes, which use loads of energy without care. Apart from climate change, degradation of land, water, and air resources is some of the other environmental challenges to urban development. Increasing the proportion of built-up area, especially in urban areas, affects drainage patterns and results in increased amount of surface runoff. Natural drainage patterns have been disturbed by filling up lakes in Mumbai and Bengaluru to carry our urban development. This has blocked the natural drainage systems and has caused periodic floods during monsoons.

Increase in built-up area has also led to the reduction in open spaces, and increase in impervious surfaces such as buildings, roads, parking lots, rooftops, driveways and sidewalks, and compacted soils leads to reduced infiltration and increase in surface runoff. With increase in population, supply of developed land has become very limited, leading to the creation of high-density pockets in urban areas or another form of slums. Air, water, and land pollutions, particularly in megacities, could be reduced to a significant level by promoting green technologies, green buildings, clean energy, and reliable, efficient, and affordable public transport systems. Delhi Metro has shown the way.

Slums and squatters represent the failure of sustainable land use planning and the policy framework. Dharavi, the second largest slum in Asia, is located in Mumbai. But slums can be seen as providing housing to around 800,000–1 million people in just 2.39 km^2. The slum has a density of approximately 334,728 persons/km^2, which is way high for a decent human habitat (also see Fig. 20.5).

Growth of slums imposes environmental, governance, and demographic challenges. With the increase in urban population due to natural growth and immigration

Fig. 20.5 Slums in an Indian city

from surrounding towns and villages, housing demand, particularly affordable housing demand, also increases. Inability of government (land use planning) to provide affordable housing units at the same pace as the increase in demand has led to the proliferation of slums. At the same time, inability of city governments to control land mafia makes slums as the governance challenge. Slums also represent oppression in the form of evictions and threat of evictions by authorities to the slum dwellers. Slums also represent a demographic challenge as large numbers of people immigrate to cities. With increase in urban population, demand for water has increased tremendously exerting pressure on surface and groundwater resources.

20.3.3 The Mobility Challenge

Delhi's transport system primarily consists of road, rail, and air providing accessibility for both intracity and intercity movement of people and goods. Delhi is well connected by air services and has a large number of flights to all parts of the world and country. Domestic and international airports are located in Delhi with the latest infrastructure and other facilities. Indira Gandhi International Airport comprises of two terminals: Terminal T1 is used for domestic flights, and Terminal T3 acts as an important international airport linking different parts of the world. A large number of international airlines and Air India use this airport.

Road-based transport system in Delhi is developed and maintained by the National Highways Authority of India (NHAI), Public Works Department (PWD), Delhi Municipal Corporation (DMC), New Delhi Municipal Corporation (NDMC), Delhi Cantonment Board (DCB), and the Delhi Development Authority (DDA). In 2011, the length of roads in Delhi was 32,663 km including 388 km of national highways under PWD and this excludes the highways controlled by the NHAI. With economic liberalization in the early 1990s, Delhi has witnessed a significant growth in the number of private and personal automobiles such as cars, jeeps, motorcycles, and scooters. Public transport such as buses, auto-rickshaws, and taxis has, however, lagged behind (also see [69]). The road network has increased from 28,508 km in 2000–2001 to 32,663 km in 2011. The road network of Delhi during the last six decades is shown in Table 20.4.

The city is organized around the ring roads, which were planned and developed after independence by the Delhi Development Authority (see Fig. 20.6). The figure also shows that the blue-colored roads have 80 m right-of-way, and the red roads have 60 m right-of-way. Maximum percentage of area under roads is made up of roads with 45-m right-of-way shown in green.

In any large city, the public transport system plays an important role in catering to travel demand for work, education, and social activities. The present public transport system in Delhi comprises of bus service provided by Delhi Transport Corporation, private operators, and cluster buses run by the DIMTS. Apart from this, the rail services are provided through ring railway and suburban trains operated by the Northern Railways and Delhi Metro run by Delhi Metro Rail Corporation.

Table 20.4 Road length in Delhi (km)

Agency	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010
MCD	27,139	27,139	27,139	27,139	27,139	27,139
NDMC	1550	1550	1290	1290	1290	1290
DCB	144	144	144	144	144	144
National highways	30	30	37	57	400	424
Other roads	360	360	370	400	2400	2435
Total	29,223	29,223	28,980	29,030	31,373	31,432

Source Economic Survey of Delhi (2010)

Fig. 20.6 Road network of Delhi, 2009. *Source* UTTIPEC [76: 26]

20.3.3.1 Bus Services

Delhi Transport Corporation is the main organization tasked with providing efficient bus services to the people of Delhi at affordable prices. DTC was handed over to the Government of the NCT by Government of India in August 1996. The performance of DTC during 2001–2012 is given in Table 20.5.

As is shown in Table 20.5, the load factor dropped (maximum capacity not being used) significantly in the year 2008–2009 and the service has not been able to reach that mark till 2011–2012. Another problem was that private bus services provided through individual bus owners in the 1990s caused chaos on the roads of Delhi and increased number of fatalities on the roads. These bus services have been discontinued since January 31, 2011. These buses are now replaced with buses under cluster scheme in which buses owned by corporate entities are allocated certain specific routes in the city and fares are fixed through a due process by Delhi government. Delhi government launched the cluster scheme in 2008 for the corporatization of private sector carriage buses. Bus routes have been grouped together to form a cluster. All 657 bus routes in Delhi have been classified into 17 clusters so as to leverage bus network in order to meet rising commuter demand.

With the bus rapid transit (BRT) becoming operational on May 1, 2008, and the development of dedicated 5.7-km corridor for the service, bus service in Delhi was expected to improve. But due to poor identification of bus corridor and poor design, the BRTS could not be successful and now the BRTS is being dismantled by Delhi government.

(a) **Rail Network**

The rail network in Delhi has been planned and developed as both broad-gauge and meter-gauge lines as shown in Fig. 20.7. Delhi is an important junction on the rail

Table 20.5 Performance of DTC from 2001–2002 to 2011–2012

Year	Fleet number	Percent fleet utilization	Vehicle utilization (km/bus per day)	Load factor	Number of passenger carried
2001–2002	3286	71.68	211	82.66	854
2002–2003	3082	79.85	214	72.51	1008
2003–2004	3656	85.49	224	65.33	906
2004–2005	3470	83.98	230	67.72	962
2005–2006	3469	90.51	226	74.42	973
2006–2007	3444	81.47	199	77.18	951
2007–2008	3537	82.47	177	87.82	848
2008–2009	3804	77.03	171	68.83	772
2009–2010	4725	80.99	184	69.84	776
2010–2011	6204	75.03	185	71.43	700
2011–2012	5892	84.27	199	77.75	863

Source Economic Survey of Delhi (2012–2013)

Fig. 20.7   Railways in Delhi

map of India linked with all the metropolitan cities. Directly, Delhi is connected by 8 radial lines extending to suburban areas spreading in the states of Uttar Pradesh and Haryana.

The rail network has been planned with two lines known as the Goods Avoiding Lines (GAL) and Delhi Avoiding Lines (DAL) creating a ring in the city and ring rail system in Delhi. The GAL offers a direct entry from Ghaziabad to New Delhi bypassing the congested Delhi Railway Station area. The DAL provides a direct passage from the major yards—Tughlakabad and Ghaziabad directly into the Delhi—Ambala Kalka section and through Lajpat Nagar, Patel Nagar, Daya Basti, and Azadpur link.

(b) **Metro Rail Network**

Delhi Metro is serving Delhi, Gurgaon, Noida, and Ghaziabad in the National Capital Region as shown in Fig. 20.7. Delhi Metro happens to be the world's thirteenth largest metro systems in terms of length. Till April 2014, the network is developed in the form of six lines, plus the seventh Airport Express line, with a total length of 190 km serving 137 stations including the Airport Express stations. Of the total metro stations, 36 are built underground, five at-grade, and the rest elevated.

Delhi Metro has a combination of elevated, at-grade, and underground lines and uses both broad-gauge and standard-gauge rolling stocks.

Delhi Metro is being developed in phases. Phase I completed 58 stations with 65 km of route length of which the route of 13 km is placed underground and 52.1 km is built at surface or elevated. As of November 2010, DMRC runs around 2700 trips daily between 06:00 and 23:00 traveling with an interval of 2 min 40 s between trains at peak frequency. Delhi Metro experiences an average daily ridership of 2.4 million commuters. Phases I and II of Metro Rail Network have about 190-km-long network with 142 stations and have presently begun operating in Delhi and the NCR. The urban mobility pattern is increasingly witnessing sea change with the gradual expansion of the Metro, and about 1,800,000 passengers use the system every day. Once Delhi Metro system is fully developed in 2020, it is expected to offer the following benefits to citizens:

- Reduction in 2,182,000 passenger trips from the roads of Delhi, which will have transferred to Delhi Metro.
- It is expected that there will be 2600 less buses on Delhi roads.
- Increase in the average speed of buses from 10.5 to 14 km/h is highly likely.
- Delhi residents will be able to save 2 million man-hours per day due to reduced travel time.
- Saving in fuel costs, worth Rs. 5 billion per year.
- The system completion will also add to comfortable and safe traveling by the commuters.
- Delhi Metro will contribute to reducing atmospheric pollution levels by 50 %.
- The number of accidents on Delhi roads will come down drastically.
- There will be improvement in the overall quality of life in the city.

DMRC is also developing suburban rail in the NCR connecting a number of cities such as Noida, Greater Noida, and Gurgaon. Once completed in the next 15–20 years, suburban rail will make travel in NCR possible as envisaged by the regional planners in the NCR Plan. NCR then would be able to realize its full potential as a coherent regional entity. Rapid Metro Rail Gurgaon (RMRG) was commissioned recently linking with the Yellow Line of Delhi Metro. Although RMRG is built as a separate metro system, tickets of Delhi Metro can be also used in the RMRG network. With Delhi Metro becoming operational in the city, public transport in Delhi has witnessed perceptible positive change. With all three corridors of Phase I completed and some lines of Phase II also made operational, Delhi Metro now carries about one million passenger trips every day. This is a great achievement of the Delhi Metro Rail Corporation (see Fig. 20.8).

(c) **Regional Rail Transit System**

Regional Rail Transit System (RRTS) will be a rail-based system that will connect fast-developing towns in the NCR. The goal of the RRTS is to reduce the dependence of commuters on road-based transportation to a combination of road-cum-rail transportation systems. National Capital Region Planning Board (NCRPB) in its

Fig. 20.8 Phases of Delhi Metro Rail system. *Source* [24]

horizon plan for 2032 has identified eight Regional Rapid Transit System Rail Corridors (also see Fig. 20.9):

- Delhi–Gurgaon–Rewari–Alwar (158 km)
- Delhi–Ghaziabad–Meerut (67 km)
- Delhi–Sonipat–Panipat (89 km)
- Delhi–Faridabad–Ballabgarh–Palwal (60 km)
- Delhi–Bahadurgarh–Rohtak (70 km)
- Delhi–Shahadra–Baraut (56 km)
- Ghaziabad–Khurja (83 km)
- Ghaziabad–Hapur (57 km).

The RRTS corridors' development is proposed broadly along the existing rail alignments with the primary purpose of connecting the present and potential growth centers providing a rapid transportation system for intraregional movement (see Fig. 20.9).

(d) Intermediate Public Transport

Intermediate public transit in Delhi mainly includes mini buses, RTV, and phat-phat sewa along with cycle-rickshaws, three-wheelers, and taxis. These para-transit modes play an important role in catering to the intraurban travel demand of the city. Although their modal share of trips is limited to 3.1 %, it is an integral part of the
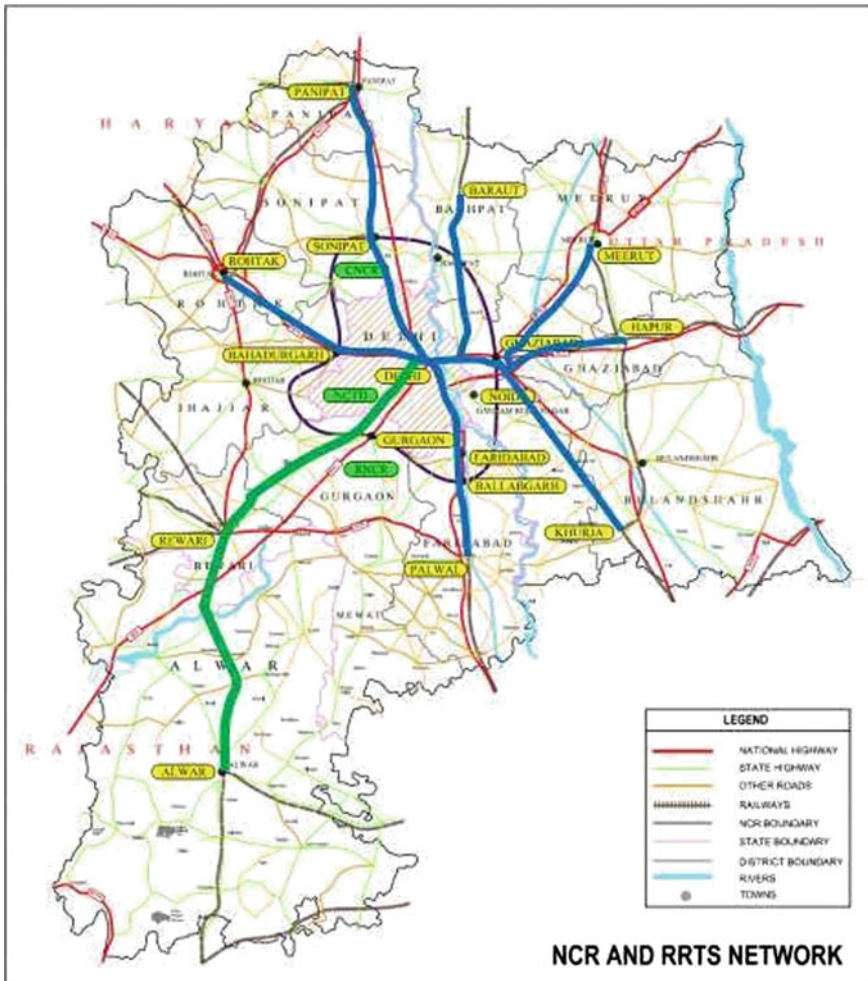
Fig. 20.9 Regional rail transport network in the national capital region

city transport system. Auto-rickshaws are an important and popular means of public transportation in Delhi as they are considerably cheaper than taxis. Cycle-rickshaw and e-rickshaw (recently introduced) have increasingly become popular modes of travel for short-distance travel in the city. The pedal-powered rickshaw is also accessible easily throughout the city and is cheap and environment-friendly but does involve extremely hard physical human endeavor bordering cruelty.

(e) **Vehicle Population**

The number of vehicles in Delhi has increased from 31.64 lakhs in 1999–2000 to 74.53 lakhs in 2011–2012. Overall, the number of vehicles has increased between 2013–2014 and 2014–2015 with a rate of 6.89 %. The total number of motor vehicle registered in Delhi in 2015 is 8.8 million (see Table 20.6).

(f) **Traffic Characteristics**

Magnitude of traffic on major roads of Delhi demonstrates a constant increase. The construction of flyovers at various locations has apparently arrested the process of congestion and delay. Increasing number of vehicles and reduced road capacity has led to shifting of traffic from one intersection to another. Due to poor enforcement, road capacities have decreased due to illegal encroachments and parking. A study was conducted in 2002 by CRRI for Government of India [21] to assess nature and magnitude of road traffic for 51 locations in Delhi. The results show that the roads are carrying more than 100,000 vehicles in the inner and middle areas of Delhi. Traffic is most critical on bridges across Yamuna—ITO Bridge carrying the maximum traffic followed by the Nizamuddin Bridge. Traffic is constantly increasing at a rate of about 2.5 % per annum, and heavy intensity of traffic has been adding to the environment degradation of the city. In fact, traffic is the main source and contributor to pollution levels in Delhi. Presently, B.Z. Marg, one of the important

Table 20.6 Vehicle population in Delhi, 2015

S. No.	Mode type	Number of vehicles		Growth rate
		2013–2014	2014–2015	Percent
1	Cars and jeeps	2625,250	2,790,566	6.30
2	Motorcycles and scooters	5,296,163	5,681,265	7.27
3	Ambulances	1519	1527	0.53
4	Auto-rickshaws	78,750	81,633	3.66
5	Taxies	74,758	79,606	6.48
6	Buses	19,641	19,729	0.45
7	Other passenger vehicles	11,289	11,284	−0.04
8	Tractors	1651	1637	−0.85
9	Goods vehicles	149,147	160,156	7.38
10	Others	106	28	−73.58
Total		8,258,274	8,827,431	6.89

Source Government of NCT of Delhi [41: 169]

arterial roads of Delhi, carries more than 200,000 vehicles. An analysis of the composition of vehicles in the inner, middle, and outer areas reveals that proportion of cars has increased throughout Delhi and proportion of Intermediate Public Transport (IPT) modes such as auto-rickshaws and taxis has gone down from 1991 to 2002. The proportion of two-wheelers has remained more or less same during this decade.

(g) **Travel Characteristics**

In Table 20.7, we present the modal split of trips made in Delhi. According to the RITES study conducted in 2007, a comparison between 2007 and 2001 is provided in Table 20.7.

As evident from Table 20.7, bus trips have decreased from 40.2 % in 2001 to 18.8 % in 2007, which has resulted in increase in trips made by cars and two-wheelers. It is also seen that the maximum percentage of trips are walk trips of the order of 34.3 %. Trips made by auto-rickshaws have reduced from 2.1 % in 2001 to 1.8 in 2007. It is noteworthy to mention that trips made by Delhi Metro have substantially increased to the tune of average 2.5 million trips in 2015.

Table 20.8 shows average trip lengths corresponding to different modes of travel. As far as planning is concerned, comparatively shorter trip lengths are preferred over longer trip lengths. In Delhi, train has the longest average trip length of nearly 28 km followed by shared taxi (24 km), chartered buses (22 km), and pool car

Table 20.7 Modal split of the trips made in Delhi

S. No.	Mode type	Daily trips 2007		Daily trips 2001	
		No. of trips	Percent	No. of trips	Percent
1	Car	1,855,655	8.0	1,216,645	6.9
2	Pool car	49,752	0.2	–	–
3	Taxi	23,990	0.1	–	–
4	Shared taxi	149,373	0.6	–	–
5	Two-wheeler	3,232,286	14.0	2,031,679	11.6
6	Auto-rickshaw	421,285	1.8	366,175	2.1
7	Shared auto	108,447	0.5	–	–
8	Bus	4,334,113	18.8	7,063,682	40.2
9	Chartered bus	215,326	0.9	–	–
10	RTV	212,807	0.9	–	–
11	School bus	1,461,230	6.3	–	–
12	Cycle	1,002,986	4.3	626,041	3.6
13	Cycle-rickshaw	1,473,086	6.4	425,235	2.4
14	Metro	550,641	2.4	–	–
15	Train	89,623	0.4	82,685	0.5
16	Walk	7,931,955	34.3	5,741,369	32.7
Total		23,112,555	100	17,553,511	100

Source RITES [65]

Table 20.8 Modewise average trip length

S. No.	Mode	Trip length (km)
1	Car	11.03
2	Pool car (with education trips)	14.94
3	Pool car (without education trips)	17.40
4	Taxi (with education trips)	14.41
5	Taxi (without education trips)	16.33
6	Shared taxi	10.90
7	Shared taxi (without education trips)	23.61
8	Two-wheeler	9.12
9	Auto	5.33
10	Shared auto	3.80
11	Bus	10.23
12	Chartered bus	21.91
13	RTV	4.92
14	School bus	5.11
15	Cycle	4.31
16	Cycle-rickshaw	1.91
17	Metro	12.66
18	Train	27.81
19	Walk	1.30

Source RITES [65]

(17 km). Average trip length of all modes is 11.42 km which is reasonably high, and there is a scope of reducing this substantially (see Table 20.8).

(h) **Present Regulatory Bodies in Urban Transport Sector of Delhi**

The multiple agencies are involved in urban transport sector in Delhi, and their roles are specific but overlapping requiring greater coordination among these organizations (see Table 20.9).

Although a number of initiatives have been taken by Delhi government to improve the transport system in Delhi, there are still many issues to be addressed including the improvement of public transport system. The key emerging issues to be addressed are as follows:

- Absence of integration among the various modes of transportation avoiding the piecemeal approach,
- Absence of standards and norms for intermodal integration,
- Absence of a coordinated organization or an institutional framework for inter-modal operations like UMTA,
- Low-intensive land utilization with respect to major transport corridors,
- Utilization and integration of ring rail system with the urban transport network,
- Restructuring of land use along ring rail with proper feeder services,
- Lack of access control on ring road and outer ring road,

Table 20.9 Transport regulatory bodies and their roles in Delhi

Authority	Role
Delhi Transport Corporation (DTC)	Operating bus services
State Transport Authority (STA)	Vehicle registration, license, permits, bus service routing and also all private operators of bus services, and RTV are under the purview of STA
Delhi Metro Rail Corporation (DMRC)	Construction of infrastructure for metro rail, operation of services as well as feeder systems
Public Works Department (PWD) Delhi Municipal Corporation (DMC)	Construction and maintenance of roads and street infrastructure Construction and maintenance of roads and street infrastructure and parking facilities
New Delhi Municipal Council (NDMC)	Construction and maintenance of roads and street infrastructure and parking facilities in its area of jurisdiction
National Highways Authority of India (NHAI)	Construction and maintenance of the national highways
Delhi Development Authority (DDA)	Planning and orderly development of NCT Delhi
Unified Traffic and Transportation Infrastructure (Planning and Engineering) Centre (UTTIPEC)	Framing and enforcement of standards for transport planning practices, capacity building, enforcement measures, road safety audits, and traffic engineering practices
Department of Transport, GNCTD Delhi Police	Overall planning of transport infrastructure in Delhi and coordination between different departments Traffic police is entrusted with the management of traffic on city roads and also ensuring safety of commuters
Institute of Urban Transport, Ministry of Urban Development	Framing standards and guidelines for transport planning practices, capacity building, road safety audits, and traffic engineering practices

- Out of four proposed directional metropolitan passenger terminals proposed in the Master Plan for Delhi 2001, East Delhi terminal known as Anand Vihar is only functional. Action should be taken on other terminals also,
- One truck terminal on G.T. Road along NH-1 is functional, and the remaining three are yet to be developed,
- Absence of bicycle facilities on major bicycle corridors,
- Absence of comprehensive parking policy for the city,
- Absence of by-pass orbital links for road and rail-based traffic,
- Road accidents are increasingly becoming a major challenge due to poor road design and non-adherence to traffic rules by majority of road users.

20.3.4 The Governance Challenge

Decentralization is defined as devolution of functions, apart from functionaries and finance, to lower-level jurisdictions, and transfer of powers or delegation of powers from central or state authorities to regional and local authorities. In the case of Indian cities, 74th Amendment to the Constitution of India paved the way for devolution of powers from the state governments to directly elected urban local bodies: municipal corporations, municipal councils, and nagar palikas. De facto challenges still remain and are being faced by urban local self-governments every day. First, it must be highlighted that still urban local bodies are being run primarily by appointed civil servants and not by elected representatives. Second municipalities do not have financial autonomy.

Despite the efforts of the State Finance Commissions (SFCs) to devolve financial resources from time to time to local governments, urban local government continues to depend upon the state and central government grants to a larger extent. Third, important functions such as land use planning and land development still remain in the hands of development authorities controlled directly by the states. Fourth, capacity building is another issue, particularly in relation to urban planners because India does not really produce sufficient number of planners so that each city could have at least one planner. Polycentric form of governance, elected mayor (empowered), and economically stronger ULBs through SFC functioning properly could successfully face the governance challenge.

As far as land use planning is concerned, the Constitutional Amendment also provided for the setting up of District Planning Committees which were tasked to prepare district development plans. Entire country now has District Planning Committees. However, functioning of DPCs needs to be made more effective and DDPs need to be urgently prepared in all states? Even where district development plans have been prepared, they are not being implemented fully. There appears to be a wedge between *de jure* and de facto, very similar to master plans for cities as convincingly shown by Pethe et al. [59]. Development plans (both district development plans and master plans) in their official form do not get implemented, and reality does not in any way resemble with what was officially intended. Under these circumstances, instead of unsympathetically criticizing development plans, we may work toward making plans dynamic in the form of strategic documents rather than comprehensive blueprint plans. Strategic dynamism is necessary for making official development plans move and change like the free markets do in accordance with changing context [59: 129].

Other related governance challenges to city planning and development include the following:

- Under resourced town and country planning organizations at the state level,
- Lack of adequately trained human resources, particularly land use planners,
- Non-operational and non-existent metropolitan planning committees and District Planning Committees,

- Lack of public participation involved in the preparation of development plans including non-preparation of district development plans and metropolitan development plans,
- Overlapping of jurisdictions of a large number of organizations dealing with the same geographic areas,
- Lack of well-defined roles and responsibilities of urban local bodies.

Apart from the above-mentioned issues, capacity building remains a central institutional challenge in Indian cities. For example, the number of town planners in India is over 4000 only as registered with the Institute of Town Planners of India or ITPI in comparison with the number of towns in India according to the [18], that is, 7953. So the first issue is that on an average, for every 2 towns, there is only one town planner. The second issue is that majority of these registered planners are concentrated in major cities of Delhi, Mumbai, Jaipur, etc., and involved in institutions such as Delhi Development Authority, City Industrial Development Corporation, Jaipur Development Authority, Chennai Urban Development Authority, and Haryana Urban Development Authority. In order to realize economically buoyant and socially equitable cities in India, multidisciplinary teams comprising of land use planners, urban economists, and social scientists (geographers, sociologists, anthropologists), civil engineers, and architects are required to be appointed in each city to carry forward the agenda of sustainable land use planning and faster economic growth. Although there is a problem of supply of adequate land use planners at the moment (currently Government of India is in the process of setting up additional new planning institutions), at the same time enough employment opportunities are not being created for trained planners and their positions are taken up by other professionals.

The Smart Cities Mission will be implemented by an organizational arrangement dubbed as the special-purpose vehicle. The SPV is a limited company incorporated under the Companies Act 2013 and will be promoted by equity shareholding of 50 % each by the state government and an urban local body. Private sector and financial institutions could hold equity shares in the SPV if equal share of equity shares between the state government and urban local body is maintained. The SPV will perform several functions. 'The SPV will plan, appraise, approve, release funds, implement, manage, operate, monitor and evaluate the Smart City development projects. Each Smart City will have a SPV which will be headed by a full time CEO and have nominees of Central Government, State Government and ULB on its Board' [57: 12 and 35–36]. The SPV must ensure that it is a credit-worthy organization in the market, which is able to raise resources from the market. The SPV is allowed to implement projects through joint ventures, subsidiaries, public–private partnerships, turnkey contracts, etc.

This kind of organizational arrangement is highly focused on efficiency, productivity, and profitability, which on its own terms is not to be derided. But after 74th amendment to the Constitution of India enforced in 1993, elected

municipalities have a major role to play in city building and maintenance including land use planning as listed in the Twelfth Schedule to the Constitution. However, in the Smart Cities Mission, the elected urban local government appears to have little or no role in the implementation of the Smart Cities Mission except some participation of selected mayors and municipal commissioners or chief executive of ULBs in the State-Level High-Powered Steering Committee and very limited participation of some ULBs in the Board of Directors of the SPV. Central government expects that 'the rights and obligations of the municipal councils with respect to the Smart City project [are delegated] to the SPV' [57: 39]. If these organizational arrangements were to be implemented, it will create a large 'democratic deficit' and even larger democratic deficit in cities like Delhi where municipalities directly report to the central government and not to the state government.

On the other hand, national-level Apex Committee headed by the Secretary and MoUD with representatives from related ministries and organizations will approve proposals for the Smart Cities Mission, monitor their progress, and release funds. This Committee will consist of Secretary, Housing and Poverty Alleviation, Secretary (Expenditure), Joint Secretary, Finance, MoUD, Director NIUA, Chief Planner, and Town and Country Planning, select Principal Secretaries of States, and select CEOs of SPVs as members with Mission Director as the Member Secretary. Further, the representatives of organizations such as UN Habitat, World Bank, TERI, Centre for Development of Advanced Computing, Centre for Smart Cities Bangalore and other bilateral and multilateral agencies and urban planning experts could be invited [57: 15]. On similar lines, state-level committees headed by respective state chief secretaries would be established with the exception that such committees would also include selected mayors and municipal commissioners or chief executive of ULBs and heads of concerned line departments. This bureaucratic arrangement at central and state levels may appear necessary and interventionist, but it is appropriate for disbursal of funds and monitoring of projects under the Smart Cities Mission (also see Figs. 20.10 and 20.11).

Resident Welfare Associations in Delhi under the Bhagidari flagship scheme of the Government of Delhi have further contributed to the democratic deficit by excluding the non-propertied citizens or slum dwellers. The Bhagidari Cell quickly defined three primary 'stakeholders' considered worthy Bhagidars: market/trader and industrial associations, bureaucrats across the municipal, state, and central government departments operating in Delhi, and Resident Welfare Associations (RWAs) based in DDA-approved residential colonies, membership of which is open only to property owners. This meant that residents of slums and unauthorized colonies (as well as renters across the city) were excluded from the 'citizen–government partnership,' the voices of whom, the Delhi government claimed, were represented by RWAs, the so-called grass-roots citizens associations (GNCTD 2006: 3 as quoted in [34:516]).
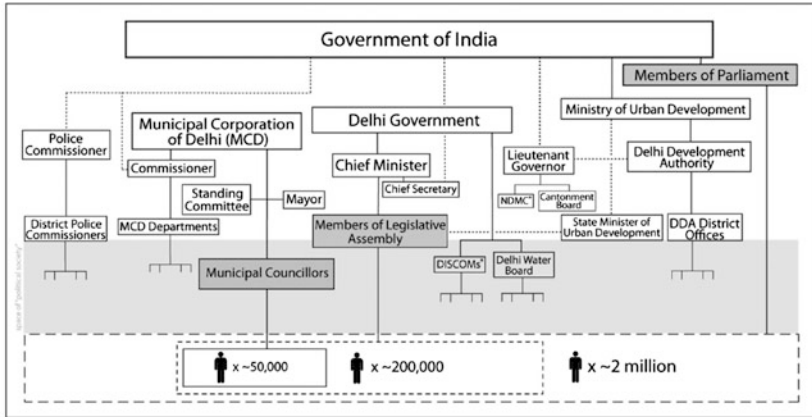
Solid lines within the figure indicate direct bureaucratic hierarchy; lower boxes are subordinate to those higher on the figure. Dashed lines indicate that a given administrative position is directly appointed by a superordinate body (usually the Government of India [GoI]). For example, Delhi's State Minister of Urban Development is appointed by the Ministry of Urban Development from among the Members of the Legislative Assembly (MLAs); Delhi's Lieutenant Governor, directly appointed by the GoI also chairs the DDA; and, although the Chief Minister is chosen by the ruling party of the Legislative Assembly made up of the city's 70 MLAs, her Chief Secretary is a senior bureaucrat (officer in the Indian Administrative Services) appointed by the GoI. The shaded boxes represent directly elected positions; the population boxes at the bottom show the approximate number of citizens represented by each elected official. Branches of the diagram hanging below the lowest designated position in any given hierarchy that lack titles indicate the domains in which lower level bureaucrats operate. There are more than 120 public bodies operational in Delhi (Jain, 2003); only a handful are shown here. The large shaded area indicates the state space in which Chatterjee's (2004) 'political society' is strongest. The degree to which a branch or box falls in this space represents how prone it is to the pressures of 'political society'.
* 'NDMC' stands for the New Delhi Municipal Council, which serves the same function as the MCD, only in the more geographically confined administrative areas of New Delhi; the Cantonment Board is the municipal body that oversees Delhi's Cantonment area; 'DISCOMs' stand for the electricity distribution companies, which are regulated by the Delhi government.

Fig. 20.10 Administrative structure of the NCT Delhi. *Source* Ghertner [34: 510]
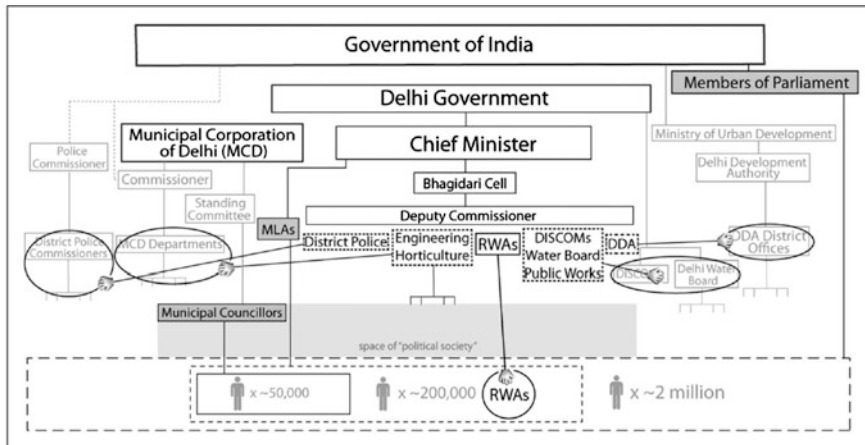
This figure shows how the space of 'political society' has become both shallower – i.e. those in political society cannot reach high enough up into the state to access the bureaucrats that can bend the rules in their favor – and narrower – i.e. the poor now cannot reach as wide a range of government departments – than shown in Figure 1. The hand symbols indicate the original positions in state space from which various government bodies have been moved under Bhagidari.

Fig. 20.11 Reconfigured administrative hierarchy under the Delhi government's new Bhagidari scheme. *Source* Ghertner [34: 521]

20.3.5 *The Challenge of Urban Planning*

Delhi developed city planning system early on in the country. Delhi Development Act 1957 provided the basic legal framework within which the statutory Master Plan for Delhi was mandated. It took few years after the promulgation of the Act that the Master Plan for Delhi was prepared and enforced in 1962. The primary goal of the master plan was to plan for 'orderly development' in Delhi, the task which Delhi Development Authority resoundingly failed. The Former Chief Minister of Delhi, Sheila Dikshit, was reported to have said that two-third of Delhi is built in an unauthorized manner blaming Delhi Development Authority, the planning agency controlled by the central government, for this failure.

Although Delhi Development Authority has been able to create major built environment in the city particularly housing for the middle- and high-income groups, the planning agency could not succeed in providing housing to the urban poor who engaged in slumming and unauthorized development in the absence of adequate supply of low-income housing. According to its own records, DDA has 'completed less than 10 % of its low-income housing projects' (DDA 2006 as quoted in [35: 511]). Second, aspect of the housing challenge is that the DDA has been reducing land entitlements of the low-income families by reducing the plot size in this income category to lowest level possible and eventually replacing land entitlements with low space entitlements. Master Plan for Delhi, 1981, proposed 67 m^2 land for each low-income family, which was reduced to 32 m^2 in the next version of the master plan, i.e., Master Plan for Delhi, 2001. In the latest version of Master Plan for Delhi, land has been replaced with built space of 32 m^2 dwelling unit size under the new land policy. The third aspect is that when housing for poor is not provided, a failure on its own terms, and these families squat on public lands throughout the city, evictions and displacements become inevitable when these lands are needed by the planning agency for various reasons. Failure of the planning agency for being unable to fulfill its legal mandate of providing certain percentage of low-income housing, sows seeds for future evictions and displacements of the urban poor.

Another challenge that planners in DDA could not face successfully was that of the pollution of the river Yamuna waters by a number of developments that take place in and around the river Yamuna and also letting untreated wastewater into the river. Construction of the Commonwealth Games Village, a large residential development, meant to accommodate players during the Commonwealth Games held in October 2010 in Delhi, DTC bus depot for which case is still pending in the court, Yamuna Bank Metro Station and train depot, etc., contributed to the violence of the river Yamuna. Some see this behavior of planning agency as colluding with potential violators of the planning and environmental laws. As Amita Baviskar puts it:

> The subsidy to builders included bailing out Emaar MGF, the Dubai-based real estate developer contracted to build the Games Village. Under a public-private partnership (PPP) arrangement, the DDA allotted 27 acres of prime land for free to the company to build 1168 luxury flats to house athletes and officials. Under the terms of the contract, the

firm would sell two-thirds of the flats while DDA would sell the remainder. After the financial downturn of 2009, the cash-strapped company appealed to the government for help and the DDA responded by giving it an interest-free loan of $100 million, to be repaid in the form of additional flats [3: 51].

Specifically related to the Smart Cities Mission, the DDA has played little, if any role, in making the Delhi smart. This is so when the DDA-developed residential colonies are crying for modernization through advanced technologies. DDA has recently prepared a new land policy based on the well-known land pooling technique prevalent in other parts of the country for several decades. This land policy was supposed to address the limitations of the earlier land policy of bulk acquisition. But it has created more complications by installing long-drawn land assembly process to be used by the private developers. So far, no land is assembled under this land policy, although this new land policy was approved by the Ministry of Urban Development on September 5, 2013, as shown on the DDA Web site and has also been included in the Master Plan for Delhi, 2021, as its 19th chapter [23: 19-1–19-4]. If even after more than two years, the policy has not been able to facilitate the land assembly, the DDA planners need to look for reasons for its non-implementation.

20.4 Making Delhi a Smart City: Economic Buoyancy and Spatial Justice

Given the serious implications of the challenges faced by the Indian city generally and Delhi in particular, it is reasonable to expect that among other city planning policies, the Smart Cities Mission in India would address these challenges. Smartness of Indian cities could be determined by examining whether the Smart Cities Mission addresses the above elaborated urban challenges and to what extent it addresses these issues. But before we do that, it is imperative that we examine the New Delhi Municipal Council area as it conceived as a Smart City in NCT Delhi.

20.4.1 New Delhi Municipal Council: A Smart City of Delhi

The Smart Cities Mission earmarked one smart city for the National Capital Territory of Delhi. Initial rumors of three smart cities in Delhi have quickly faded. The State-Level High-Powered Steering Committee (HPSC) under the chairmanship of the Chief Secretary, Government of the National Capital Territory of Delhi (GNCTD), recommended New Delhi Municipal Council to be created as the smart city. On August 27, 2015, Ministry of Urban Development, Government of India, accepted the recommendation for participation of New Delhi Municipal Council in the second stage, i.e., the City Challenge round.

For the preparation of the Smart City Proposal, New Delhi Municipal Council hired KPMG Advisory Services Private Limited. After deliberations, the Council of the NDMC approved the Smart City Proposal on December 7, 2015, which was supposed to be submitted to the Ministry of Urban Development on December 15, 2015, for inclusion and consideration in the City Challenge competition. Once the NDMC cleared the City Challenge stage, the Ministry of Urban Development would allocate funds to the NDMC. But before this, the NDMC Smart City Proposal has to be approved by the State-Level High-Powered Steering Committee.

On January 29, 2016, Ministry of Urban Development, Government of India, declared the list of 20 cities, which would be funded under the Smart Cities Mission. New Delhi Municipal Council, the only smart city of the GNCT of Delhi, also found place in that list of 20 cities. These 20 cities were selected on the basis of the feasibility of the proposal, cost-effectiveness, result orientation, citizen participation, strategic plan, vision and goals, etc. Total funding amounting to Rs. 50,802 crores for 20 cities and towns over five years will be made available by the central government. Out of this amount, Rs. 38,693 crores will be spent on area development and Rs. 12,109 crores on 56 pan-city solutions [71].

As far as Delhi is concerned, one question that has become bone of contention at least among planning scholars is why a proposal to make the NDMC a smart city is proposed by the GNCT of Delhi? This issue becomes important because the NDMC contains only 3 % of the total population of Delhi and a very small area of the metropolis. Moreover, the NDMC area is highly developed physical and social infrastructure with no slums. At the same time, the NDMC has been continuously receiving large annual budgets per head when compared with the other three municipalities of Delhi, previously known as Delhi Municipal Corporation.

We treat the Smart Cities Mission as an urban policy reform. If reforms mean policy adaptations to changing social, economic, and political circumstances, then reforms are needed, even necessary. Nobel Prize winner, economist, and philosopher Amartya Sen argues that three factors are required to be considered before undertaking any policy reforms. These are 'reach, range, and reason—or more elaborately: (1) the reach of the results to be achieved, (2) the range of the ways and means to be used, and (3) the reason for choosing the priorities we pursue' [65: 1971]. Reach refers to reforms being *person-related* and *even-handed.* Person-related means that reforms positively contribute to the lives people want to live and freedoms they want to enjoy, and even-handed means interests and freedoms of all, particularly the poor, are looked after. Reforms therefore must pursue inclusionary ends. Range refers to diversity of means such as nature of economic growth, social commitments, and democratization. Thus, instruments to achieve ends include range of reforms in the economic, social, and political spheres. Reason refers 'the constant willingness to ask why exactly they are doing what they are doing' [65: 1973]. Reason constantly poses a question to policy makers or reformers why a policy is being implemented and why they are doing so. Among other things, I would also like to evaluate the Smart Cities Mission (as it stands as a policy) in India against Sen's range, reach, and reason (also see [28: xi–xxxiv]).

Whether the Smart Cities Mission in India meets the five challenges of urbanization discussed above when compared with the analytical outline given by Amartya Sen is the task we pursue now.

20.4.2 Smart Infrastructure

The Smart Cities Mission focuses on the application of 'smart solutions' for the development and maintenance of infrastructure and services. In all the policy document lists 21 smart solutions, ranging from smart water meters through to smart parking, integrated multimodal transport, and telemedicine and tele-education, a smart city infrastructure includes 'adequate water supply, assured electricity supply, sanitation including solid waste management, efficient urban mobility and public transport, intelligent traffic management, affordable housing, especially for the poor, robust IT connectivity and digitalization, good governance especially e-governance and citizen participation, sustainable environment, safety and security of citizens particularly women, children and the elderly, and health and education.'

Could the Smart Cities Mission meet the challenges of urban infrastructure? The policy intent is present, but it lacks details about how to build and maintain smart infrastructure. With Rs. 100 crores per city per year from the central government and another Rs. 100 crores from the state government, it is woefully inadequate funding for making a city smart. An arterial road construction in a city would cost nearly Rs. 2 crores/km, and a single low-floor bus would cost about Rs. 55 lakhs. Construction of a metro line per kilometer costs Rs. 175 crores. Even BRT costs Rs. 15–20 crores/km. Similarly, laying out sewer lines would cost heavily. There is a little indication about sources of funds for building and maintaining the smart infrastructure.

Second, it does not mention anything on the serious issues of open defecation and manual scavenging. The reforms are therefore neither person-related nor even-handed. Talk of inclusivity is mere policy rhetoric. However, effective implementation of sanitation-centered policies and programmes will help make Indian cities smart. For example, under the Swachh Bharat Mission, 28,948 community and public toilets have been completed till October 2015 as per the information displayed on the Dashboard Swachh Bharat Mission of the Ministry of Urban Development. Similarly, the National Urban Sanitation Policy does make mention of 'safe management of human excreta,' as more than '37 % of the total human excreta generated in urban India is unsafely disposed.' It recommends that '100 % of human excreta and liquid wastes from all sanitation facilities including toilets must be disposed of safely.' This policy also addresses the pressing issue of open defecation and suggests concrete measures to make Indian cities open defecation-free cities and towns. The issue of manual scavenging is also taken up in this policy [55: 1–2]. Funding for providing latrines to tackle the problem of open defecation will come from the Integrated Low Cost Sanitation scheme run by the

Ministry of Housing and Poverty Alleviation where the central government will provide 75 % subsidy, the state government will provide another 15 % subsidy, and the remaining 10 % of the cost will be borne by individual beneficiary households. 'The main objective of the scheme is to convert around 6 lakh dry latrines into low cost pour flush latrines by 31st March 2010. … the Scheme for Integrated Low Cost Sanitation … essentially focuses on provision of latrines to prevent open defecation in order to eliminate manual scavenging' [55: 9–10].

Convergence of a number of urban policies is significant for making the Smart Cities Mission successful as far as building and maintenance of basic infrastructure are concerned. The Smart Cities Mission is fully aware of integrating number of 'other programmes and schemes with the Smart Cities Mission' [55: 17].

20.4.3 Smart Environment

One of the core infrastructure elements in a smart city is 'sustainable environment' whose meaning is left unexplained. The word environment appears in Annexure 4: Challenge Stage 2: Criteria and Indicative Table of Contents, where a specific question is asked about the impact of a certain proposal on the environment and can significantly impact the selection process due to high score awarded to this question [57: 35]. Whether this concern and criteria involving impact of a proposal on environment will also result in compulsory environmental impact assessment is unclear. But these provisions should be read with relevant environmental laws and regulations. For example, environmental impact assessment has been made mandatory under the EIA 2006 notification made under the Environmental Protection Act 1986 where prior environment clearance is required for all projects listed in the Schedule of that notification including Common Effluent Treatment Plants, Common Municipal Solid Waste Management Facility, building and construction projects of $\geq 20,000$ m^2 of area 150,000 m^2 of built-up area, townships and area development projects covering an area ≥ 50 ha, and built-up area $\geq 1,50,000$ m^2.

In order to make the smart environment in the NCT Delhi, we suggest the following policies:

- Public transport should be strengthened by adding new fleet of buses, which is due since the last decade. Reach of Delhi Metro should be further strengthened by timely completion of Phase III.
- Cleaning of the river Yamuna is linked up with stopping of the direct disposal of wastewater into the river. Urgent policy attention is required from the municipalities as well as the PWD to design decentralized sewerage system embedded in advanced technologies for its long-term maintenance.
- Sanitation being the most important aspect of life in Delhi, Government of the National Capital Territory of Delhi should undertake serious steps to eliminate open defecation in the city. This could be easily done by the municipalities by

involving communities in designing and day-to-day running of community toilets. Of course municipalities must make sure that adequate amount of water is made available for cleaning up these community toilet blocks. We need to avoid the past pitfalls. For example, the Municipal Corporation of Delhi gave contract to Sulabh International for managing over 2000 pay-and-use toilet complexes in Delhi. On July 2006, the MCD retook control of these toilet complexes due to dispute over poor operations and maintenance (Larrousse et al. 2006:14). The project failed due to its complexity, which could be only understood if communities and citizen groups also get involved.

- Odd–even formula, which has been accepted by a majority of Delhi according to media reports, should be strictly implemented in the NCT Delhi with fewer exemptions. Particularly, women should not be excluded from this scheme if congestion on the roads has to be reduced, and consequently, air pollution has to be minimized. At a later stage, even two-wheelers should be included after making appropriate arrangements for better public transport including bus, metro, and IPT.

20.4.4   Smart Mobility

Smart mobility involves smart parking and integrated multimodal transport system according to the Smart Cities Mission. Continued expansion of city, the vision of the Government of NCT of Delhi envisages comprehensive and strong public transport system so that the share of person trips in a day catered by the public transport rises to 80 %. Revamping of the public transport infrastructure is under consideration, with the continued expansion of metro rail linking both sides of the river Yamuna, procurement of new buses, etc. Transport system of the city calls for comprehensive improvement under a visionary integrated multimodal public transport plan to meet the future demand (Fig. 20.12). Metro, Light Rail, and BRT systems have been recommended to be developed on many corridors based on estimated travel demand. As per the proposed public transport plan, the total length of Metro Rail within Delhi and the NCR by 2021 will be about 414 km; Light Rail about 40.3 km; and BRT about 650 km.

20.4.5   Smart Governance

Involvement of all citizens in local decision making about how built environment should be produced and reproduced and how basic services should be provided should be considered the centerpiece of smart governance. Bhagidari scheme in Delhi was antithesis of this aspiration and statutory provision made under the 74th amendment to the Constitution of India. In the case of Bhagidari, only propertied
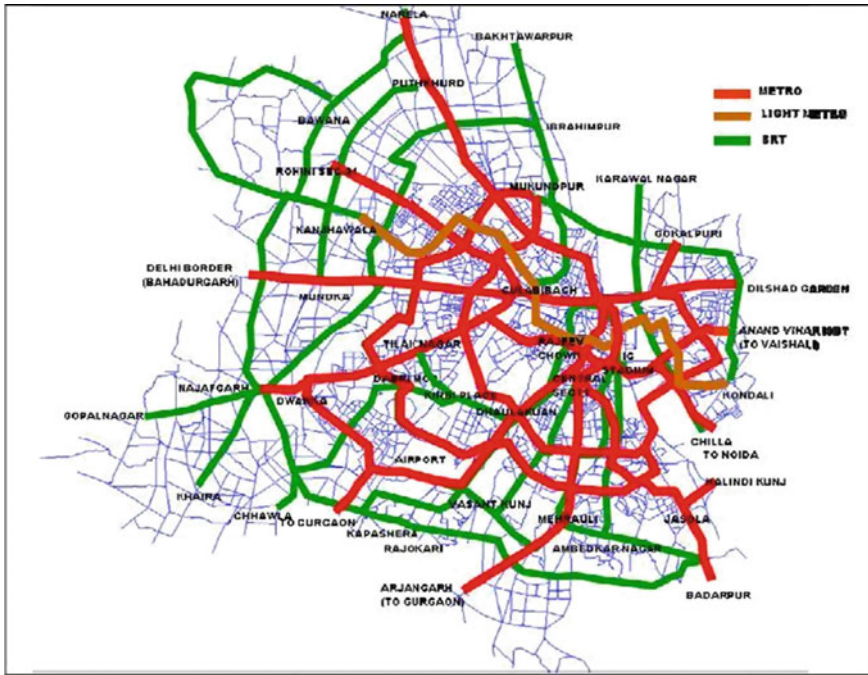
Fig. 20.12 Proposed multimodal public transport system in Delhi

people are regarded citizens, and therefore, they are eligible to be members of the
Resident Welfare Associations at the expense of exclusion of 69 % of citizens
living in slums and unauthorized colonies in Delhi [35: 516]. So smart governance
in Delhi should address the first principle of smart governance, i.e., exclusion of a
majority population from the decision-making processes.

After issuing the first list of 20 cities for funding under the Smart Cities Mission,
the Ministry of Urban Development wants to know the progress being made by
various state governments for setting up the special-purpose vehicles for imple-
mentation of the smart city development plans. New Delhi Municipal Council is a
peculiar case whereby the municipality already reports to the central government
through LG and the elected state government remains on the margins. Additionally,
the Smart Cities Mission would compel implementation of the smart city NDMC
projects through SPV, an appointed body largely made up of non-elected members.
It will be run like a corporation under the Companies Act. We argue that the Smart
Cities Mission should be implemented by democratically elected local govern-
ments, in this case, the NDMC in consultation with the state government. We also
argue that exclusion of almost the entire NCT Delhi from the Smart Cities Mission
is an unsmart move on the part of the Government of the National Capital Territory
of Delhi because this step excludes 97 % of the population of NCT Delhi.

20.4.6   Smart Human Resources

Only few people may know that Delhi houses more than 200 Fortune 500 companies and city's economic performance is double than that of India [6: 49 and 23]. The World Wealth Report 2011 ranked Delhi as the 37th richest city in the world. The Asia Pacific 2016 Wealth Report places Delhi at the 20th rank in terms of high net worth individuals (investible assets exceeding US$1 million or more) with a total of 20,600 high net worth individuals. It is expected that Delhi would be the second richest city in terms of HNWIs in Asia Pacific by 2025 (www. asiapacificworldreport.com). Delhi also scores the first rank among the very high-performing metropolitan clusters [5].

While economic progress is less reported in both popular media and scholarly works, Delhi's problems are much rehearsed particularly in critical scholarly research with a major focus on slums and the uncertain future of slum dwellers and unauthorized developments. One of the major planning instruments such as the Master Plan for Delhi is discussed and dissected more for what it provides for slum dwellers than for any other policy. Scholarly work largely appears to be employed to highlight what is wrong with the city and who has committed these wrongs to the urban poor [2, 5, 26, 34, 35, 48, 64]. Whether these works should be appreciated because they represent an aspiration and desire for securing justice for the marginalized groups in the city is an unsettled and contested question. This question is hardly contested in the scholarly journals and books but through the implementation of neoliberal policies, programmes, and projects. Whether urban studies scholarly research is largely reactionary as authors examine these policies after these have been pronounced and implemented is another issue that requires separate debate and discussion. Here, we want to explore whether some solutions could be found to the much criticized city of Delhi. 'What is to be done' is the most critical question that we intend to answer through this chapter with the case of Delhi. We believe that problems are resolvable challenges. So in this section, we present a brief history of the NDMC smart city of Delhi before coming back to the question of five challenges of Indian urbanization.

We would like to argue that the entire National Capital Territory of Delhi should be considered for smart city development under the Smart Cities Mission. There are at least two reasons for making this proposal. First, the NCT Delhi has been facing a number of urban challenges, five of which have been discussed above. Second, the NCT Delhi has huge potential to become a smart city because it has number of strengths including its sustainable economic position in terms of rising per capita income and gross domestic product and a large and growing number of millionaires living in the city. Third, the city has a long tradition of city and regional planning. Only making the NDMC area as a smart city is like investing public funds where there is a little need of doing so because already huge sums per head are invested in NDMC area, several times more than DMC areas. More deserving candidates for public investment are those parts of the city, which would leverage private investments and improve the quality of life of all citizens of Delhi. More

specifically, areas like East Delhi would deservedly benefit from public investments as housing and infrastructure is generally in shambles in this part of Delhi.

Furthermore, Delhi performs very well on the key development parameters of drinking water, higher education, cooking gas, and sanitation facility. For example, drinking water within home is more than India's mean of 47 %. Human capital of Delhi translated as percent of people with educational qualifications of graduate and above is also more than the India mean of 11 %. Households equipped with sanitation facilities are also more than the India mean of 47 %, and households with LPG as cooking fuel are also more than the India mean of 29 %. Only on account of households electrified, Delhi is similar to the India mean of 67 % [6: 49]. With this level of provisioning, Delhi stands among the top few metropolitan cities such as Bengaluru, Kochi, Ludhiana, Chandigarh, Pondicherry, and Goa leaving behind cities such as Mumbai, Kolkata, Hyderabad, and Chennai.

In 2011, nearly 1.4 % population of India lived in Delhi, which is clearly indicative of the fact that a lot many people are attracted to the national capital [41: 18]. As far as population is concerned, it has increased from 1.7 million in 1951 to 16.7 million in 2011, an increase of 9.6 times since 1951. Population growth rate of Delhi has moved upward in the first four decades beginning 1951 and then sliding downward in the last two decades. In 2011, population growth rate of Delhi nearly halved that of 1961 growth rate. Government of Delhi attributes this reduction in population growth rate to attraction of some proportion of population to priority towns which could have otherwise migrated to the metropolis in the absence of development of priority towns (see Table 20.10). Population growth rates may have fluctuated somewhat over the last seven decades, but there has been nearly tenfold increase in actual population of the capital, generating its own momentum in terms of opportunities and problems.

Growth of population on its own terms does not explicate smart city development or lack of it. Two additional factors are significant and these are age structure and education levels of population. Agewise distribution of population figures is very encouraging as it shows that Delhi has consistently maintained over 40 % of the total population between the age-group of 20–49 (see Table 20.11). This young population represents an important element of smart city economic growth if it is adequately educated, trained, and skilled in top universities and colleges that are

Table 20.10 Population growth of Delhi, 1951–2011

S. No.	Year	Population (000)	Percent growth
1	1951	1744	–
2	1961	2659	52.44
3	1971	4066	52.93
4	1981	6220	53.00
5	1991	9421	51.45
6	2001	13,851	47.02
7	2011	16,788	21.20

Source Government of NCT of Delhi [41: 18]

Table 20.11 Agewise distribution of population in Delhi, 1991–2011

Age-group	1991		2001		2011	
	Number	Percent	Number	Percent	Number	Percent
0–14	3,273,482	34.75	4,492,939	32.44	4,565,319	27.19
15–19	914,871	9.71	1,427,979	10.31	1,667,375	9.93
20–24	982,866	10.43	1,426,860	10.30	1,764,060	10.51
25–29	956,788	10.16	1,358,925	9.81	1,668,326	9.94
30–39	1438,035	15.26	2,211,006	15.96	2,753,943	16.40
40–49	867,731	9.21	1,432,467	10.34	2,008,410	11.96
50–59	504,149	5.35	759,505	5.48	1,196,361	7.13
>60	439,520	4.67	719,650	5.20	1,147,445	6.83

Note 'Age not stated' category accounted for 0.46 % of the total population in 1991, 0.15 in 2001, and 0.1 in 2011
Source Census of India—Primary Census Abstract (2011)

located in the city. When skilled, this young population becomes the backbone of Delhi's buoyant economy.

According to UNFPA [73: 13], the demographic dividend 'is the economic growth potential that can result from shifts in a population's age structure, mainly when the share of the working-age population (15–64) is larger than the non-working-age share of the population.' In Delhi, over 60.12 % population was in the age-group of 15–59 in 1991, it increased to 62.2 % in 2001, and this further jumped upward to 65.87 % in 2011. Potential benefits of investing in young population 'include greater economic productivity, more resources for better quality infrastructure and services as fertility rates decline, increased political stability and transmission of achievements to coming generations' [73: 99]. This implies larger investments in higher technical education, creation of world-class higher education institutions, and creation of conducive urban environments in Delhi, which is attractive for producing and retaining 'creative classes' for work, residence, and tourism. More than producing talented young people, retaining them is equally, if not more significant, for economically vibrant Delhi in a globalized context.

According to the millennium development goals, Delhi State Report 2014, Delhi has literacy rate of 96.46. Although it is an excellent figure when compared with literacy data of 1951 for Delhi, it does not build a lot of confidence for making Delhi a smart city when literacy is defined as a basic capability of being able to read and write. Thus, we need to look further, notwithstanding basic education remains pivotal to start any kind of development.

Delhi has some of the best higher educational institutions in the country such as Delhi University, Jawaharlal Nehru University, Indian Institute of Technology, Dr. B.R. Ambedkar University, Delhi Technological University, Indira Gandhi Delhi Technical University for Women, Indraprastha Institute of Information Technology, Netaji Subhas Institute of Technology, Indira Gandhi National Open University, Jamia Millia Islamia, Guru Gobind Singh Indraprastha Vishwavidyalaya, All India Institute of Medical Sciences, Jamia Hamdard, Indian Law Institute, National

School of Drama, Indian Agricultural Research Institute, Indian Institute of Foreign Trade, National Museum Institute of History of Art, Conservation and Museology, TERI School of Advanced Studies, and School of Planning and Architecture, New Delhi. Over the years, these institutions have served the country and the city of Delhi well (also see Table 20.12).

Therefore, in order to make a really smart city, higher level of literacy will not suffice. Young learners and experienced professionals must have technology-centered advanced skills and knowledge to be able to usefully and actively participate in producing the smart city as well as taking benefits from such a city by getting closely involved in the smart processes embedded in advanced technologies for delivery of services and governance. World Development Report 2016 talks about the 'digital dividend' whereby the actual realization of smart citizenship would depend on cognitive, social and behavioral, and technical skills ([79]; also see Fig. 20.13). According to the Human Development Report 2015, work is the fundamental motor force for human development. The Report concludes that 'human creativity, ingenuity, innovation and work can expand choices, enhance well-being and ensure freedom for every human being in an equitable and sustainable way—so that human progress, indeed, leaves no one behind' [72: 181].

World Bank Report 2015 dealt with the complex subject of 'mind, society, and behavior' and pointed out that 'captures the idea that paying attention to how humans think (the processes of mind) and how history and context shape thinking (the influence of society) can improve the design and implementation of development policies and interventions that target human choice and action (behavior). To put it differently, development policy is due for its own redesign based on careful consideration of human factors' [78: 2]. Both the latest reports of the World Bank seek to substantially advance development centered on human factors rather than materials and machines per se. Poverty consumes 'cognitive resources' and imposes

Table 20.12 Higher educational institutions in Delhi, 2009–2015

Type of institution	Year					
	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15
Universities	8	8	10	10	11	11
Deemed universities	12	12	12	12	12	12
Institutions of national importance	2	3	3	3	3	4
Colleges for general education	78	78	81	81	81	81
Colleges for professional education	107	106	103	103	100	100
Total	207	207	209	207	207	208

Note School of planning and architecture became the institute of national importance under an Act of Indian Parliament in 2014
Source Government of NCT of Delhi [41: 223]

Cognitive	Social and Behavioral	Technical
Literacy, numeracy, and higher-order cognitive skills (for example, reasoning and creative thinking) Raw problem-solving ability versus knowledge to solve problems Verbal ability, numeracy, problem solving, memory, and mental speed	Socioemotional skills and personality traits Openness to experience, conscientiousness, extraversion, agreeability, and emotional stability Self-regulation, grit, mind-set, decision making, and interpersonal skills	Manual dexterity and the use of methods, materials, tools, and instruments Technical skills developed through postsecondary schooling or training or acquired on the job Skills related to specific occupations (for example, engineer, economist, IT specialist)

Fig. 20.13 The types of skills needed in a modern economy. *Source* [79: 33]

'cognitive taxes' leading to poorer decision making and low aspirations [78: 81–91]. The World Bank 2014 report similarly points out 'India's experience shows that states with more flexible labor regulations and lower costs of compliance tend to have greater labor mobility and higher productivity and employment in the formal manufacturing sector.'

But how far residents of Delhi are educated? What percent are graduates and postgraduates and how many of them are professionally qualified. Answers to these questions could pave the way for making the city of Delhi a smart city.

Although the literacy level is over 86 % in the city, Delhi has only 19 % citizens with graduate, postgraduate, and professional degrees. However, this is much higher than the India-level figure of only 7 % [40: 75]. This implies that Delhi has 2.6 times more graduates, postgraduates, and professional degree holders than all India average. Overall, Delhi has 3,189,720 graduates, postgraduates, and professional degree holders, which is more than the total population of countries such as Armenia, Mongolia, Bahrain, and Qatar individually (see Fig. 20.14).

Given all the above-mentioned advantages particularly the advantage of youthful and skilled human resources, Delhi is poised to become the smart city with better policy framework and some financial help from the central government and smart governance by Delhi government and other development agencies. Looking after all citizens through equitable distribution of benefits and opportunities is good for capital accumulation, although neoliberal regimes may find it difficult to comprehend this.

Delhi: Human Resource by Level of Education, 2013
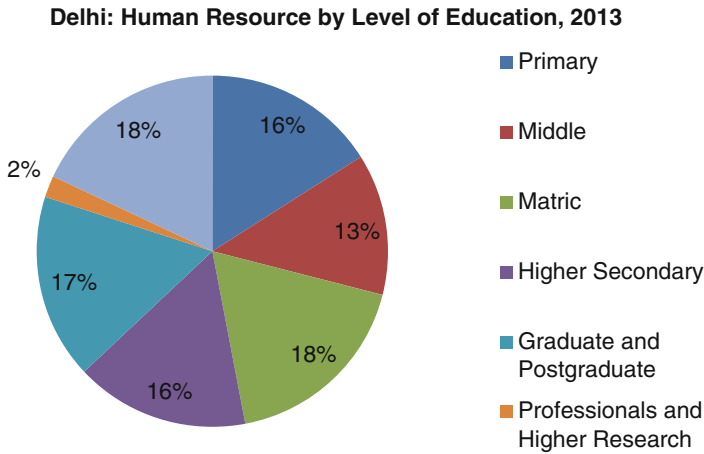
Fig. 20.14 Human resource by the level of education in Delhi. *Source* Government of the National Capital Territory of Delhi [43: 75]

20.5 Concluding Remarks

The Smart Cities Mission appears to focus on the selected aspects of smart city project including the use of information technology embedded in the built environment and efficiency leading to the economic growth at the direct cost of tackling the crucial impending issues of urban development challenges of infrastructure, environment, mobility, planning, and governance. The Mission has little to say directly on the environmental challenges, and it has a lot to say on running the Smart Cities Mission through CEOs of companies under the special-purpose vehicle. This could reduce the significance of elected urban local governments' already fledgling status due to limited financial and human resource capabilities. Even on the challenge of urban infrastructure, the Mission would succeed only if it sought convergence with other urban policies such as the National Urban Sanitation Policy and the Swachh Bharat Mission (Urban).

In the case of NCT Delhi, we propose that Delhi government should start a process of selection of parts of the city, which could be considered for development under the Smart Cities Mission. Selection under the City Challenge is an administrative exercise aimed largely at selecting cities for funding on the basis of identified parameters. Prior to the application of the City Challenge, Delhi government should technically establish on the basis of need and reach, which areas should be developed as smart cities by keeping in mind majority of the population. Indicative list of such parameters could include slope, protection of natural environments like the river and the ridge, income, governance, etc.; only after this Delhi government should worry whether its Smart City Proposal will get selected for central funding. Lastly, funding for the Smart Cities Mission must substantially increase; the existing funds are totally inadequate for making cities smart.

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Part VII
India-Varanasi

Chapter 21
Smart Economy in Smart Cities Varanasi India: Case of a Smart Traditional Economy of Knowledge-Based Institutional Services and Creative-Cultural Products

Joy Sen, Mouli Majumdar, Deepanjan Saha and Abhik Chaudhuri

Abstract Next to 'Sustainable City' and 'Resilient City', 'Smart City' is apparently the new buzzword in the discourse on development of cities across the globe. This is particularly true for India with the Ministry of Urban Development, Govt. of India taking up the mission to develop a hundred smart cities to guide planned urbanization across the country. The concept of 'smartness' in cities has largely meant to be driven by modern advances in technology, particularly in Information and Communication sector (ICT), and its interface with functioning of cities. However, besides such reliance on modern technologies and its implication on smart growth, scholars and governments have tried to recognize the power of traditional economies, which have been able to sustain over centuries, and appropriate them to present scenarios. This chapter on

J. Sen (✉)
Department of Architecture and Regional Planning, Ranbir and Chitra Gupta School of Infrastructure Design and Management, IIT Kharagpur, Kharagpur, India
e-mail: joysen@arp.iitkgp.ernet.in

M. Majumdar
Ranbir and Chitra Gupta School of Infrastructure Design and Management, IIT Kharagpur, Kharagpur, India
e-mail: moulimajumdar@gmail.com

D. Saha
Department of Architecture and Regional Planning, IIT Kharagpur, Kharagpur, India
e-mail: saha.deepanjan@gmail.com

A. Chaudhuri
Tata Consultancy Services, Mumbai, India
e-mail: abhik2.c@tcs.com

Varanasi (India) presents cases from the city which exemplify its strength on traditional knowledge system as a driver of its economy; and thereby, a driver for urban development. Accordingly, the chapter is being split into three sections. The first section identifies the development potential based on ecological innovation, particularly, for the Greater Rajghat–Sarnath Region in the Varanasi City Region. The study indicates that innovation hubs tend to cluster and form a network of innovation zones. Under this ambit of innovation-led development, the understanding of clustering has further been noted in the study of clusters of few cultural industries from Varanasi City Region, as noted in the latter section. In the final section the possibility of ICT augmentation for smart economy and smart governance in the city of Varanasi has been explored. Thus, the city of Varanasi highlights the strength of its economy, which is partially driven by ecological innovation and creativity, with a promise to drive a smart growth.

Keywords Ecological innovation · Creative economy · Traditional clusters · Varanasi

21.1   Introduction

Varanasi with its 3000-year-old footprint is one of the oldest and continuously inhabited cities in the world. It is known by various names which includes—*Kasika*, *Avimukta* (never forsaken), *Anandavana* (forest of bliss), *Rudravasa* (the place where Rudra or Lord Shiva resides); more popularly as *Kasi/Kashi*: the 'luminous city as an eminent seat of learning' [1]; and Varanasi as the city which spans between the confluence of river Ganga with the stream of Varuna in the North and that of Assi in the South. Strewn with 84 '*ghats*'(stepped embankment along the river) between the 3 km interface of river Ganga and the ancient settlement, Varanasi forms a mosaic of various cultures, thoughts, social norms and paradoxes (Fig. 21.1).

   Varanasi is a Class I city, and its municipal corporation has a population of 1,198,491 (urban areas with population more than 1,00,000 are classified as Class I towns as per Census 2011) [2, 3]; and a large floating population of tourists—both national and international—as tourism is a dominant sector of the city's economy. Varanasi's economy is also hugely dependent on informal sector which accounts for over a third of the workforce. Small-scale cottage industries form a major part of the economy.

   Apart from small-scale industries, other sectors that influence the economy of the city are handloom, handicraft, hospitality and education sector. Varanasi is also known to be the cradle of learning, new thought and innovation. A great number of thinkers, poets, prophets, educationists have made the city a receptacle for many revolutionary, and sometimes even conflicting, schools of thought.

   The interpretation of smart economy is varied and might focus on great infrastructure, excellent public services such as healthcare, quality domestic and international connections, broadband, fiscal incentives and tax breaks, high quality education system, publicly funded research, and others. The natural inclination is to
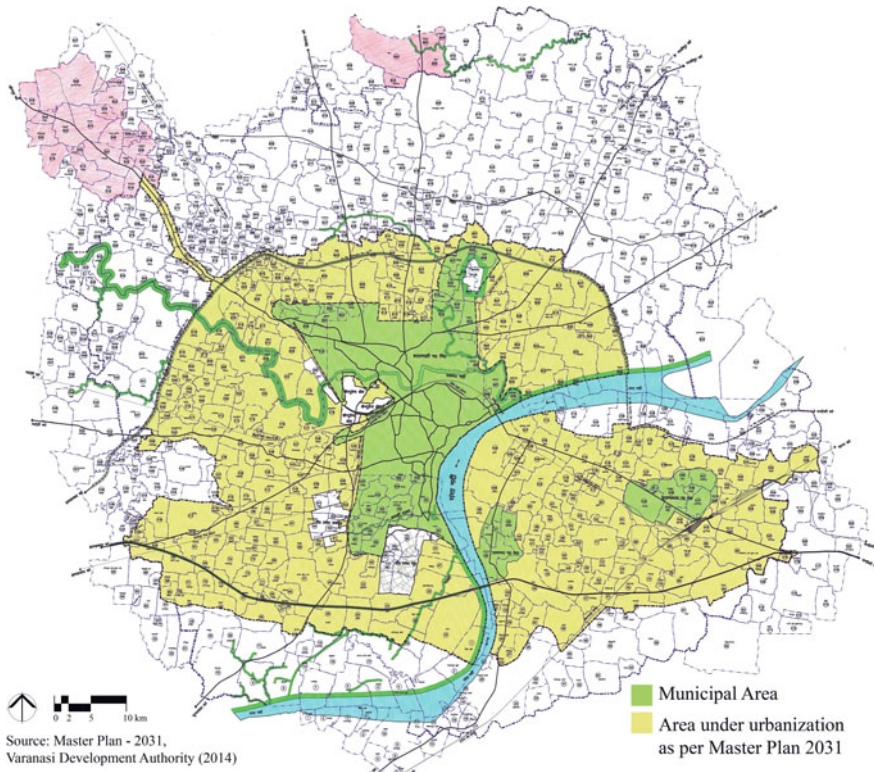
Fig. 21.1 Varanasi City Region

take advantage of the intrinsic quality of a region that will lay the foundation for the smart economy.

In the following sections, major strengths of Varanasi city's economy are being discussed in a bipartite approach. The first section establishes the development propensity based on ecological innovation—i.e., innovation through grouping of academic institutions, spiritual institutions, social/entrepreneurial setups and activities; while the latter discusses the various clusters of cultural industries spread across the city—i.e., industries-related production of cultural goods and services. Recognition of these zones/clusters is needed so as to frame policies as a step towards smart economy.

The development factors for eco-innovation zone as derived from [4] can be summarized under following five heads.

- Technology and Communication,
- Creativity and cultural infrastructure,
- Human capital,
- Knowledge workers,
- Spatial clustering.

Table 21.1 Strategies for ecological innovation-based development for Varanasi city

	Short-term strategies	Midterm strategies	Long-term strategies
Technology and communication	Extension of the *Panchkroshi Marg*—a pilgrim trail encircling the city	Provision of outer ring road connecting NH2, NH56 and NH29	Reduction in through traffic reduced traffic on NH2 direct access to traffic of trans-Varuna area
Creativity and cultural infrastructure	Upgradation of existing heritage structures, provision of public utilities, tourist information centres	Activity clustering through organizing '*yatra*' (tour), village tours, gathering '*mela*' (fairs) to attract knowledge workers	Cultural clustering to enliven the city areas, recreating and regenerating the areas into cultural hubs
Research and education facilities	Upgradation of existing education/research facilities	Propose and facilitate investment in the research and education institutions	Clustering of research/education facilities with industries: from systems-driven to innovation-driven
Knowledge workers	Providing research facilities, skill development centres, workspaces, entrepreneurial opportunities	Providing affordable housing, amenities, services to attract knowledge workers	Outdoor recreation opportunities, diverse ethnic and cultural settings to attract knowledge workers
Spatial clustering	Augmentation/clustering of existing innovation hubs to form innovation zones	Assimilation or network of innovation zones	A network of exploratory-experimental laboratories for an entire generation

Table 21.1 notes the broad recommendations for the city of Varanasi with particular focus on ecological innovation-led development summed up as follows under long-term, short-term, midterm and the aforementioned five parameters.

21.2 Section-A: Ecological Innovation-Based Smart Economy

21.2.1 Introduction: Conceptual Approach

Over the last few decades, innovation of knowledge-based economy aiming at symbiosis of high-order human development and environmental–ecological preservation is being recognized as a major aspect of smart economy and sustainable development. For ages, India has been practising this belief which has led to Vedic or '*gurukul*'—traditional residency form of learning wherein the roots of modern science and technology lie embedded. This form of knowledge sharing has

later resurfaced through expressions of the ecological–humane exploratory laboratories like that of Rabindranath Tagore in form of 'Shantiniketan', Mahatma Gandhi in form of 'Sabarmati ashram' and that of Rishi Aurobindo in form of 'Auroville' are to name just a few.

When one considers Varanasi which has always been a vibrant centre for cultural and intellectual activities it is instinctive to strengthen the existing intellectual clusters of the city rather than dispersing it following the current trends of urban sprawling in her peripheries. The idea can be summed up through the term 'Ecological innovation' [5].

'Ecological innovation' in context to this study tries to encapsulate the idea of innovation through grouping of academic institutions, spiritual institutions, social/entrepreneurial setups and activities.

Tying Varanasi with ecological innovation through the Geddesian triad of 'work-place-folk' [6]: innovation rising from place itself: 'Varanasi being 3000 years of assimilation of pilgrimages, mystics and scholastic tradition', combining it with work in form of amalgamation of 'traditional knowledge systems of Art, crafts, rituals, riparian economy, weaving, music and performing art with technological innovation framework' leading to social innovation for folks in form of 'physical spaces that stimulate innovation at a mass-level forming linkages between various sectors'.

This study would explore through a case study a possible methodological framework to explore the potential of Greater Rajghat–Sarnath zone or the trans-Varuna region which holds the strength and the opportunity of being developed as a high-order ecological innovation zone and possible strategies to enhance it.

21.2.2 Ecological Innovation: An Overview

Ecological innovation involves the commercial application of knowledge to develop processes and products which lead to technologically advanced, socially acceptable and innovative paths towards sustainable form of development. It is more often perceived as a technological term referring to innovative products or processes to elicit direct or indirect ecological improvements, but it should also bring greater social and cultural acceptance because that determines learning and the practical effectiveness of ecological innovations [5].

21.2.3 Ecological Innovation-Based Development: Case of Varanasi

As the economy has shifted over couple of decades from heavy dependence on industrial mass production to more knowledge-based goods and service production setting the tempo knowledge and innovation-driven urban development.

Varanasi has always been a seat of learning offers both the resources and propensity to be enhanced to an ecological innovation zones especially the Greater Rajghat–Sarnath Region. In context to this study, ecological innovation aims to stimulate environments which are conducive to innovation, learning, creativity and change, through clustering of knowledge-based activities that consists of the tripartite: academic institutions, psychic/spiritual institution and creative economy/livelihood setups.

21.2.4 Education Hub versus Innovation Hub

21.2.4.1 Education Hub

Primary aim is to build a critical mass of local and international actors strategically engaged in education, training, knowledge production and innovation initiatives. It can be categorized into three parts as follows:

- **Student's hub** The key activity is the education and training of local and international students, recruitment and exchange programs
- **The skilled workforce hub** Focuses on student education and training but also on developing a skilled work force and foreign students are encouraged to remain in the host country for employment purposes
- **Innovation/knowledge hub** Based on development of cluster of institutions, educational hubs and research and development activities, supporting business in well-defined geographic precincts [7].

  According to [8], there are three major types of innovation clusters.

- Clustering of knowledge-intensive service sector activities around corporate head offices.
- Clustering based on a knowledge network that encompassed both regional learning institutions and for profit industry research teams. Innovations produced in the knowledge network were adopted and developed economically by proximate industries.
- Their third type refers to creative industry clusters largely based on cultural knowledge generation like movie-making, popular music and related areas.

21.2.5 Innovation Zone Developments Characteristics

Innovation zones which may be considered as spatial expression of knowledge-based urban development that chiefly refers clustering of

- Research and development activities.
- High-tech manufacturing of knowledge-intensive industrial and
- Business sectors linked by mixed-use environment including housing, business, education and leisure within an urban-like setting.

In the following section, we explore the scope for spatial clustering of knowledge/innovation hubs to form eco-innovation zone generating physical spaces where these traditional knowledge hubs can be amalgamated with modern technologies as the driver of smart economy.

21.2.6 Study Area: Greater Rajghat–Sarnath Region

The city of Varanasi is spans between confluence of river Assi with Ganges in south and that of Varuna in the north. It can be broadly be categorized into two broad zones of trans-Varuna and cis-Varuna. The major part of the Varanasi city that one experiences falls within the cis-Varuna area, while the area chosen for study in this context falls within trans-Varuna region, extending from Rajghat plateau at Varuna–Ganga confluence up to Sarnath towards north. More specifically, the planning domain consists of following Wards: 1, 3, 4, 5, 6, 7, 11, 13, 15, 16, 18, 20, 25, 26, 27, 30, 50, and 57. As one move towards the Greater Rajghat–Sarnath Region from the main city, the ritualistic agglomeration-based activities of the dense city-core give way to more agrarian and meditative lifestyle. Rajghat–Sarnath Region has been chosen again and again over the time, by likes of Lord Buddha, Anne Besant, Jiddu Krishnamurti for humanitarian innovation laboratories. So the study aims to establish, earmark and augment this zone with a balance of built and unbuilt spaces to form a network of ecological innovation hub leading to humane exploratory laboratories that would nurture and guide the young minds of the new generation (Fig. 21.2).

The conceptual approach being as follows:
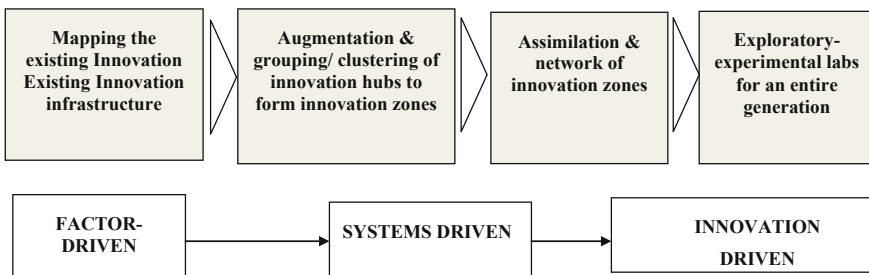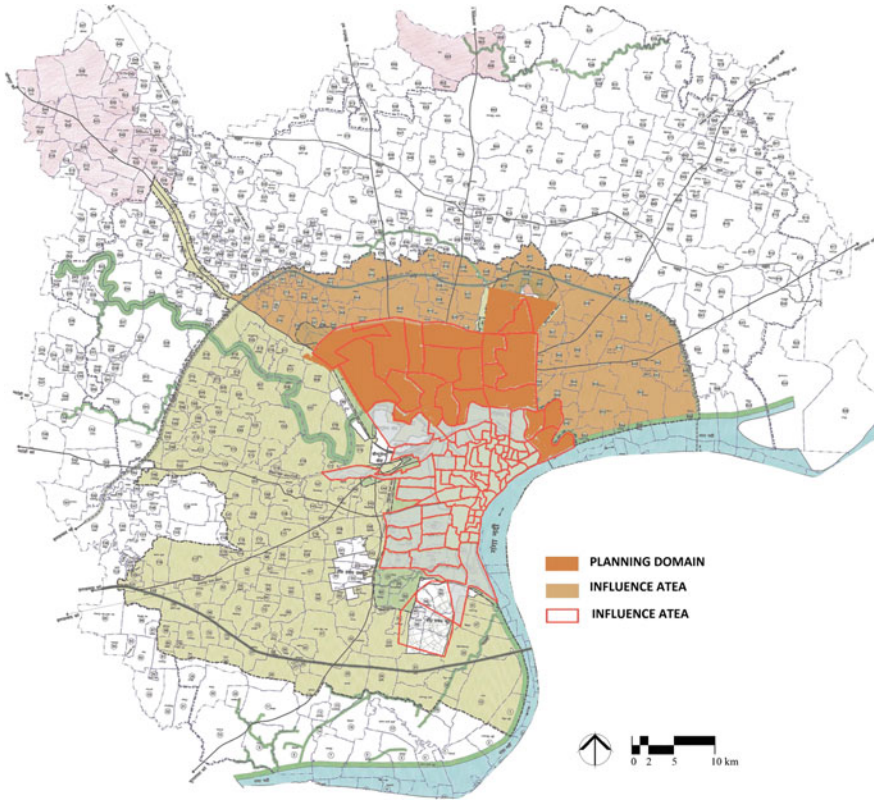
Fig. 21.2 Planning area

21.2.6.1 Aim and Objective

The study aims to formulate strategies for augmenting Greater Rajghat–Sarnath Region into ecological innovation zone through twofold approach:

- Establishing the ecological-development propensity of Greater Rajghat–Sarnath Region.
- Earmarking and clustering the innovation hubs to form a network of innovation zone.

The details of methodology and objective are summed up in the following Figs. 21.3 and 21.4.
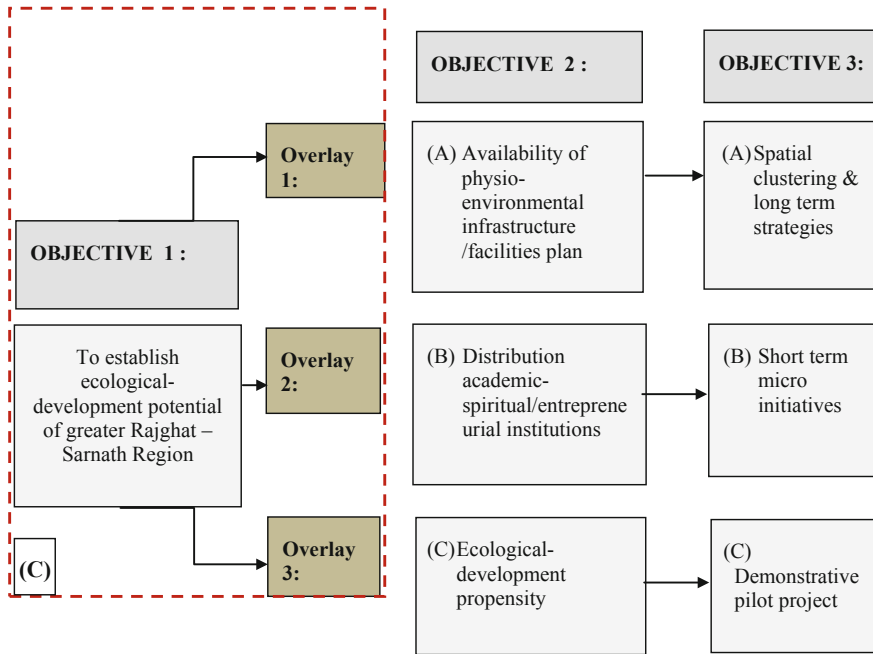
Fig. 21.3 Approach methodology and objectives

21.2.6.2 Analysis

The approach structure of analysis can be categorized into following four steps summed up below:
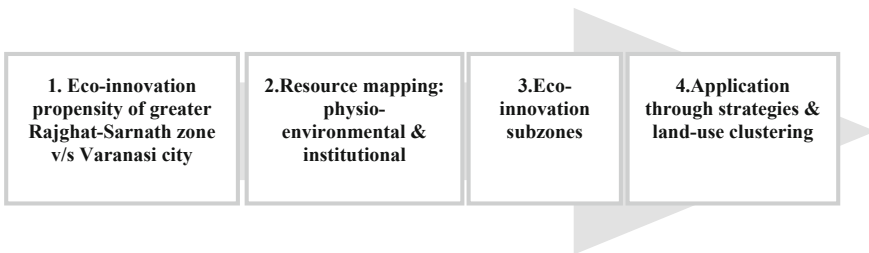
The details of the process are discussed in the following sub-sections.
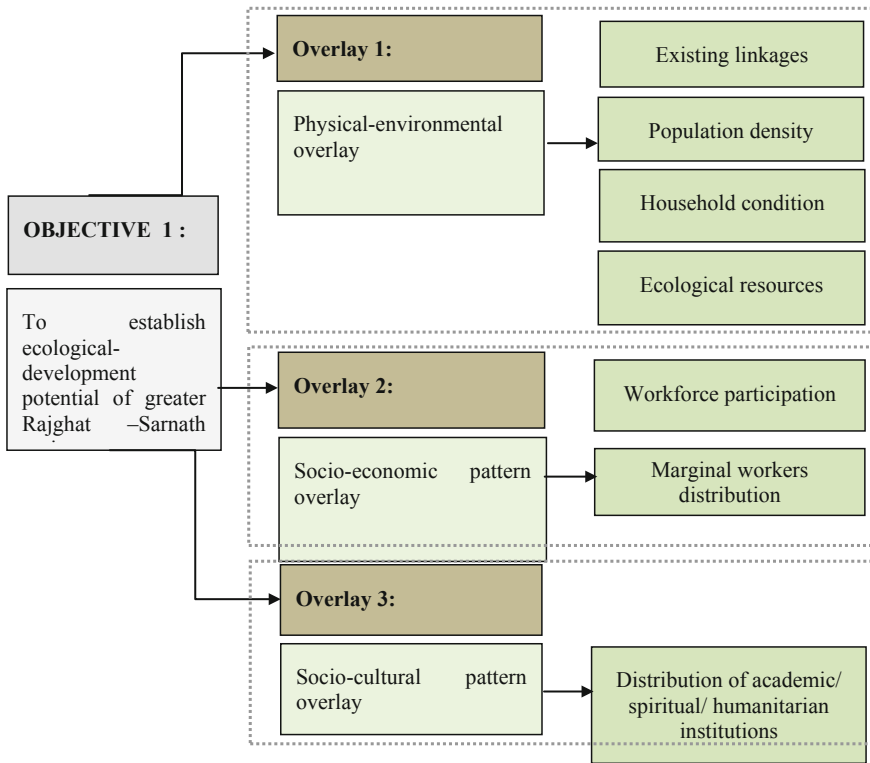
Fig. 21.4 Detail of part 'C' of the methodology as in Fig. 21.3

21.2.7 To Establish Eco-Development Potential of Greater Rajghat–Sarnath Region versus Varanasi City

The first step attempts to establish that the Greater Rajghat–Sarnath zone has higher propensity of being developed into an ecological innovation zone through overlay method.
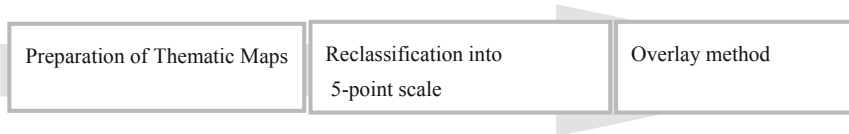
In the first stage, thematic maps were prepared considering broadly physical-environmental pattern overlay, socio-economic pattern overlay and sociocultural pattern overlay and the parameters used are as follows:

- Physical-environmental overlay existing linkages, population density house-hold condition and ecological resource.
- Socio-economic overlay workforce participation, marginal workers distribution.
- Socio-cultural overlay distribution of academic/spiritual/humanitarian and entrepreneurial institution.

After that, thematic maps are classified into scale of five they are overlaid.

Five being the highest score i.e., it has highest potential to be developed into ecological innovation zone and one being the lowest score i.e., having the least potential.

The resultant map shows the ecological innovation potential of Greater Rajghat–Sarnath zone to be higher compared to the Varanasi city and within this region Rajghat plateau and Sarnath shows the highest potential (Fig. 21.5).
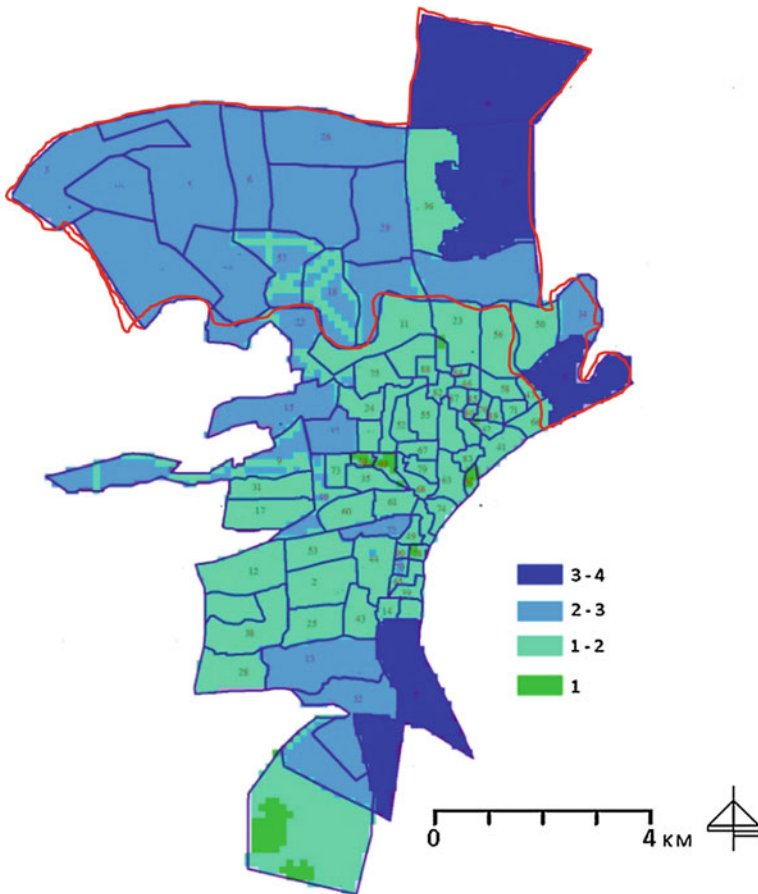
Fig. 21.5 Overlaid map showing ecological-development propensity
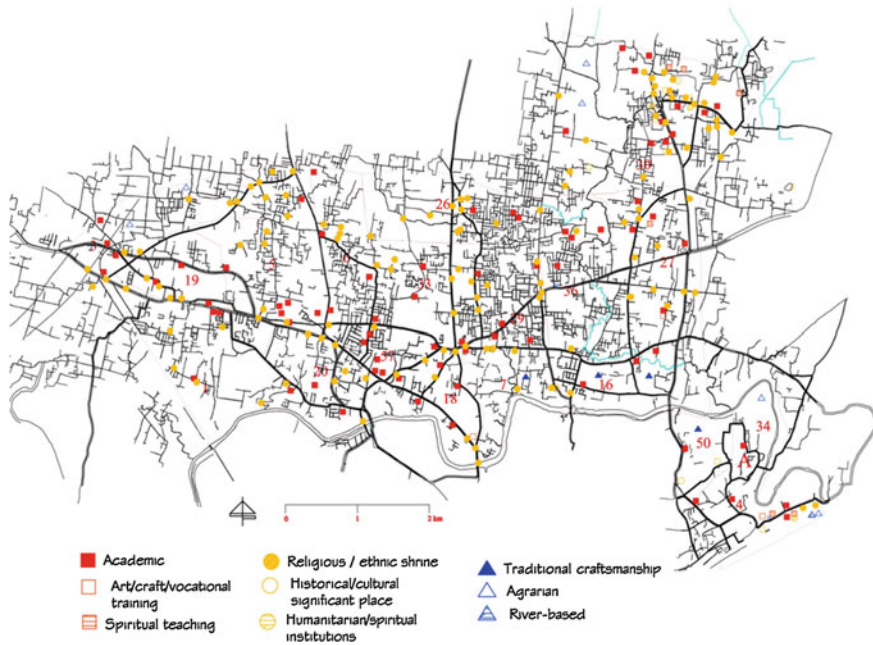
Fig. 21.6 Map showing distribution of institutions

- Physio-Environmental Infrastructure/Facilities Plan
- Distribution Academic-Spiritual/Entrepreneurial Institutions

The ecological innovation concept also encapsulates the idea of environmental sustainability. So availability of physio-environmental resources forms an important aspect, as the right combination of both built and unbuilt spaces forms the environs for ecological innovation development. For the aforesaid purpose, the physio-environmental infrastructure facilities are mapped.

Mapping the distribution of existing institution is an important aspect as it would be the basis for further augmenting these existing innovation hubs to form eco-logical innovation cluster. The available knowledge/innovation institution is marked in the form of (i) academic, (ii) spiritual, (iii) livelihood/creative economy generating centres or holistic centres which will promote all three together (Figs. 21.6 and 21.7).

21.2.8 Ecological Innovation Activity Predominance Within Greater Rajghat–Sarnath Region

The approach to mark the ecological innovation activity predominance within Greater Rajghat–Sarnath Region can be split into two parts, first uses the location quotient analysis to mark the predominant activities and second uses weighted
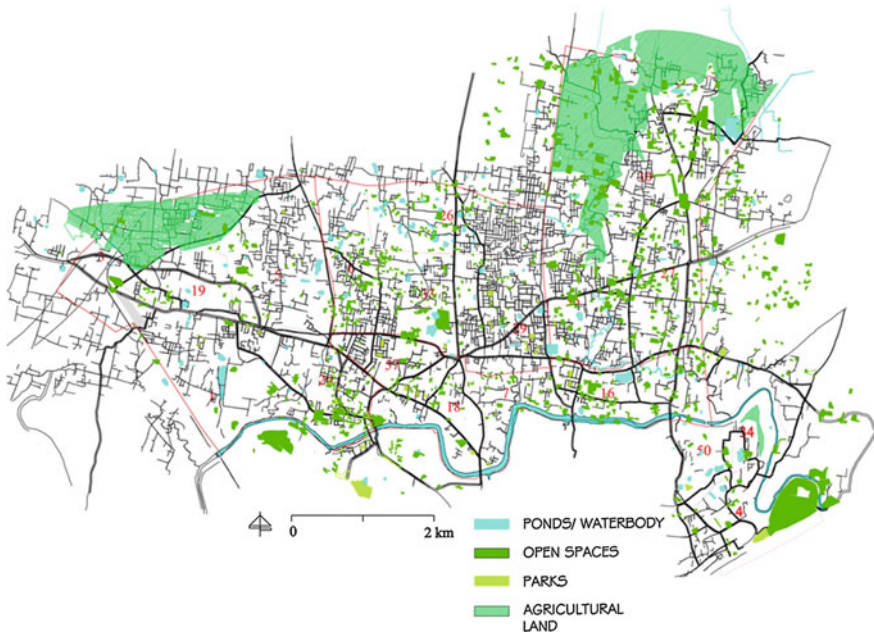
Fig. 21.7 Physio-environmental facilities map

matrix method is used to scale the ecological innovation propensity of Rajghat–Sarnath Region into zones of high, medium and low. To conclude the two thematic maps IE. The development propensity map and predominant activity maps are overlaid to get the final activity cluster map (Fig. 21.8).

21.2.8.1 Proposals

The existing predominant activity and ecological innovation propensity are analysed for the study area and depending on the result zones were marked out. The proposed zones are marked out according to the following parameters: existing linkages, green footprint, built footprint, existing ecological innovation clusters and building uses. The zones identified are broadly under categories:

- Ecological Innovation zone with predominance of academic innovation.
- Ecological Innovation zone with predominance of innovation in spiritual/psychic development.

Academic & spiritual institutions with high development propensity

Spiritual & other forms of livelihood with low development propensity

Academic & other forms of livelihood with moderate development propensity

Spiritual, academic institutions & other forms of livelihood with high development propensity

Academic institutions & traditional craftsmanship with moderate development propensity

Spiritual & Agrarian form of livelihood with high development propensity
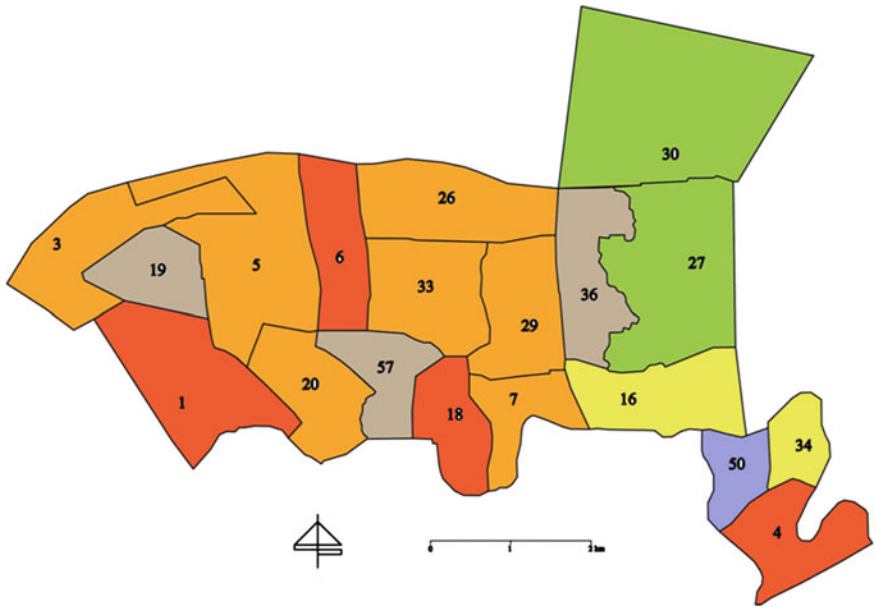
Fig. 21.8 Ward map showing identified clusters of predominant activity

- Ecological Innovation zone with predominance of social/entrepreneurial innovation (Fig. 21.9).

Through this example, we visualized creating an environment that would act as catalyst in bringing together the individual hubs and assimilating it, then augmenting it, not only spatially but also at institutional level translating from factor-driven individualistic approach to systems-driven clusters. Thus, forming an ambience that would be like a network of humane exploratory laboratories as breeding spaces for smart economy—reinventing the strengths of traditional knowledge systems through advantages of modern technologies.

The Ghats of Varanasi

Saree   Wood-craft   Wooden toys   Glazed Terracotta   Porcelain
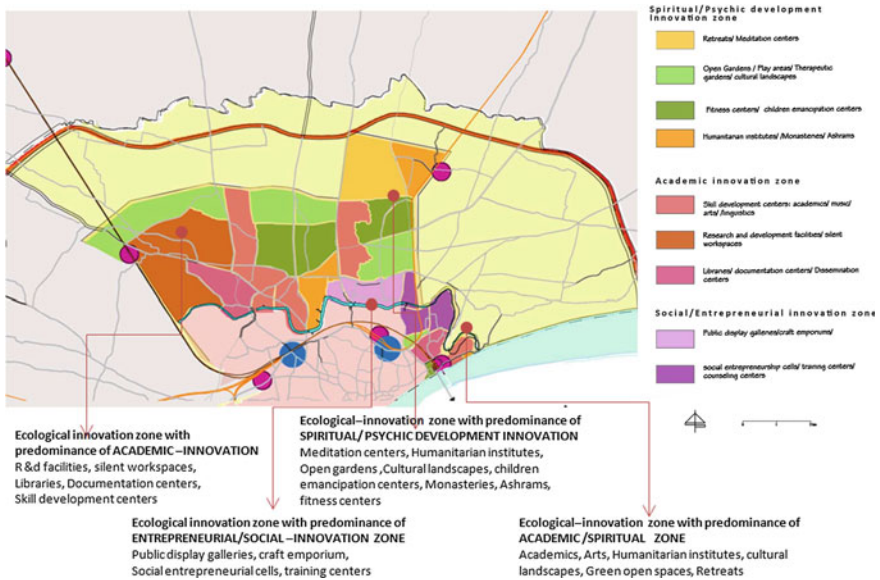
Fig. 21.9 Map showing proposed ecological innovation zones with predominant activities

21.3 Section-B: Cultural Industries-Based Smart Economy

21.3.1 Creative Economy of Varanasi

Creativity, knowledge and innovation have increasingly been acknowledged as drivers of sustainable socio-economic development. UNESCO [9], in its report on 'Creative Economy', has highlighted the need to ensure that 'culture and human rights inform the new course for sustainable development'—a kind of development which is not only economically viable, but also socially inclusive, environmentally sustainable, and brings in peace and security. Given this backdrop, creative economy has been identified a growing sector of the economy; and it necessitates better comprehension of knowledge-driven planning process of our urban centres.

As noted by various researchers, creative industries tend to cluster to take advantage of the concentration of skilled human capital, creative class and appropriate built environments. Moreover, creative atmosphere spurs and sustains the entrepreneurial spirit in the domain of cultural production [10]. Such creative-clusters further shape the urban morphology; and consequently, influence the overall planning process of the city. As per the 'creative class' concept propounded by Florida [11], creativity has been identified as one of the sources of competitive advantage for cities.

The historic city of Varanasi is a repository of traditional art and crafts, music and dance, literature and philosophy, and many other domains of knowledge. Hence, for centuries, the economy in Varanasi has been shaped by such indigenous traditional knowledge which has manifested itself into various cultural products, goods and services. Tradable cultural products, such as silk 'sarees', wooden toys and metal-craft, are major manufactured items in the city, with more than half of the working population being engaged in weaving industry.

Given an underlying base of innovation, as discussed in the previous section, the creative economic advantage of the city is being discussed in this section. Major cultural production clusters in the city-region have been discussed in the following paragraphs. This includes silk weaving, betel-leaf and wooden toys which the city is famous for. Besides that, it also discusses the pottery industry centred in Chunar, a historic town in the Varanasi City Region.

21.3.2   Silk Weaving

Banarasi Silk *Saree*—traditional clothing worn by women across large parts of India—has been crafted in Varanasi since fifth century CE. The weavers are highly clustered in the dense neighbourhoods of Madanpura in the city-core, and Alaipura, Jaitpura, Adampura, NatiImli in the periphery of the city. In recent times, weavers have largely shifted from handloom to power-looms. Additionally, with the advent of a variety of synthetic and mixed silk, dynamics of the trade, and also the craft, has witnessed a huge transformation.

Silk-weaving industry of Varanasi is a good example of how changes in any of the phases of the 'Culture Cycle' transform the economy as a whole. A typical culture cycle comprises of the stages of culture-creation, production, transmission and dissemination, exhibition and consumption. Change in cultural consumption patterns (demand for light-weighted *saree*, contemporary design motifs) has deeply influenced the industry in present times.

Issues and challenges, though the silk-weaving industry is the largest in Varanasi and has maintained its reputation over centuries now; the condition of the weavers' communities is ailing. These weavers live in residence-cum-workshops in dense neighbourhoods.

The state and national governments have devised a number of policies to safeguard the rights of these workers by designating them as national level skill development centres.

About 80–90 % of the looms used at present are power-driven; and thence, are dependent on power-supply which is heavily erratic in this part of the city, being absent for about 5–7 h daily. Still weavers are adopting power-looms over hand-looms as weaving a sari on a power-loom requires about four-and-a-half hours, whereas it takes almost a full week and more on the latter. It may be observed that the booming sector of power-looms has led to denigrating the position of a master-weaver to that of a labour.

21.3.3 Betel-Leaf (Paan) Industry

The art of having processed betel-leaf or, '*Banarasi Paan*' is a traditional culinary practice characteristic of Varanasi City. Despite of having no production in the region, the traditional knowledge of processing held at household level qualifies it as a cultural industry.

Betel-leaves are sourced from the states of West Bengal and Odisha; sold in the wholesale market of Paan-Dariba in Chetganj; bought by individuals/families who process the leaves at household level at various city-quarters in Varanasi within a radius of about 5–6 km (particularly, Khojwa, Ishwargangi, Hukulganj and Aurangabad). Processed leaves are sold back to the wholesale market for distribution across the country. The processing involves smoking of betel-leaves with wood-charcoal in a closed chamber for a period of about 20–25 days; which renders the leaf soft, less bitter and paler in colour; thus, enhancing its value. This processing has taken the shape of a household industry engaging families in various city-quarters.

- Raw material primarily, betel-leaves are of two varieties: *Jagannathi* (from Bengal and Odisha) and *Magaihi* (from Bihar). While the former variety is available round-the-year, the latter is limited to the period of November till February.
- **Business/Turnover** The wholesale trade (*satti* in Hindi) operates twice in a week: Tuesdays and Saturdays. Each day, transactions of about 40–50 lac rupees are made. It is one of the largest markets in eastern Uttar Pradesh (or *Purvanchal*) in North India.
- **Employment** About a thousand workers, registered with the society '*Barai Sabha*', are engaged with the conduct of processing of leaves, whereas about 500 more are operating unregistered. Indirectly, about 2000–3000 retailers ('*beeda-waley*') are selling dressed leaves (*paan*) at numerous sale-points spread all across the city of Varanasi.
- **Association** '*Barai Sabha*'—a registered body looks after the welfare of the workers who are engaged in processing of raw leaves. '*Chaurasia Samaj Benares*' is also a sociocultural association for the community which is engaged with the industry.
- **Social structure** *Barai* is a Hindu caste-community mainly found in the eastern and central Uttar Pradesh, engaged in the cultivation and selling of betel-leaf. *Chaurasia* is a significant sub-caste, besides *Katiyar, Jaiswar, Mahobia* and *Nag*. In the western Uttar Pradesh, they were replaced by the *Tamboli* community.
- **Associated industries** The adjoining areas of the *Paan-Dariba* market in Chetganj are dotted with shops selling allied products, such as betel-nut, *masala* (spices), lime, *kattha*, utensils specific to the art of dressing the leaf.

Issues and challenges Following shortcomings were identified by the President of '*Barai Sabha*'—a society registered in 1953.

- As shelf life of betel-leaves cannot be enhanced by keeping them in cold-storage, the trade is largely affected by variations in climate and consequent fluctuations in the produce. However, there is not any special package (recovery options) from the government to protect workers/traders against such risk.
- Lack of suitable provisions for loans from banking and insurance agencies.

21.3.4 WoodWork Industry

Varanasi is known for its wooden toys and other wood-based crafts. The woodwork industry is broadly classified into four types of jobs: turning, cutting, carving and painting. Khojwa, Sarai Nandan, Kiraiya, Gai Ghat, Reori Talab are the major clusters in the city. Different stages in woodcraft are accomplished in separate areas spread across the city of Varanasi. For instance, woodworkers in Khojwa are predominantly engaged in turning-job; wood blocks are cut, joined and painted in distinct areas. Hence, the woodcraft industry in Varanasi is not clustered, and there is not any single comprehensive cluster. The finished products are sold in various markets across the city, such as the areas near the Kashi Vishwanath Temple, near Dashashwamedh Ghat with significant price variations.

   Issues and Challenges Following shortcomings were identified by the President of '*Khilouna Udyog Sahkari Samiti Ltd.*'—a NGO for Varanasi Wooden Lacquerware and Toys registered in 1953.

- **Raw-material** Owing to non-availability of desired wood-variety of Kiraiya (sourced from Bihar), Eucalyptus of inferior quality is used.
- **Infrastructure** Uninterrupted power-supply is needed as the turning-job is dependent on electricity.
- **Marketing**: Improved marketing and distribution needed.

21.3.5 Porcelain Pottery in Chunar

Chunar, situated about 45 km south of Varanasi, is a town by the river Ganga in Mirzapur District. Chunar is known for its pottery, particularly the clay toys. As per the mapping held by the Ministry of Textiles, Govt. of India, about 200 artisans and 20 Self-Help Groups (SHG) are engaged in the craft.

   Pottery produced in Chunar is broadly classified into porcelain and glazed-terracotta. Porcelain craft had concentrated in Usmanpura/Dargah Sharif area, close to the national highway (NH-7) which is the supply line for both raw materials and finished products. On the other hand, glazed-terracotta workshops are situated at Bharpur line, close to river Ganga—which has been the main source of alluvial-clay used for the craft. This is a good example of a variety of differing factors which

drive formation of clusters. For instance, *'availability of distribution network'* has dictated the concentration of porcelain workshops along the highway and market; whereas *'availability of raw material'* governs the location of terracotta workers close to the source, i.e., the river-bed.

Transformation For centuries, pottery has been a traditional craft in and around Chunar. With the establishment of a state government owned Common Facility Centre (CFC) in 1955, provision was made for potters to bake their designed raw products in the common furnaces (8–10 in nos.). Raw material (*chinimitti*) was procured from parts of Rajasthan. This had led to proliferation of porcelain pottery in Chunar. However, for almost past one decade, this industry has died as it could not compete with the hub in Khurja in Uttar Pradesh, as the latter had witnessed various technological advancements, such as electrification of furnaces. Over time, the potters in Chunar have shifted to a newer material—'Plaster of Paris' (PoP). There are only very few potters left in the cluster who are working with porcelain. This is an example of workers adopting a new material so as to adapt to prevailing market situation.

Employment As per the president of the potters' association in Chunar, presently there are about 220 factories registered with the association, engaging about 2200 workers. Broadly, the products are toys, cups and plates, jars, soap-stand and many others. The president suggested advancement of technology to revive the porcelain craft. Separately, there are about 30–35 glazed-terracotta workers clustered at Bharpur line. Terracotta figurines are coated with paints and are baked in the furnace to render the finished glazed product. Traditionally, furnace is integrated within a potter's house. Usually, every family member is engaged with the craft and the tasks are well segregated. However, this cluster is also dwindling.

Design innovation With the switch from porcelain to 'Plaster of Paris' (PoP) as the basic raw material, the design possibilities have changed. Porcelain products which are sold in Chunar today are largely sourced from Khurja, as the production here in Chunar has stopped. The products/artefacts in PoP are produced from moulds and submit to the forces of homogeneity in design, as they lack any signature of the craftsmanship of workers in Chunar.

21.4   Section-C: Possible ICT Augmentations for Smart Economy and Smart Governance

Like any other cities, the historic city of Varanasi also has interdependent and interconnected systems that build-up the critical infrastructure like water, power and fuel, waste, transport, food, human services, city communications, buildings and workforce, as shown in Fig. 21.10.

To become a 'smart' city, Varanasi needs balanced focus in term of creating and upgrading the city infrastructure in four major areas of physical infrastructure, social infrastructure, environment management and city governance by leveraging
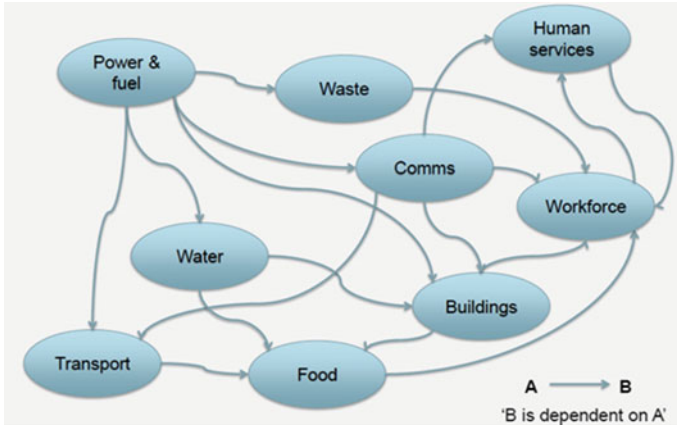
Fig. 21.10 Interdependent systems in cities [15]

the 'technology triad' of Information and Communication Technologies (ICT), Internet of Things (IoT) and Geospatial Technologies (GT), as depicted in Fig. 21.11. Holistic improvement of the basic services of this city and the quality of life of the citizens can be achieved with a focus on digitally enabling the core infrastructure services like water supply, sanitation and solid waste management, urban mobility and public transportation management, energy management, connected healthcare, online education and e-governance. The technology triad enables cyber intelligence-based real time experience of the services with increased urban efficiency, making these 'smart'.

Two key features of 'smart' cities are citizen-centricity and digitally enabled infrastructure. Essentially, a 'smart' city is a seamless union of technology, government and society to enable 'smart' living, effective governance and convenient public services [12, 13]. Varanasi, as a 'smart' city, can enable the citizens to engage with the basic infrastructure services on offer and converge 'hard infrastructure, social capital including local skills and community institutions, and (digital) technologies to fuel sustainable economic development and provide an attractive environment for all' [14], thus strengthening the existing economy to a 'smart' economy.

Fig. 21.11 Technology triad for smart cities
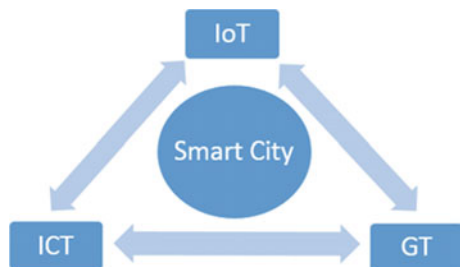
For a heritage city like Varanasi, ICT and Geospatial Technologies will play an important role by improving business infrastructure, providing efficient service delivery to the citizens, enabling innovation through technology adoption fuelling jobs and economic growth, monitoring natural resource consumption and reducing impact on environment. And, the IoT technologies will provide the opportunity to transform city infrastructure from traditional systems to next-generation 'smart' systems utilizing Machine to Machine (M2M) communications, ubiquitous sensor network and near real time data analytics. A meshed network of IOT technologies will help to develop a highly efficient and interdependent system of systems that will create a connected Varanasi in true sense.

The synergistic interdependency and interconnectedness of 'smart' services in Varanasi can provide immense opportunities for superior quality of living and effective governance. Some of the 'smart' services that can be considered for Varanasi are shown in Fig. 21.12. The digital fabric of interdependent systems will be dynamic in nature, with instantaneous data gathering from public services. The insights gained can help in managing energy efficiency of buildings, mapping social data for crime prevention, monitoring flood situations and driving public consultation, trend analysis to strategize prompt actions. As a result, governments can decrease costs of service delivery through enhanced operational efficiency. The concerted effect of these 'smart' services creates a supportive ecosystem for entrepreneurial activities, innovation, productivity enhancement and economic growth.

Effective risk assessment and management of the interconnected cyber systems is a prime necessity for ensuring security of 'smart' services in Varanasi. Appropriate measures have to be taken to identify and address risks of the interdependent systems on a round-the-clock basis to address cyber-attacks. Gathering and analysing real time data with supervisory control and data acquisition
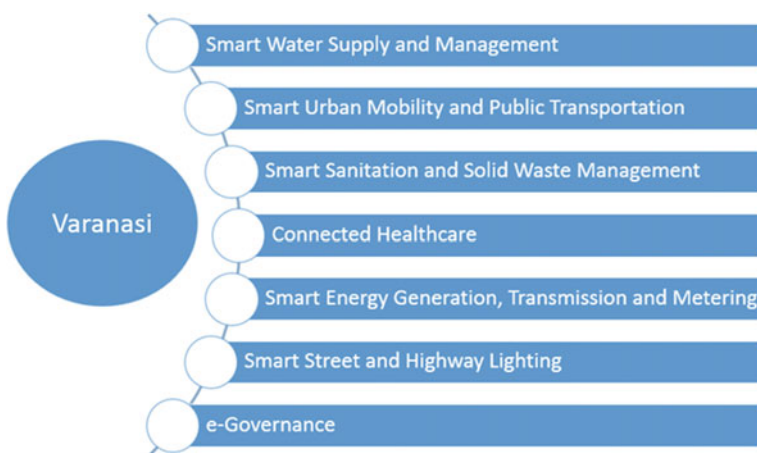
Fig. 21.12 Glimpse of 'smart' services for Varanasi

(SCADA) will help in predicting the cyber security failures for necessary action in order to prevent a complete lock-down of critical 'smart' services. The shared risks of the interdependent 'smart' systems of the city have to be effectively managed to help the citizens realize the benefits of 'smart' living in Varanasi with a perception of security, trust and confidence.

21.5 Conclusion

The cases of Varanasi exemplified in the aforementioned sections represent the inherent smartness of the traditional economy of the city. Ranging from knowledge-based institutional services to cultural products, as described in sections A and B, respectively; the city of Varanasi exhibits its strength in diversity and resilience to destabilizing market forces. Such attributes need be studied in detail so as to evolve a holistic approach to recognize a larger notion of 'smartness', and further strengthen such traditional economies embedded with many historic city systems. Thus, Varanasi sets a good example of an innovation-driven smart economy, which is set on two bases: traditional and the modern.

The interconnectedness between tradition and modern as a holistic vehicle of all-inclusive smartness can be best unfolded through a living exploration. The name of the exploration is Varanasi, which the present chapter has upheld. Varanasi is the epitome of Indian tradition and an Indian concept of pristine order, on the one hand; and it is also a living vehicle of sustainable adaptiveness to continuity and change over time, on the other. Through a reconciliation of the two, the best of smart creative economy is approached. It can be explained through quotations. They come from the works of E.F. Schumacher:

1. In the seminal work 'Small Is Beautiful' [15], Schumacher wrote: 'The exclusion of wisdom from economics, science and technology was something which we could perhaps get away with for a little while, as long as we were relatively unsuccessful; but now that we have become very successful, the problem of spiritual and moral truth moves into the central position … ever-bigger machines, entailing ever-bigger concentrations of economic power and exerting ever greater violence against the environment, do not represent progress: they are a denial of wisdom. Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful.'

2. Schumacher also wrote of what he called 'Divergent problems.' They involved reconciling opposites such as justice and mercy, 'stability and change, tradition and innovation, public interest and private interest, planning and laissez-faire, order and freedom, growth and decay.' He believed that 'everywhere society's health depends on the simultaneous pursuit of [such] mutually opposed activities or aims' and that 'no real understanding is possible without awareness of

these pairs of opposites which permeate everything man does.' The way to reconcile them was through 'such higher forces as love and compassion, understanding and empathy,' and most importantly, wisdom.

Understanding Smart economy in the case of Varanasi calls for such bandwidths of wisdom.

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Part VIII
India-Vijayawada

Chapter 22
From Smart Agriculture to Smart Economy: Case of Vijayawada City Region

N. Sridharan, Raktim Ray and Aparna Soni

Abstract Smart City, as this chapter proves, is the one that adapts to its dynamic structural changes in the economy within a shortest possible time without causing pitfalls. Vijayawada–Guntur–Mangalagiri–Tenali (VGTM) area, which has been identified as the capital region of the newly created state of Andhra Pradesh with its capital Amaravati in Guntur District, is fast adjusting to this structural change and plans to bring in technology to boost its economic dynamism. From that of a 'rice bowl', the region is transforming itself into a major service sector region, servicing not only the region, but is emerging as a major node in the eastern coast.

22.1 Introduction

The urban population is expected to increase from 28% in 2001 to 36 % in 2026 [1]. The rhetoric of smart city has emerged at a very important juncture of Indian urbanism. McKinsey report has identified that economic growth and urbanization have always moved parallel. The economic reforms and liberalization which Indian economy has adopted in early twentieth century, finally, have started exhibiting the outcomes. The average household income has observed a steady growth in decade. The structural change in the economy from agriculture to tertiary sector, scale jumping the industrial sector, has brought in spatial shift in the urbanization process

N. Sridharan (✉)
Department of Regional Planning, School of Planning and Architecture, New Delhi, India
e-mail: dr.nsridharan@gmail.com

R. Ray
School of Planning and Architecture, Bhopal, India
e-mail: raktim.ray@gmail.com

A. Soni
RICS, Amity University, Noida, India
e-mail: ar.planneraparnasoni@gmail.com

itself. The economic integration with global markets has reinforced new forms of spatial, social and cultural transformations. These transformations has slowly percolated in class transformation which can be observed with the emergence of new social groups, an 'intermediate stratum'—the urban Indian middle class [2]. The political economic shift in India has accelerated a new growth dynamics with encouraged market consumption [2, 3]. McKinsey report [4] has identified household earnings of Rs. 200,000–10,00,000 per annum as middle class. As per the report, by 2025, 41 % of India's population will fall in this price bracket. This rising numbers of Indian middle class that emerged post-1985 have brought new policy direction in the development discourse with their modified aspirations and changing 'urban lifestyles'. The aspirations of 'Roti-Kapda-Makan' (Bread-Cloths-Housing) have shifted to consumption-oriented high-speed transportation corridors, internet, and improved civic amenities of 24 × 7 water supply. These aspirations create a new rhetoric in urban India [5] that has ushered the idea of heuristic therapy to spatial problems. Datta [5] has argued this heuristic therapy as 'technocratic nationalism' which is evident with initiation of new urban mission by Indian government—'Smart City Mission' [6]. The mission guideline has conceptualized urban transformations through 'smart solutions' where focus has been given on 'harnessing technologies' (Smart Cities Mission Statement and Guidelines 2015). The 'technocratic nationalism' creates a disjuncture when with there exist a serious technological divide and lack of mechanisms for skill development.

This chapter argues about an alternative approach to smartness which inculcates the principles of innovation, efficiency and inclusion. The approach also moves beyond the constructed ontology of mega city-centric urbanism and looked through the lens of city region perspective. The study takes the opportunity for critical analysis of this approach taking the case study of new capital region of post-bifurcation Andhra Pradesh state that was once the rice bowl of the south. The geographical focus of the case study is the erstwhile Vijayawada–Guntur–Tenali–Mangalgiri (VGTM) urban agglomeration, which is also identified as the capital city region of Amaravati [Draft Perspective Plan—2050 for Andhra Pradesh Capital Regional Development Authority (APCRDA)].

22.2 Regional Setting

The erstwhile Vijayawada–Guntur–Tenali–Mangalgiri (VGTM) area holds an important position in the urban dynamics of the newly formed Andhra Pradesh state. This area is also part of the capital city region which has been identified as by Andhra Pradesh Capital Region Development Authority (APCRDA). Vijayawada, the 30th largest metropolis in eastern coast of India, is an important transit node connecting south to north by both rail and road networks. Vijayawada urban agglomeration (VUA) had a population of 1.49 million as per 2011 census, which makes it a second largest city in the newly formed state of Andhra Pradesh. VUA is spread into two districts, namely Krishna and Guntur, and consists of Vijayawada
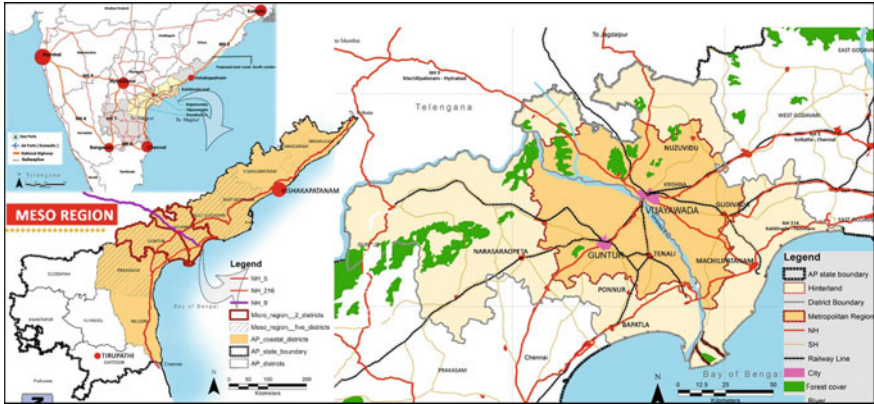
Fig. 22.1 Location and regional connectivity of VGTM area. *Source* Authors

Municipal Corporation, 14 outgrowths, 2 municipalities and 6 census towns [7]. This region is rich in terms of rice, tobacco and cotton. During 5th and 6th centuries, the entire Krishna valley was an important center for Buddhist culture with Amaravati as capital, 18 miles away from Vijayawada on the southern banks of river Krishna. Existence of early trading during this period is evident from the number of ships from various foreign countries such as China, Indonesia, Cambodia, Ceylon and Persia. Early trade links that depended on agriculture produce shifted to other allied product trading over the years. Formerly known as Bezwada, the British connected the city with Madras Presidency (current day Chennai) through waterways, roadways and railways to transport the construction material, cotton and tobacco. The strategic position of the town commanding the coastal trading routes of the Bay of Bengal determined its economic importance through the centuries (Fig. 22.1).

22.3   Urban Dynamics of VGTM Area

According to 2011 census, 1.84 million persons lived in urban area of Krishna District, out of 4.51 million persons (total population of Krishna District), which means urbanization level in Krishna District was 40.81 %, much ahead of India (31.2 %). Moreover, the urban population growth rate in Krishna District (2001–2011) was 37.23 %, compared to the rural population that declined by 6 %, conveying the fact that Krishna District is rapidly urbanizing [8]. Vijayawada forms major share of urban Krishna (56.9 %) and VUA (70.3 %) in terms of population. It means major development is taking place beyond municipal boundary. Majority of the rich farmers that migrated to the city occupied the outlying rural areas such as Patamata and Gunadala, which later became urban areas with extension of city

Table 22.1 Demographic growth in VGTM area

Years	Vijayawada (Municipal corp)				Vijayawada urban agglomeration	
	Population	Population decadal growth (%)	Area (km^2)	Density (Person/km^2)	Population	Population decadal growth (%)
1961	230,397	42.93	24.14	9544	269,536	44.61
1971	317,258	37.7	29.4	10,791	395,084	46.58
1981	461,772	45.55	29.4	15,707	613,756	55.35
1991	701,827	51.99	55.56	12,632	845,756	37.80
2001	845,217	20.43	61.88	13,659	1,033,562	22.21
2011	1,048,240	24.02	61.88	16,940	1,491,202	44.28

Source Adapted from [10, 11]

limit. Migration of rich peasants into the city was one of the strong factors of city growth in the past, whereas the poor migrants settled mostly along the river, canals and hill slopes, forming the present slum areas. The contributions of population growth are mainly due to natural growth and in-migration from neighboring villages. For instance, during 1991–2001, natural growth contributed 53 % and in-migrants 47 % in VMC [9].

The census 2011 exhibits an interesting urbanization trend in east coast. The urbanization pattern has been characterized with the emergence of numerous census towns along the national highway. Spatially, these census towns have emerged as an outcome of functional dependency of major urban centers to these settlements. Census has classified these as urban agglomeration. Vijayawada is also not an exception to this. The growth of several census towns in and around Vijayawada in the last decade has catalyzed the urban expansion of Vijayawada (Fig. 22.2). Vijayawada urban agglomeration[1] has observed a decadal growth rate of 44.28 % (Table 22.1).

In Krishna District, Number of Census Towns[2] have increased from 1 to 11, from the year 2001 to 2011, whereas in the Guntur District, numbers of census towns remained the same. Statutory towns[3] in Guntur have increased from 10 to 13, but in Krishna, it remained the same as 6 settlements. This exhibits the urbanization pattern of this VGTM region, which is characterized by city region pattern of development. Moreover, it also reveals that the growth direction is moving beyond

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[1]Urban Agglomerations (UAs): A continuous urban spread comprising one or more towns and their adjoining out growth(s).

[2]Census Towns: All villages with a minimum population of 5000 persons in the preceding Census, at least 75 % of male main working population engaged in non-agricultural activities and a population density of at least 400 persons per km^2.

[3]Statutory Towns: All places with a municipality, corporation, cantonment board, notified town area committees, etc.
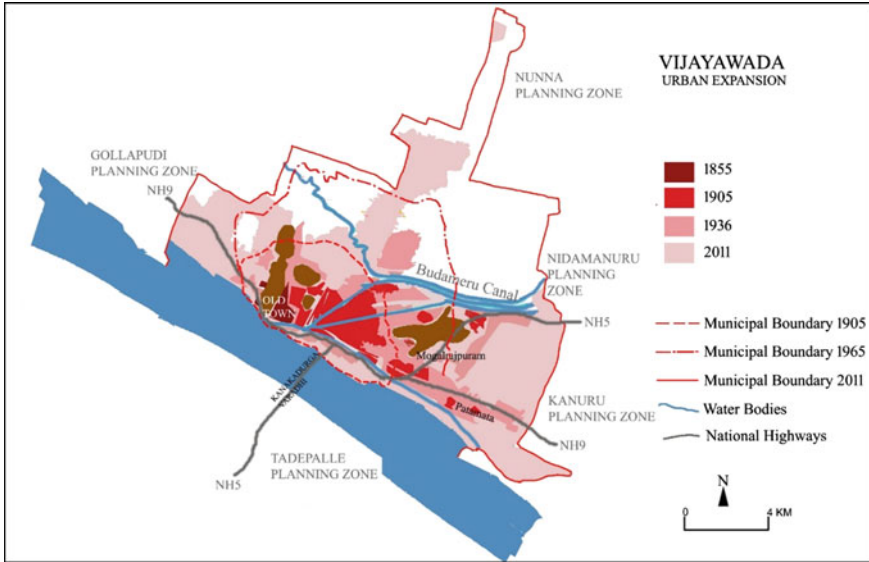
Fig. 22.2 Urban expansion of Vijayawada. *Source* Sridharan et al. [12]

Table 22.2 List of functional dependency parameters

Type of parameter	Indicators
Demographic	Density
Regional connectivity	Air, railway, highway, major roads
Economic activity	Port, SEZ, industry, major agricultural market
Communication infrastructure	Telephone, post and telegraph, internet connectivity
Banking infrastructure	Nationalized banks, agricultural credit society, non-agricultural credit society
Social infrastructure	Specialty hospital, general hospital, primary health care, dispensary
	University, degree colleges, junior colleges, secondary schools, primary schools

Note All maps provided have been composed and created by SPA Vijayawada students of Bachelors in Planning, 2011–2015 and 2012–2016

Guntur Municipal Corporation Area than in the Vijayawada Municipal Corporation Area.

To understand the intra-settlement dependency and the urban dynamics of the VGTM area, the analysis is performed with help of functional parameters. The parameters that were taken into consideration are given in Table 22.2.

The analysis exhibits eight types of hierarchies in the settlement system (Fig. 22.3). These hierarchies are regional growth center: Vijayawada; subregional
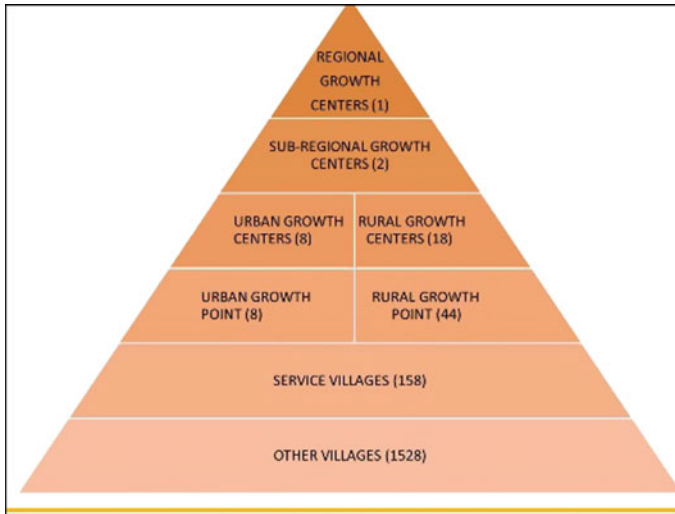
Fig. 22.3 Settlement hierarchy. *Source* Authors

growth center: Guntur and Machilipatnam; urban growth center: Tenali, Mangalagiri, Gudivada, etc.; and rural growth centers: Gannavaram, Vuyyuru, etc.

The geographical distribution of these settlements reveals that Class I settlements are coming up near Vijayawada city along the NH 5, whereas more Class II settlements are increasing in number in the central part of the region (Fig. 22.4).

22.4 Smart City Components

Cities are complex systems of political economic attributes along with infrastructural, technological and cultural attributes. Interconnections between different internal and external components of the systems play an important part in the dynamics of 'smartness' of a city [13]. An existing review of the literature identifies that there is a failure in the global policy direction to link smart city with smart economic approach. The reason for this failure is manifold. Most of the smart cities have failed to address the spatial embeddedness of cities economic component. Otherwise, cities have been juxtaposed with utopian urbanism (Miles 2007). This has created a disjuncture in the spatial identity of the city. The historicism of spatial transformation is important in the context for spatial embeddedness [14]. The spatial strategies that were being followed in the Indian context so for missed the economic component. The master plans of even major economic engines such as Mumbai, Delhi or Chennai missed out on local economic development. The research aims to eliminate this policy gap through contextual analysis of spatial transformation in the context of Vijayawada City region. The approach includes
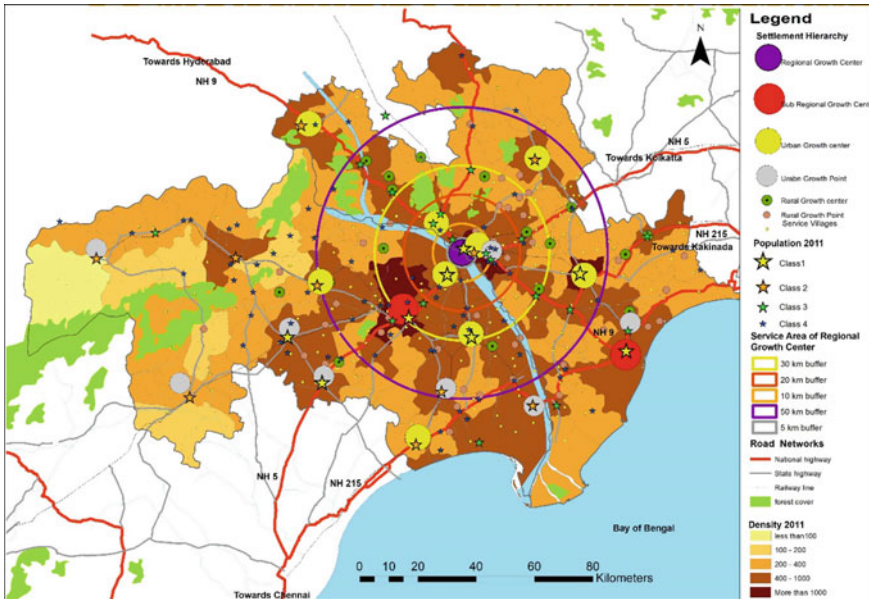
Fig. 22.4 Settlement hierarchy of VGTM area. *Source* Author

understanding of major structural elements of economy and their interconnected-ness with spatial forms. Hence, it aims to attain maximum spatial efficiency, a process-oriented (spatial prioritization model) land use plan that supports high economic productivity.

In the analysis, smart governance, smart human capital, smart environment, smart living and smart economy have been identified as ubiquitous components of 'smartness' [13, 15]. The potential role played by technology has been understood as the meta-factor in smart cities initiative [15], and thus, a 'Smart city' is defined as an organic integration economic systems along with physical, digital and human systems in the built environment, to deliver a sustainable, prosperous and inclusive future of its citizens [16]. It is a conscious effort to achieve prosperity, effectiveness and competitiveness on multiple socioeconomic levels [17]. To build a stronger understanding, more literature review went into deciphering the factors that helped to create a 'smart economy'. The Smart Cities Council's [18] Readiness Guide, the planning manual for building tomorrow's cities today (Redmond VA), was accepted as a working definition, with the following factors: (a) Innovative spirit, (b) entrepreneurship (ease of doing business), (c) economic image and trademark, (d) productivity flexibility of labor market, (e) International embeddedness and (f) local and global connection. Many of these approaches have juxtaposed some of the parameters in a top-down approach without addressing the contextual reality on ground. The 'third world urbanism' is distinctive in nature with its complexities and dynamism. The research acknowledges this complexities and dynamism and hence

adopts a bottom-up approach with institutional engagements to identify the parameters for 'smartness'. The institutional engagement was carried out with participation from city officials as well as gram panchayats (rural local self-governance institutions) representatives from 24 revenue villages.[4] A detailed land use survey was conducted to generate a land use map on the updated base map. The household level survey, covering a sample size of two percent of population of each settlement, was carried out in a stratified way. Each settlement has been profiled bringing out the socioeconomic status of the residing population. The economic survey has helped to understand the intra-dependence of settlements and the catchment area of their interdependence on to the capital region. The filed work is also helpful to understand the extent of displacement because of the development process. The survey has portrayed that landless agricultural laborer group is going to be the most affected population as a part of the displacement. This brings a critical dynamics into the approach. As smart city approach strives toward a sustainable urban future, the dimension of inclusion is also a necessary subcomponent of it. The research aims achieving the inclusivity through 2-fold processes: (i) integration of formal and informal sectors of economy and (ii) through skill development of displaced population for alternative economic opportunities.

22.5 Smart Economy and Smart City Growth

Although several authors have built different smart city components, smart economy has identified as a key component for smart city growth in this chapter. While defining smart economy, some authors focus on its characteristics of flexibility and competiveness; others highlight on operational efficiency through innovation, networks and technology dependency [13]. Strategic document prepared by the Irish government in 2008 has highlighted innovation the utilization of human capital as key aspect of smart economy. It has also brought sustainability parameters through incorporating the idea of 'green economy' as an element of 'smartness'. Anttiroiko et al. [19] described smart economy as networking economy of cooperation. Drawing examples from these literatures and also through prioritization of aspirations of citizens, the research builds its contextual parameters for smart city growth. The identified parameters are the following: (a) Innovation through economic clusters, (b) time efficiency, (c) competitiveness, (d) inclusion, (e) networks of functions and (g) economic flexibility.

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[4]Revenue Village: As a definite surveyed boundary, and each village is a separate administrative unit with separate village accounts. It may have one or more hamlets. The entire revenue village is one unit.

22.5.1 Economy of VGTM Area

According to 2010–2011 (second revised estimate) Gross District Domestic Product (GDDP) of Krishna District at constant 2004–2005 prices was INR 23,998 crore (US $ 3593 million), with sectoral composition of GDDP in agriculture, and industry and services sectors were 26.6, 16.6 and 56.8 % (refer Fig. 22.5), respectively [20]. In last six financial years, gross value added in agriculture sector reduced by 6.9 % and service sector gained by 6.3 %, while industrial sector experienced a very little change. Notably, Krishna District's contribution ranks second in agriculture (8.2 %), seventh in industrial (4.2 %) and fourth in service (6.6 %) sectors among 23 districts of joint AP. Krishna District per capita income at factor cost at constant (2004–2005) prices [21]. It was INR 46,629, even higher than AP state INR 39,434 and India INR 36,342. Over last six years, Krishna District's per capita income at factor cost has increased over 1.52 times at constant (2004–2005) prices. The city is a major commercial hub with concentration of wholesale and retail activities and acts as a local, regional, national and international market place. It is currently a major trading place for processed Virginia tobacco, cotton and turmeric [9]; Vijayawada Urban Development Authority 1971).

As a business hub, the agricultural commodities produced in the coastal region find their market in Vijayawada for local and domestic consumption and for export. The major cultivated crops are paddy and vegetables. The city is also rich in mango production with few mango orchards located in the outskirts of the city, which acts a source of revenue. Food processing industry based on agriculture and allied sector also contributes to the economy in terms of employment and income. There are a number of solvent extraction plants, rice mills, oil and grain mills in the city. The city has two industrial estates: Auto Nagar Industrial Estate, located in the eastern part of the city, covering 340 acres, which houses industrial units which are small and medium in nature. The other estate is located at Kondapalli, 16 km from the city. In addition to these estates, large agro-based industries are located in Kanuru on the eastern outskirts of the city and a Super Thermal Power Station is located near Vijayawada.
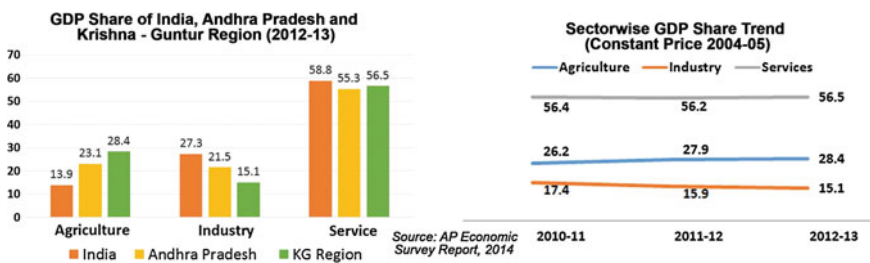
Fig. 22.5 Sectoral share of district domestic product of VGTM area. *Source* State statistical handbook, Andhra Pradesh 2013

The economy analysis clearly identifies agriculture, trade and real estate as the dominating sectors of the economy. This region is termed as the 'rice bowl' of east India because of very high productivity of paddy. The spatial distribution of the productivity (Fig. 22.6) exhibits very high productive areas along the Krishna River within the two districts.

The location quotient analysis of the industries identifies agro-based industries and manufacturing as the basic sector industries, the reasons being very high agricultural productivity and labor intensiveness. The manufacturing predominates with the already existing auto cluster of the region. Past history of labor unrest, coupled with various labor movements that still operate in the states, compelled the state to encourage small-scale sector. This gets reflected in the heavy concentration of (92 %) industries in micro- and small-scale sector. Moreover, agriculture dependency propelled these small-scale units favorably. The spatial distribution (Fig. 22.7) clearly shows major industrial clusters are centered toward Vijayawada City and predominantly automobile clusters. There is one IT park which is emerging in the vicinity. But the functional operation is still not started.

The data collected from the Andhra Pradesh Industrial Development Corporation also reveals that there are 34 industrial estates in these two districts of Krishna and Guntur (17 each), 80 large and medium industrial units with Rs. 3700 crores of investments and 6900 micro, small enterprises in Krishna District alone. In Guntur, apart from 17 industrial estates, 51 large-scale industrial units with Rs. 1350 crores
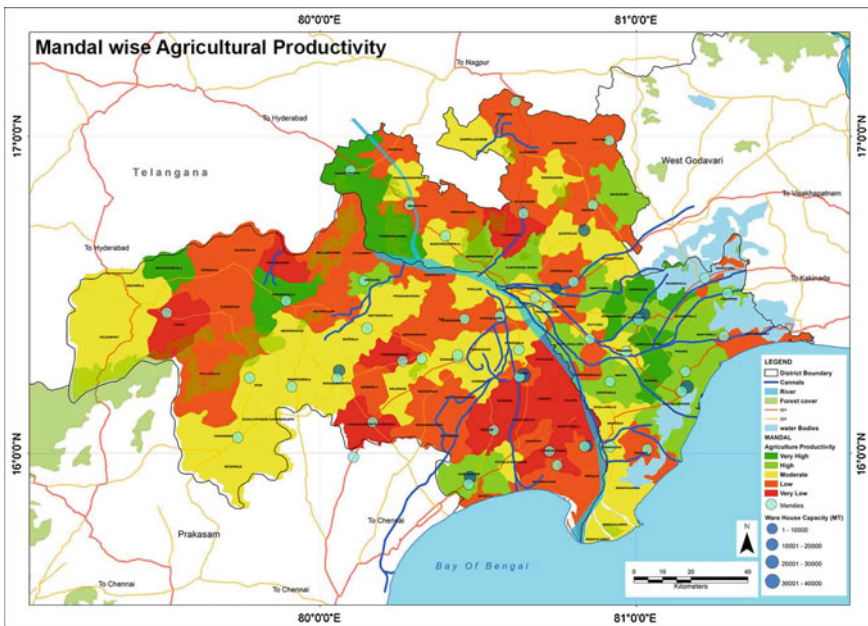
Fig. 22.6 Agriculture productivity in VGTM area. *Source* Prepared by authors based on District Statistical Handbook, Krishna and Guntur Districts 2013
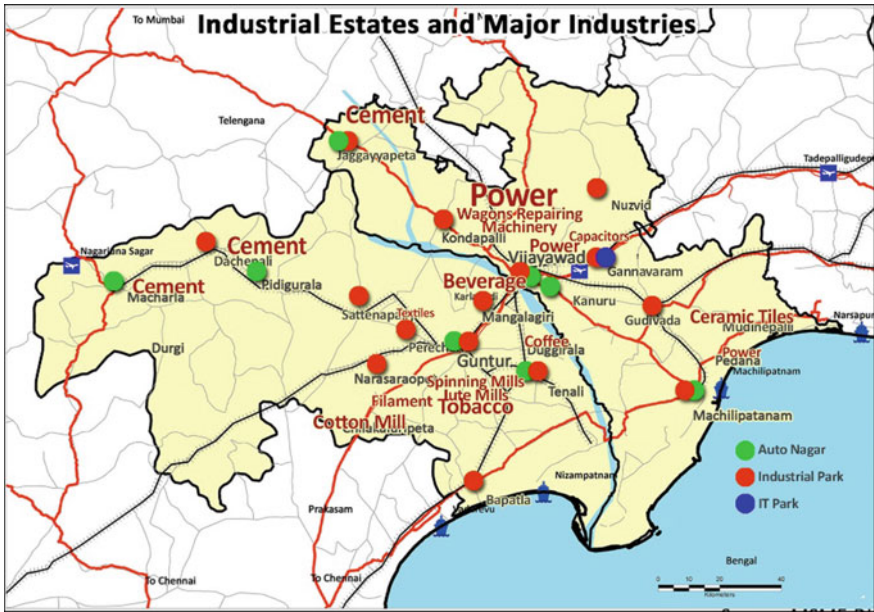
Fig. 22.7 Industrial locations in VGTM area. *Source* Prepared by authors based on District Industries Center, Vijayawada and Guntur 2014

of investment and 7390 micro, small enterprises employing 67,500 people existed in 2013. On the whole as stated earlier, micro and small enterprises constitute 92 %, followed by large-scale (6 %) and medium (2 %) industries in VGTM area.

22.5.2 Smart Mobility of VGTM Area

Three national highways (NH), i.e., NH-5, NH-9 and NH-214A pass through the VGTM area. NH-214A is recently upgraded to national highway and connects to major district roads to improve the connectivity along the coastal areas of Andhra, especially port towns. The National Highway-5 is also a part of the ambitious Indian government project 'Golden Quadrilateral'. Vijayawada railway junction also acts as an important component of the mobility perspective. It is considered to be the second busiest railway junction, and also, it is the divisional headquarter of the South Central Railway zone (South Central Zone: Vijayawada Profile, Indian Railway). It also acts as an important contributor in the freight movement of the area.

Zoning (Fig. 22.8) has been done considering the directional movement of the traffic using primary network. It is observed that majority, i.e., 38 % of the goods trips are
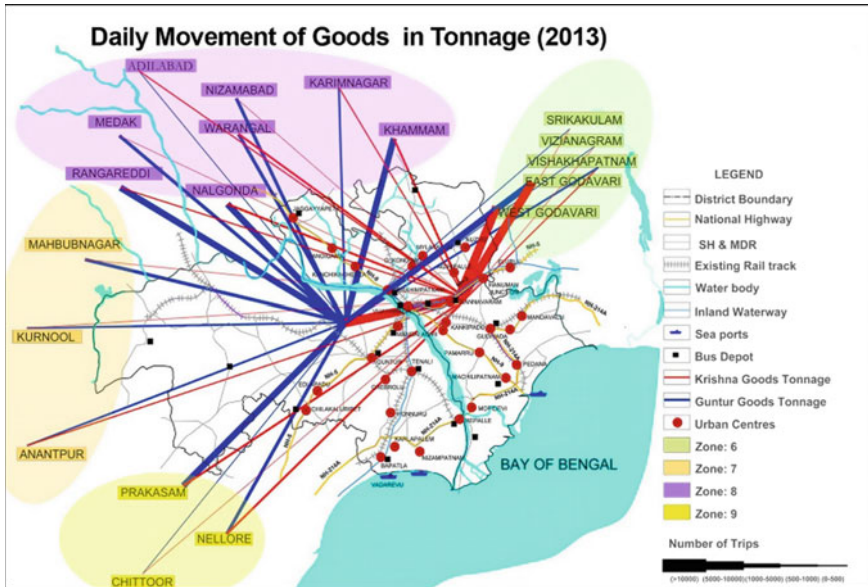
Fig. 22.8 Daily freight movements in the VGTM area. *Source* Primary Survey 2014

along Zone 8 toward Hyderabad; 28 % of the trips are along Zone 6 toward Kolkata; 18 % along Zone 7 toward SH-5; and 9 % along Zone 7 toward Chennai [22].

22.6 Spatial Embeddedness

The research aims to attain spatial efficiency through embedding economic component on the existing space. To understand the embeddedness, the research analyzes the existing land cover of the VGTM area. The total area of the region (2011) is 20130.5 km^2. Figure 22.9 and Table 22.3 represents the land cover map in the region showing land covered by water bodies, built-up area, agriculture, forest, barren/wasteland and wetlands. The dominant land cover in the region is agriculture, which includes cultivable land, fallow land and plantation. It accounts for 73.43 % (14,782 km^2) of the total area of VGTM. But in terms of productivity, built-up area through its commercial, industrial activities contributes more than agricultural activities or allied activities in terms of domestic product. Moreover, declining agricultural productivity and its contribution to the domestic product reveals the decreasing importance of agriculture. The initiative of locating the new capital of Andhra Pradesh in Amaravathi (in Guntur District) further pushes the economic structure of the VGTM area toward tertiary sector activity than its original strong hold of agriculture. Initially, there were contestations and conflicts when the agricultural lands were acquired for the new capital. However, the
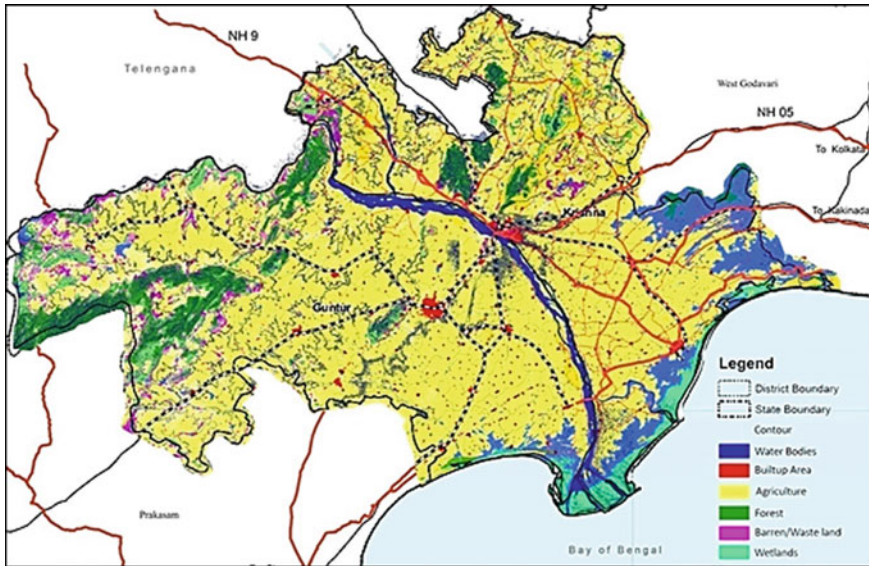
Fig. 22.9 Land cover map of VGTM area. *Source* A.P. Remote Sensing Department 2013

Table 22.3 Land Cover under various land uses in VGTM area

Land cover	Area in km^2	Percentage of total
Built-up	967.3	4.81
Agriculture	14782.0	73.43
Forest	2169.3	10.78
Barren and wasteland	714.6	3.55
Wetlands	472.9	2.35
Waterbodies	1024.4	5.09
Total	20130.5	100

Source A.P. Remote Sensing Department 2013

speculative builders' lobby pushed the construction sector to its new heights, after the declaration of Amaravati as the new capital of Andhra Pradesh.

The productivity figures across sectors also reiterate our earlier hypothesis that there is an economic embeddedness that is emerging in the region, each depending on the other for its basic survival. Another interesting aspect that emerges from microstudies through field work is that there are innovative clusters that are emerging, which scale jumps the major metropolitan region of Vijayawada [14]. Many activities such as marine fish processing, textile manufacturing, paddy processing, tobacco products are linking themselves to global value chain making the city region rich in terms of its economic efficiency. Based on our field studies and analysis, innovation (through innovative clustering of economic activities), time efficiency through connectivity and mobility of labor, and overall inclusion in terms

of spatial inclusion, socioeconomic inclusion are the key forces that will determine the future of this city region.

22.7 Smart Way to Move Ahead for the City Region

For smart economy to function in a city space, spatial efficiency is the key factor. The aim is to "Anchor urban growth of the new capital in a spatially efficient, 'Global', inclusive and sustainable economy."

The broad objectives toward the above are as follows:

- Build a foundation for competitive and innovative economy for all.
- Arrest the available land resource for maximizing spatial economic productivity.
- Attract human resource and investments for sustainable functioning of the economy.
- Fashioning 'time' as a scarce resource to be efficiently utilized.

This can be achieved through innovation, time efficiency and inclusion. At least two of the three factors we could observe in the case of Vijayawada City region: innovation and time efficiency, though inclusion, in terms of spatial, social and economic has been a far cry. We present this idea in Figs. 22.10 and 22.11.

The strategy first involves measuring the quantum of three types of assets to be arrested in the capital region. These are also the tacit outputs of the economic growth in the region (refer Fig. 22.10).
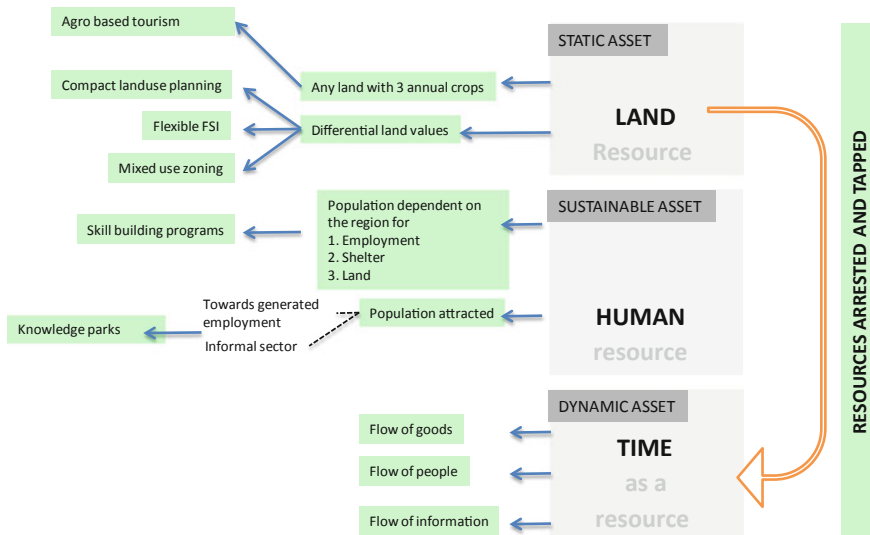
Fig. 22.10 Resource flows and its linkages with land
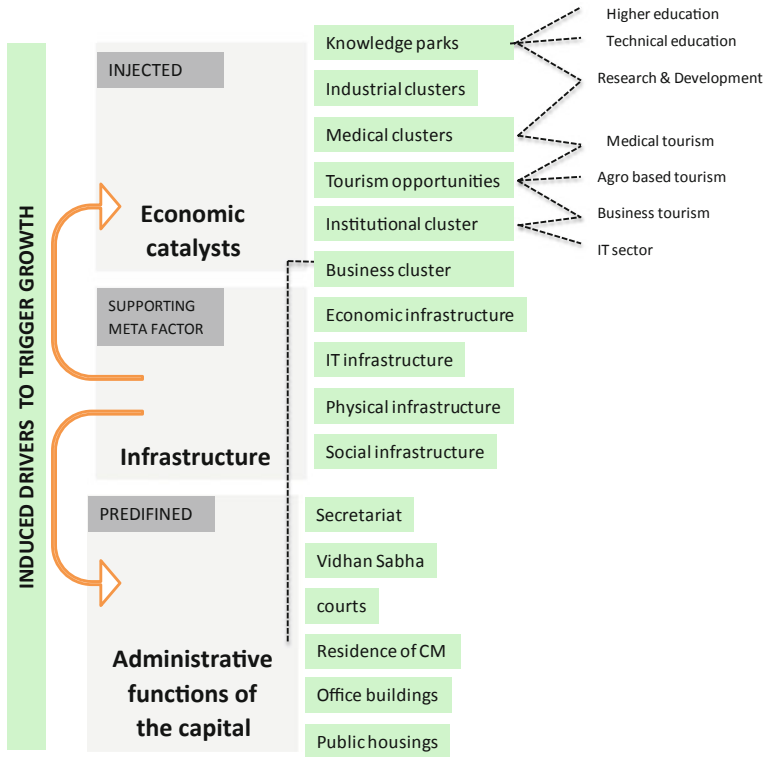
Fig. 22.11 Flowchart on engines of smart economy. *Source* Authors

- Static asset—Land
- Sustainable resource—Human
- Dynamic asset—Time

The development plan must synchronize phased development such that requisite skilled labor is available to be absorbed at all stages. The first phase is to be supported by local skill development programs to retain and build upon the demographic dividend. This mitigates the risk of 'Greenfield development' unable to attract sustained population inflow with changing economic structures and employment opportunities. Technological capacity building is the second face of the same coin, where technology upgrades itself with time. Also, the subsequent land needs are to be designed to support infrastructure and human capacity upgrades and upscales, in each phase of development.

Three segments have been identified and prioritized to be induced as drivers to trigger economic growth refer Fig. 22.11:

- Pre-defined administrative functions of the capital (a service-based capital city economy).
- Injected economic catalysts.
- Supporting meta-factor of intelligent infrastructure for enhancing the efficiency of the above two.
- These three are conceptualized to be the external inputs that cyclically increase the efficiency of the local assets mentioned above.

Economic catalysts include the 'innovative clusters' approach, which is already emerging in this region. The idea behind the clusters is to link the local product with global value chain market.

(i) **Innovation** The smart economic plan has proposed nine specialized clusters. These clusters are presented in Fig. 22.12.

   (a) **Integrated Food Processing Cluster** Keeping into consideration the rich agricultural base of the region, the food processing cluster will help the local agro-products to get marketed in the global market. This cluster focuses on increased productivity through technological advancement.

   (b) **Integrated Auto Engineering Cluster** Reviving the existing auto cluster and integrating it with engineering cluster. This cluster has a huge potential for absorption of labor force.

Fig. 22.12 Innovative clusters in the city region of Vijayawada–Guntur. *Source* Prepared by authors based on the analysis of the region

(c) **Vijayawada Pharma Cluster** Hyderabad is listed among the top priority location for pharmaceutical hub, but simultaneously Vijayawada is emerging as a second preference because of upcoming capital as well as centrally located in the Coastal Andhra. The region has already observed influx of floating population due to hospital tourism. The proposed pharma cluster is planned to capitalize the opportunity of hospital tourism.

(ii) **Time Efficiency** strategized to have three facets:

- Flow of goods/economic produce
- Flow of people
- Flow of information
  To achieve time efficiency, the spatial plan proposed Multi-Modal Logistic Park. A Multi-Modal Logistics Park provides all types of transportation facilities at a place for the end user or defined as a rail- and road-based inter-modal traffic handling facilitation comprising container terminals, bulk break cargo terminals, warehouses, facilities for mechanized handling, inter-modal transfers, aggregation/desegregation, etc. to handle freight traffic. The key components of a Multi-Modal Logistics Park are warehousing, transport and value-added services. The potentiality lies in:

  (a) Connected to National Highway.
  (b) Major junction for lorry operations for several decades with 1000 vehicles carrying goods throughout country daily.
  (c) Well connected to largest junction in South India, over 300 express, passenger and freight trains passing through it daily.
  (d) Expansion of Gannavaram airport is bound to give a fillip to growth of entire South Coastal A.P.
  (e) High availability of labor but low or managerial workforce

(iii) **Inclusion** Andhra Pradesh has a vision of making Andhra as a fully developed state in India by 2029 [23]. To achieve this aim, it has an ambition of training 15 million people through skill development. Though many of the new skills are from construction to service provision, the capital city region will demand more skills; hardly, there are four institutes (3 in Guntur and 1 in Vijayawada) imparting skills. With displacement of labor from the fields due to Capital City Development Project, it is estimated that little more than 30,000 population will be jobless. To skill them is a huge task as majority of them belong to higher age group, and are not willing to go for a new occupation. Second aspect is that of spatial exclusion due to capital development. How one integrates villages in the new capital region especially that falls within the capital city area and those in Vijayawada is pressing issue for the smart economy. Adding fuel to this spatial inequality is the skyrocketing land prices, through capital development pushed land speculation. Access to land by the poor will be increasingly difficult in the years to come in this city region.

22.8   Conclusion

Though the city region has adjusted to the changing economic dynamics through spatial efficiency within a short time span, it has many unsolved issues before it can claim to have a smart economy, especially related to inclusion and exclusion in the process of spatial development. Right mix of activities and skill development in areas listed under innovation will see through this smart change that is required in this region. These activities also ensure the economic embeddedness that we outlined earlier in this chapter. One hopes to see a dynamic and smart city region of Vijayawada–Guntur with the new capital of Amaravati nearby within a short time through its Smart Spatial Planning.

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Part IX
Italy-Bologna

Chapter 23
Smart Cities, Local Community and Socioeconomic Development: The Case of Bologna

Antonio Caperna, Guglielmo Minervino and Stefano Serafini

Abstract This chapter investigates the metropolitan area of Bologna, Italy, aiming at understanding how the enforcement of a smart economy affects smart cities, and brings to social and cultural development. We especially focus on such as smart economy key factors, inter-linkages between smart economy and social development, cultural preservation, heritage conservation, and ecological management. Data analysis shows that smart initiatives do not guarantee any economic growth, especially in a context of economic and financial crisis. A good digital infrastructure can facilitate the circulation of information and offer new opportunities to economy and society, but it is not enough. We have observed that the traditional, local social structure, funded on cooperation, may rather represent a very interesting starting point toward a new peer-to-peer organization of economy and society. Notwithstanding, traditional social structures badly need an infrastructural update in order to effectively enforce new socioeconomic strategies.

Keywords ICT · Urban economy · Smart city · Bologna

A. Caperna (✉)
Faculty of Architecture, Roma Tre University, Rome, Italy
e-mail: antonio.caperna@biourbanism.com

G. Minervino
Dept. of Architectural and Urban Heritage, Meditemanean University of Reggio Calabria, Paola, Italy
e-mail: guglielmo.minervino@biourbanism.com

S. Serafini
Research Dept, International Society of Biourbanism, Artena, Italy
e-mail: stefano.serafini@biourbanism.com

23.1 Bologna: A General Overview

Bologna is a Northern Italian city of more than 380,000 inhabitants in a metropolitan area that counts up roughly 1 million inhabitants. Bologna is the capital of the Emilia Romagna region, a compulsory point of passage between the North and the South of Italy.

Bologna became a metropolitan city in 2015. The metropolitan city, as defined by a recent administrative law, includes a large core city and the smaller surrounding towns that are closely related to it with regard to economic activities and essential public services, as well as to cultural relations and to territorial features. This means 56 municipalities on a territory of 3702.3 km^2, where Bologna itself is only 140.86 km^2.

Bologna's charming historical center is one of the best preserved in the world, where many ancient palaces and churches stand and witness the cultural relevance that Bologna has had in the course of the centuries.

The first settlement of Bologna date back to the sixth century BC, when it was named *Felsina*. Gaul tribes invaded the village renaming it *Bononia* during the fourth century, but it is under the Roman Empire that Bologna became thriving and prosperous. Its prestige kept growing up until the Western Empire crumbled during the fifth century AC and Bologna was sacked and occupied by Visigoths, Huns, Goths, and Lombards, progressively losing power, population, and lands.

The city reached again a peak of grandeur during the twelfth century. From then it has grown famous as a center of culture and innovation especially because of the *Alma Mater Studiorum*, the first European university, established in Bologna in 1088 B.C. (Fig. 23.1).

Nowadays the city is an important Italian center for industry, economy, and arts. Bologna University still keeps its charm, attracting several students who add up their young energy to the fascinating buzz of the city. Bologna is also one of the wealthiest cities of Italy, often reaching a good ranking in many sectors like life quality, innovation, transportation, technology and social initiatives.

Bologna has an official vision about smart city as the tool that best interprets the different citizenship demands, providing opportunities for the implementation of people life projects. Public and private stakeholders worked according to such a vision and made Bologna the second Italian smart city after Milan [1].

23.1.1 Geography and Administrative Boundaries

Bologna is placed on the road Emilia, a roman main route that runs for roughly 300 km through the Po valley, from the city of Rimini (East, by the Adriatic Sea) to the territory of Milan (Northwest). This is one of the main axes that determined the urbanisation of Northern Italy since the 3rd century AC. Such a route is nowadays

Fig. 23.1 Picture of Bologna taken from Asinelli Tower. *Source* Mko61 IT (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons. https://commons.wikimedia.org/wiki/File%3APano_of_Bologna.jpg
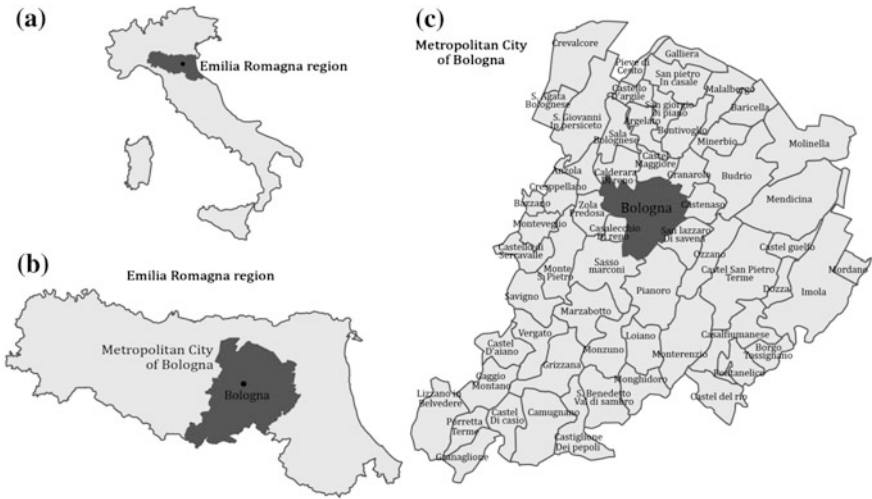
Fig. 23.2 Location of metropolitan city Bologna: **a** in Italy; **b** in Emilia Romagna region; **c** Municipalities of the metropolitan city

doubled by a motorway which forks in Bologna toward Central Italy. In fact, the city is posed at the foot of the Apennine Mountains, holding a strategic position along trading routes since the time of its foundation (Fig. 23.2).

Enclosed between the Reno river and the Savena torrent at 54 m above sea level, Bologna has at her backs the charming *Colli Bolognesi*, a famous rural hilly area covered by vineyards, and highly attractive for tourist and locals. The climate is continental (the climatic classification is "zone E, 2259 GR/G") with a wide temperature range between summer and winter, and frequent snowfalls.

23.1.2 Demography

As of January 1, 2015, Bologna had 386,181 residents, 181,417 (47 %) male, and 204,764 (53 %) female, with a density of 2741 people per km^2 and an average age of 46.5 years old, while the metropolitan territory counts 1004,323 inhabitants with a density of 2713 people per km^2 and an average age of 45.6 [2].

Due to the economical growth of the metropolitan area Bologna's residents drop in favor of the surroundings (see Fig. 23.3) and subsequently remained stable.

The number of immigrants is constantly growing since the '90s of the twentieth century. In total 58,873 foreigners represent the 15 % of the population on December 31, 2015 [3]. Over the years, the majority of immigrants were concentrated mainly in the *Bolognina* district thus transforming this popular area into a multi-ethnic neighborhood [4].
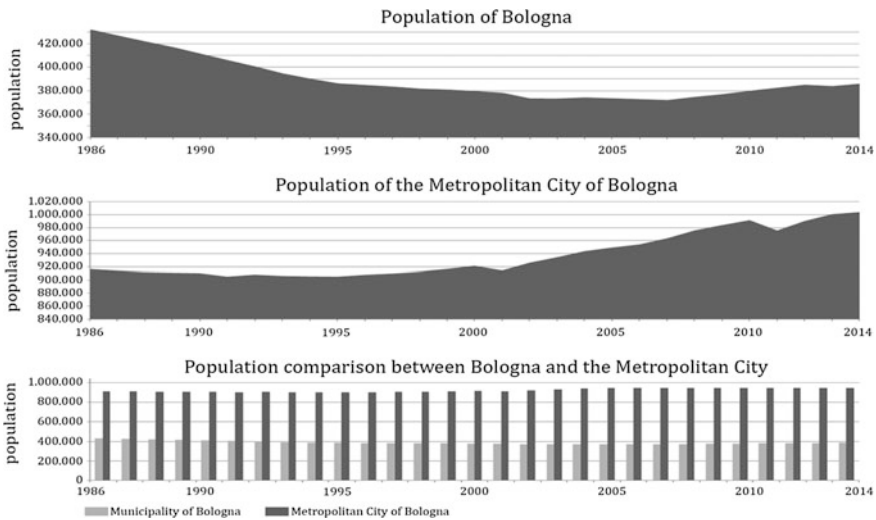
Fig. 23.3 Population change of Bologna, and the metropolitan city of Bologna

The municipality identified three possible demographic scenarios (low, middle, high) in the 2015–2030 timeframe, where the middle one is evaluated as the most likely to happen [5]. According to this one, the resident population should lightly increase, reaching 400,000 inhabitants in 2030. Average age is estimated to be 48 years. New births are expected to decrease due to the minor number of women in childbearing age, while the over 64 are expected to increase. Accordingly, the number of over 80 could rise from 35,429 to 41,000 representing more than 10 % of the population of Bologna [5]. Overall, the expected increase in the total population is due to immigration fluxes both from other areas of Italy and from abroad.

About immigration, the Italian Governments has tried to manage the immigration flow through two main tools: bilateral memorandum of understanding, which regulates the immigrants flow between Italy and auth Country, and introducing the felony of illegal immigration.

Unfortunately, the geo-political crisis in the Mediterranean basin is alimenting the illegal flows from north Africa and Turkey toward Italy and Greece. This enormous flow is putting in crisis the European Union (EU) which looks an effective policy on the reception of immigrants.

With reference to Bologna, actually 13.7 % of the population are immigrants [2, 21]. Local policies and the traditional local value of socioeconomic cooperation have avoided conflict and ghettos.

Figure 23.4 illustrates the demographic change in the metropolitan area of Bologna. Although there is a large prevalence of the municipality, we may see a particularly clear growth of the metropolitan city since 1971.
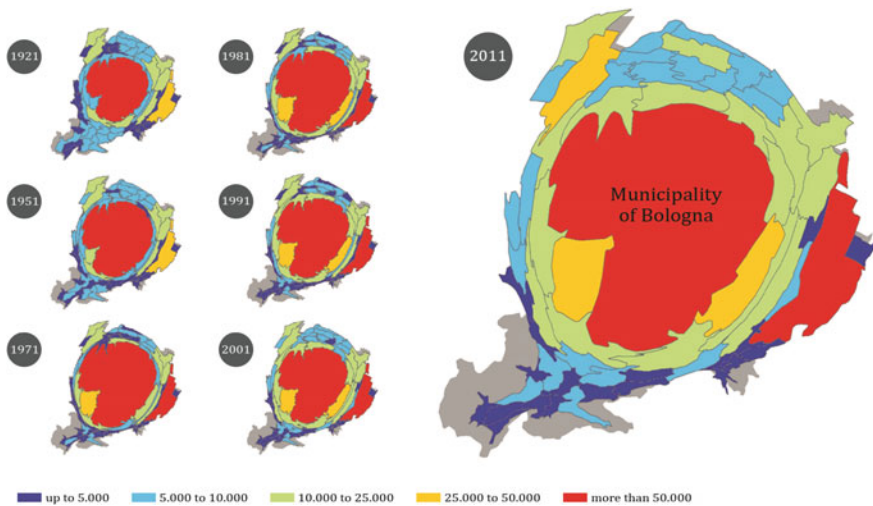
Fig. 23.4 Demographic trend in the metropolitan city of Bologna 1921–2011. *Source* Bonora (2014), Atlante del consumo di suolo, pag. 37. Bakersville

23.1.3 Governance

Established on April 7, 2014 and enforced on January 1, 2015 the new administrative entity of metropolitan city (*Città Metropolitana)* is one out of the 10 new Italian metropolitan cities [6]. The new governmental authority is represented by the metropolitan mayor who overlaps with the mayor of Bologna, along with the Metropolitan Council, and the Metropolitan Conference.

Related to the new institution, a big effort for involving the community has been the production of the *Piano Strategico Metropolitano di Bologna* (Bologna Strategic Metropolitan Plan) promoted by a committee of 34 institutions, mostly administrative institutions, and business associations, plus the chamber of commerce, labor unions, universities, and various organization of stakeholders. Officially launched in October 2011, the plan is the result of a voluntary process of many public and private subjects, aimed at building and sharing a vision about the future of the territory, 991 associations of citizens and organizations contributed to the plan and produced 551 project ideas. The process was concluded in 2013 [7].

The most significant value of the metropolitan plan is not only in the coordination of a wide territory of 56 municipalities, but in its capacity to define a shared and participated strategy, ready to operate.

Overall, the Municipality of Bologna first, and nowadays the metropolitan city, oriented the governance of the urban and rural territory toward an inclusive and shared model which has in the participatory process its most valuable asset. About this point, you can see the Sect. 20.5.

The active involvement of citizens and third sector is also supported by the implementation of the ICT platform *Iperbole2020* (http://iperbole2020.comune.bologna.it) and of several connected services that are steadily growing in number and quality.

23.1.4 Culture

Significant elements of economic, sociodemographic, and urban transformations affected the metropolitan area of Bologna since the last decades. They have generated a widespread, growing demand for culture. Facing such an increasing demand, the great potential of the metropolitan area cultural supply appears, however, limited by a strong each of homogeneity, in terms of size, financial resources, and management skills. This makes necessary the implementation of planning, development, coordination, and promotional policies, and the enforcement of cultural institutions and activities that can be only addressed properly at a territorial level. The Strategic Metropolitan Plan of Bologna aims thus at (i) establishing a regional "cultural system" network capable of triggering synergies between urban and suburban areas, (ii) rationalizing the use of financial and human resources allocated to cultural sectors by increasing economies of scale also through

different forms of partnership, (iii) improving local services and best practices by encouraging the growth of innovative and high-quality projects, characterized by strong public/private partnerships [8].

The European Union enclosed Bologna, along with eight other cities, with the designation "City of Culture" in 2000, and the UNESCO appointed Bologna as "City of Music" in 2006 because of its long and rich music tradition. These recognitions have given Bologna the opportunity to develop and showcase its cultural industry. Bologna offers an unbelievable number of dance events, theater, movies and music performances during its *Bologna Estate* (*Be'*) program. Several spectacles are for free and some are performed outdoor in the town squares. The annual *Bologna Festival*—one of the most relevant music festivals in Europe—organizes classical concerts which combine music, theater, dance, and visual arts. The *Porretta Soul Festival* gathers in the best soul and R&B musicians. The city has more than 50 public and private theaters, so there is definitely no shortage of venues. In this regard, the metropolitan plan has devoted several strategic actions to support and promote culture in multiple forms and as key for sustaining social inclusion. Actions include projects such as social-interaction theater, theater experience in education, atelier of visual and non-visual art, art therapy, musical events, etc. [8]

The city of Bologna was selected to participate in the Universal Exposition of Shanghai 2010 together with 45 other international cities.

The city has been an important center for advanced studies since 1088 when the University *Alma Mater* was established. This is the most ancient university in the Western world, counting 84,215 students in 2015. A total of 33 departments and 207 courses of which 52 international are supported by a rich budget, that amounted to 610.90 millions of euro in 2015 [9].

Many other cultural institutions operate in Bologna such as the Academy of Fine Arts with its 1500 students, the Conservatory *Giovanni Battista Martini* that, funded in the 1804, was the first public music school in Italy. Also, Bologna has been chosen by foreigner universities such as the Johns Hopkins University, Indiana University, Brown University, California University, for some of their programs.

In the metropolitan area there are more than 450 cultural institutions, public and private. The libraries are more than 250, of which 90 are of public access. Museums are 113, of which 45 are municipal, 19 radio stations, 8 TV channels, 9 major newspapers.

Among its wide heritage, *le Due Torri* (the two towers) are the symbol of Bologna, and its two most famous churches, the *Basilica di San Petronio,* established 1390, and the *Basilica di Santo Stefano* which is more than one thousand years old, are well known in Italy and abroad.

The features of Bologna can be synthesised by the famous slogan *Bologna la dotta, la grassa, la rossa* (Bologna the learned, the fat, the red). Such curious nickname, are due to three characteristics of the territory: the learned, as home to the university almost from a thousand years; the fat, because of its delicious cuisine; and the red, because red is the predominant color of its architecture (Fig. 23.5).

Fig. 23.5 Musicians in a public square of Bologna. *Source* Photo by Guglielmo Minervino

23.1.5 Mobility

The city and its metropolitan area are at the center of Italy's trades, as well of a mobility network. In Bologna two main motorway connect Northern and Southern Italy. Also, a 22-km orbital road surrounds half of the city. The negative aspect of such an intense traffic is air pollution.

The railway is important as well, Bologna has two main terminals, one of them dedicated to goods transportation. Five main railroad lines pass through Bologna, including the national high-speed line. The metropolitan rail network has 8 lines and 82 stations.

Bologna's international airport "Guglielmo Marconi" is only 6 km far from the city center and recorded 6,889,742 passengers in 2015, with an increase of 4.7 % versus 2014, reaching the seventh position for air traffic in Italy [10].

Urban mobility is assured by public day and night bus/tram service in both the urban and the suburban area, taxis and car rental. Bologna has also a car and a bike sharing service. A free taxi bike using a rickshaw called *Bi-Bo* is running the city center since 2010.

Bologna has a 120-km network of cycle paths divided into five radial routes which connect the center with the suburbs. For the future, an extension of cycle paths and an increase up to 1000 shared public bicycles are expected [11, 12]. The city aims at bringing the percentage of cycling up to 15 % within a decade through an awareness campaign in favor of soft mobility and road safety. A bikes ring road opened in 2015 which runs around the old town [12, 13]. A total of 165.5 km of

cycling path are expected to be reached within the 2016 investing an amount of 10,158,000 € from 2010 to 2016 [13]. Moreover, the construction of the first Italian bicycle's motorway, passing by Bologna, will start in 2016. This latter will link the cities of Bologna and Verona as part of the European cycle network *Eurovelo 7* [14, 15] (Fig. 23.6).

The Metropolitan City of Bologna has adopted in 2006 the Metropolitan Mobility Plan which identifies 10 strategies to improve the mobility network on a long period, aiming to develop a more integrated way of connecting places [16]:

Norway = 500 km
Sweden = 2.175 km
Denmark = 300 km
Germany = 660 km
Czech = 380 km
Austria 562 km
Italy = 1.970 km
Malta = none

Fig. 23.6 Eurovelo 7 cycling route. *Source* http://www.eurovelo.com/en/eurovelos/eurovelo-7

1. Bologna as a node of the European Transport Network.
2. New impulse to the metropolitan railway service. New interventions, redesign of the governance toward a metropolitan-scale economic sustainability of the railway service, integrated tariffs with the road transport systems, better accessibility to stations, ICT-based services for customers;
3. Three stations for the city of Bologna. Redefinition of the role of three Bologna's stations, physical improvement of the central station and its better integration with the urban traffic, a system of three stations as gates to the city;
4. Public transport in the city of Bologna. Redesign of public transport inside the city and towards the airport, new lines of tram and busses, intermodal nodes;
5. Integration of the provincial public transport. Integration and coordination between the provincial (now metropolitan) and local public transport systems, the latter separately managed by municipalities;
6. The community as main character in the design of rail services. More power to the Provincial administration in order to guarantee all of the 10 strategies. (The Province corresponds now to the metropolitan city. See Sect. 20.1.3);
7. The new ring road of Bologna and the North Loop. Integration between the two major planned road infrastructure of Bologna, and redesign of the secondary road system that connects them with the city;
8. Introduction of a road pricing for high-speed roads and tariff for parking lots inside the city as tool to finance new intervention for the not urban road system.
9. Transverse drivability: an integrated network. Strengthening of secondary roads in the suburbs and rural areas;
10. Logistics and freight transport. Reorganization of functional hubs and districts, improving their accessibility through dedicate ways, promotion and design of a system based on intermodal node like road-railway.

After 10 years almost such of the alone 10 strategies have been undertaken and many goals achieved. In general the vision was toward a more integrated metropolitan area at a time when municipalities were independent. Since 2016, this aspect can be carried on by the new metropolitan city administration with less problems in terms of coordination, bureaucracy, time consuming and efficiency.

23.1.6 Healthcare

Bologna ranked 12 in life quality in 2015 among Italian cities [17], and it always reached good positions through years as shown in Table 23.1. Also, in 2013, it holds the second position, among major Italian cities, in urban ecosystem quality with a score of 56.12 % [18]. About the quality of the air in the metropolitan city, in 2015, some criticality emerged about PM10 emissions that exceeded the day limit 11 times during the year, making Bologna the 27th worst city about such emission. It holds the 16th position about NO_2 emission in 2013, and the 11th position about

Table 23.1 Bologna's position about quality of life in the Sole24ore ranking about Italian cities

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Position	1	7	5	12	14	13	8	1	10	3	7	12

Source from Sole24Ore. Qualità della vita annual reports

O_3 still in 2013 [19]. However, it holds the 7th position among major Italian cities about air quality [20].

The Municipality of Bologna birth rate was 8.3‰ and the mortality rate was 12‰ in 2013 [21]. Life expectancy in Bologna in 2012 was 85.7 years for females (fifth city in Italy) and 80.5 for males (third city in Italy). The increase in life expectancy for men from 2010 to 2012 was 0.3 years, while it kept stationary for women [21].

111 sport societies every 100,000 inhabitants gave Bologna the fifth position among Italian major cities for number of sportive societies, and the seventh position for the number of athletes (8339 every 100,000 inhabitants) in 2012 [21].

The public agency that manages the National Health Service is one of the biggest in Italy for size and complexity. In the Metropolitan City of Bologna the agency is articulated in 6 territorial districts with a total of 9 general hospitals, 4 minor hospital, and 54 health centers. It cured 72,000 patients, counted more than 24,000 surgical interventions, and had an annual balance that exceeded 1.7 billion of Euro in 2013 [22].

The Institute of Neurological Science has been established in Bologna in 2011 by the National Health Service and the University of Bologna. This new pole is dedicated to high research and education, medical treatment and care [22].

23.1.7 Tourism

Bologna is permanently ranked among the most attractive cities of Italy due to its cultural heritage and fine cuisine. However, in the last year it also gained popularity among those who are interested in smart cities and ICT from both a professional and an educational point of view. In fact, Bologna hosts the *Smart City Exhibition* (www.smartcityexhibition.it) since 2012, a three-day event that collects and exhibits the most updated advancements in the field through keynotes, laboratories, conferences, business meetings, trainings, and an expositive section where enterprises presents to the public their best products and solutions. The exhibition has become soon the European landmark in urban innovation, with more than 7,000 visitors, 111 events, and more than 600 speakers in 2014 [23].

A total of 1760 hotels and hotel-like structures, of which almost 50 % in the Municipality of Bologna, with a total of 39,129 beds, represents the accommodation capability of the Metropolitan City of Bologna at the end of 2014, with an increase of +8.44 % compared to 2013 [24]. These faced 1651,981 arrivals (+1.18 % compared to 2013) and 3283,548 presences (−1.37 % respect to the

2013). 41 % were foreigner tourists, mostly from Germany, China and UK. Usually people stay in Bologna 2 days averagely [24].

"Bologna Welcome" is the tourist information service managed by the municipality and a private firm. The service promotes Bologna and its territory with two touristic offices in the city and a web portal (www.bolognawelcome.com) where visitors get information about museums, hotels and events. The website allows to download informative materials, a book, and a touristic card [25]. Since 2009 a bus company provides a sightseeing tour through the historic center.

The Metropolitan City of Bologna has a touristic program of local promotion that indicates strategies and intervention to be implemented within the year. The program gets revised and refunded every year. Bologna expects to increase the welcome tourist services by implementing new technological devices, cultural events, greenways and cycle paths, and local food promotion in 2016 [26].

23.2 Steps Toward the Smart City

This paragraph wishes to illustrate the steps planned by the local governments in order to make Bologna a smart city.

During the 90s the Municipality of Bologna and the regional government devoted many financial efforts for building digital infrastructure. Actions have been taken also by other organization, like the University with its computer science department, research centers, and small and medium private firms.

23.2.1 Local Digital Agenda

The first step toward the digitalization was the adoption of the Local Digital Agenda (LDA) by the Municipality on January 14, 2012 [27]. LDA is aimed at answering the local ICT demand by strategic sectors such as school, economy, society, and mobility according to the Italian and European policy toward a digital society.

Such LDA of Bologna is in line with the European Union strategy called Europe 2020 proposed by the European Commission in 2010. Part of the strategy is the European Digital Agenda (EDA). Its main objective is to develop a Digital Single Market (DSM) to better exploiting the potential of Information and Communication Technologies in order to foster innovation, economic growth and progress. The Digital Single Market constitutes one of the seven pillars of Europe 2020 strategy for the growth of the European Union [28], and it is also one of the 10 political priorities of EU 2020 [29] (Table 23.2).

The Digital Single Market is made up of three policy areas. (i) Better online access to digital goods and services: helping to make the EU's digital world a seamless and level marketplace to buy and sell; (ii) An environment where digital networks and services can prosper: designing rules which match the pace of

Table 23.2 EU Pillars and priorities of the 2020 strategy

Europe 2020–7 pillars	Europe 2020–10 priorities
Achieving the digital single market	Jobs, growth and investment
Enhancing interoperability and standards	Digital single market
Strengthening online trust and security	Energy union and climate
Promoting fast and ultra fast internet access for all	Internal market
Investing in research and innovation	A deeper and fairer economic and monetary union
Promoting digital literacy, skills and inclusion	A balanced EU-US free trade agreement
ICT-enabled benefits for EU society	Justice and fundamental rights
	Migration
	A stronger global actor
	Democratic change

Source   https://ec.europa.eu/digital-agenda/en/europe-2020-strategy;   and   http://ec.europa.eu/priorities/index_en

technology and support infrastructure development; (iii) Digital drive for growth ensuring that Europe's economy, industry and employment take full advantage of what the digitalisation offers [29].

Another important goal of the Local Digital Agenda of Bologna was the reinforcement of democracy and social inclusion [27]. Interalie, the agenda encourages citizen participation by using digital technology. To support the participation process, the local government initiated other important actions, such as the launch of social networks, reorganization of back offices, use of tool to increase e-participation and finally, the use of app for taking advantage of services from the municipality [27].

Moreover, Local Digital Agenda offers a social and cultural promotion of the city. The Municipality of Bologna promotes and supports digital inclusion and cultural development by supporting free internet access and digital school projects. It introduce whiteboards, laptops, tablets, and e-content in schools, and transforms libraries in knowledge environments where citizens can support their cultural growth.

Bologna is one of the Italian national center of excellence in such a field, and now the local Governments of the metropolitan area are investing resources toward smart initiatives.

The Local Digital Agenda proposal presented by the Municipality of Bologna has been improved through a participate process with the community that in the first 6 months of 2012 has produced several proposals. These have been collected by an online platform *Iperbole2020* and discussed during several focus groups, and events promoted either by the municipality or by private non-profit associations.

The numbers are: 9700 visits to the online platform, 700 tweet with the hashtag #agendadigitalebo, 80 proposals from the online form, 30 sponsored events, 9 promoted events [27].

The last implemented proposal is the conversion of 30 sociocultural centers into Digital Centers where Wi-Fi hotspots were installed, thus contributing to increasing the network of free Wi-Fi accesses inside Bologna [30].

23.2.2 Bologna Smart City

Immediately after the experience of the Local Digital Agenda, the Municipality of Bologna and a consortium of public and private companies and organizations, including Bologna University, signed a memorandum of cooperation (July 2012). The memorandum aimed at identifying the guidelines for transforming Bologna into a smart city [31].

The goal is to make Bologna an intelligent and sustainable system where resources, optimization allows to both qualifying the existing services and creating new ones for a city open to the participation and the creative contributions of citizens. Projects and proposals arising from this collaboration are part of the recent Strategic Metropolitan Plan (see Sect. 20.1.3) [31].

The Bologna Smart City platform has identified seven key areas worth a development effort.: (i) Cultural heritage; (ii) Iperbole 2020 Cloud and crowd; (iii) Smart networks; (iv) Sustainable mobility; (v) Safe and sustainable neighborhoods; (vi) Health and welfare; (vii) Education and technical training [31].

The Smart City Plan for Bologna is addressed in the Sect. 20.4.

23.2.3 iCity

Particularly interesting is the multi-partner European project "iCity" [32], supported by the European Union funds. Goal of iCity is the creation of an European open platform integrated with similar partners platforms existing in Genoa, London, and Barcelona. These platforms help creative citizens, businesses, universities and associations in co-designing and managing shared services or applications through ICT infrastructure, software tools, and open data.

The guiding principle is that of "The five I": making cities Intelligent, Integrated, Innovative, Inclusive and Internet-enabled. The theme is the creation of new models of interaction between citizens and territory through the use of services and open data that the government made public [32] (Table 23.3).

Table 23.3 It shows the available opened information systems for Bologna at this moment

Bologna	Generic sensor data	
	Transport and mobility	TPER-QueryHelloBus; QueryHellobus4ivr; QueryResale CISUM-metropolitan traffic; CISUM-parking
	e-Government	
	Environment	Air quality
	Tourism and culture	CISUM-events; Cineteca DVD/VHS Catalogue; Agenda Cultural
	GIS	Geocoding
	Wi-Fi	WiFi Live Monitoring

Source iCity Project. Retrieved from http://www.icityproject.eu/information-systems-map

23.3   Economic Structure

In what follows we analyze the economic structure of Bologna's metropolitan city. To do this we have analyzed several statistical data and report from the Italian Statistical Agency (ISTAT) and from local government agencies, such as Emilia Romagna Region, and Metropolitan City of Bologna.

The goal is to provide an accurate picture of Bologna's economy in the last decade, and to search current trends linked with Smart City initiatives.

Despite its wide use we lack, a definition of what the label "smart city" really means. We have used the smart cities' definition sketched by the European Smart City initiative, i.e. a city that addresses public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership, and has the following focuses: Governance, People, Living, Mobility, Economy and Environment [33].

According to the above definition, we will try to understand whether and how smart city initiatives have influence on economy, social inclusion, innovation, entrepreneurship, trademarks, productivity and the integration in the international market.

By smart economy we mean the development of e-business and e-commerce, ICT-enabled and advanced manufacturing and delivery of services, ICT-enabled innovation, new products, new services and business models, smart clusters and eco-systems (e.g. digital business and entrepreneurship). Smart economy also entails local and global inter-connectedness and international embedding with physical and virtual flows of goods, services and knowledge.

One should finally note that all the economic indicators of the last years have been influenced by the economic and financial crisis originated in 2008. This made our job much harder, in order to identify the effective trends of what has a direct link to smart city.

23.3.1 Metropolitan City of Bologna and Its Economy

If economic performance of Emilia Romagna was near the bottom of Italy's 20 regions in 1970, the region ranks first today. Emilia Romagna also ranks 10th among European Union's 122 economic regions, and its unemployment rate is worse than in 7 other European regions only. Its per capita income is 30 % higher than the national average and 27.6 % higher than the EU average [35].

Bologna is the most populous city of the region, and it is the commercial and communication hub of the area.

Economy is characterized by a prosperous industrial sector, traditionally based on the transformation of agricultural and zootechnical products, machinery, automobiles, footwear, textile, engineering, chemical, printing and publishing industries, as well as financial, insurance and retail activity.

Macroeconomic indicators—such as value added, number of firms, and employment—show a substantial downtrend linked to the global crisis and the decrease of domestic consumption and investment. Figure 23.7 shows a substantial decrease of new enterprises in the metropolitan area in 2009.

The pro capita GDP of Bologna is still among the highest in Italy, thanks not least to a solid, active productive fabric, and an ever-growing tertiary sector. In general, since 2000–2011 the metropolitan area has increased its GDP (Fig. 23.8).

An interesting point concerns the economic model of Bologna and, more widely of the Emilia Romagna region characterized by co-operatives.

Co-operatives are the foundation of the region's economic makeup. More than 30 % of the 43,000 Italian co-operatives are located in Emilia Romagna, making it
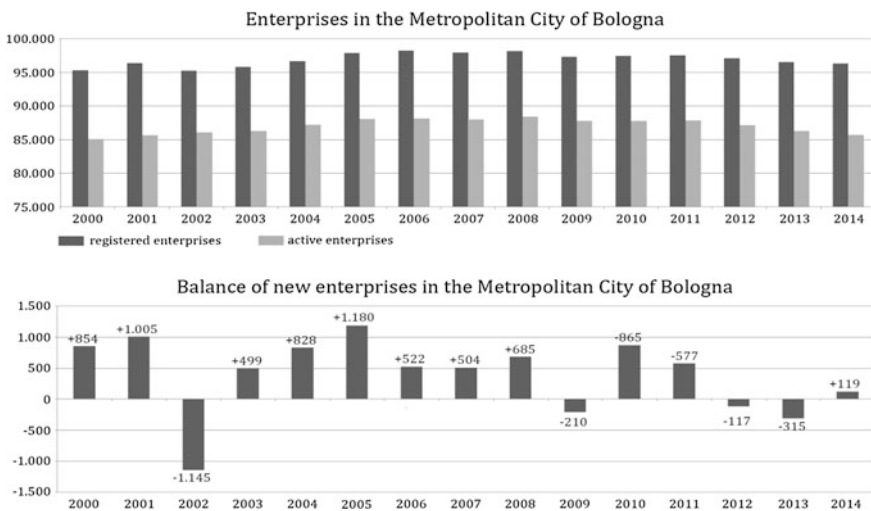
Fig. 23.7 Enterprises in the metropolitan city of Bologna. *Source* Camera di Commercio di Bologna, Report 2015

Fig. 23.8 Pro capita gross domestic product in the metropolitan city of Bologna, since 2000–2011. *Source* Eurostat
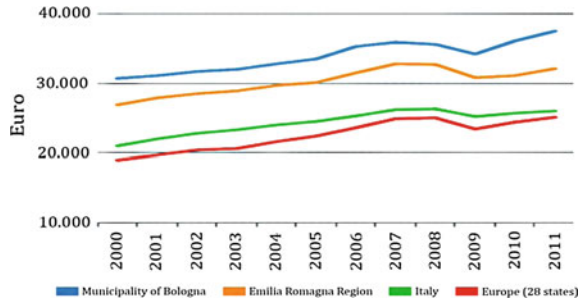
one of the most concentrated co-operative sectors in Europe. In Bologna two out of three citizens are members of a co-operative, with most belonging to several ones.

Co-operatives directly account for over 40 % of the region's GDP. Indirectly, through their economic spin-offs and their involvement in production, distribution, training, and marketing networks, the co-operatives of Emilia Romagna account for a much higher contribution to the region's economy.

The sectors in which co-operative firms are strongest include retail, construction, agricultural production, housing, manufacturing, and social services. Most public works, including large-scale engineering, construction, and heritage restoration projects, are carried out by building co-operatives owned by their employee members. In the Metropolitan City of Bologna the growth rate of cooperatives is +1.56 % in 2014 while it is +2.13 % for the Municipality of Bologna. Also, seven municipalities of the metropolitan area registered a growth rate of more than 10 % [34].

Figure 23.9 shows economic sectors and their trend in 2008, 2011, and 2013. There is a prevalence of the commercial sector that shows a stable trend in the last years, then construction industry, real estate and accommodation activities. Agriculture and manufacture, although have a bit slowed down have had the same trend. Telecommunication and information sectors show a stable trend in the period between 2008 and 2013.

About the productivity, regional data show that it is below the European average. Firms in Emilia Romagna have a decent innovation performance, despite they are less productive than EU firms on average. Such a poor regional performance can be explained by the industrial structure that is mainly based on SMEs and by the poor diffusion of ICT with respect to the rest of the EU (e.g., just 67 % of households have Internet access vs. an EU average of 74 %) [34].

As shown in Fig. 23.10, production trend (blue line) remains uncertain with production, turnover and orders declined again in 2012.

Research and development (R&D) investments show that regional firms' awareness about innovation issues is growing, yet much more effort is needed for improving firms' innovation performance. Regional firms carry out insufficient—yet growing—R&D activity and hardly collaborate with partners (businesses or institutions) in research and innovation.
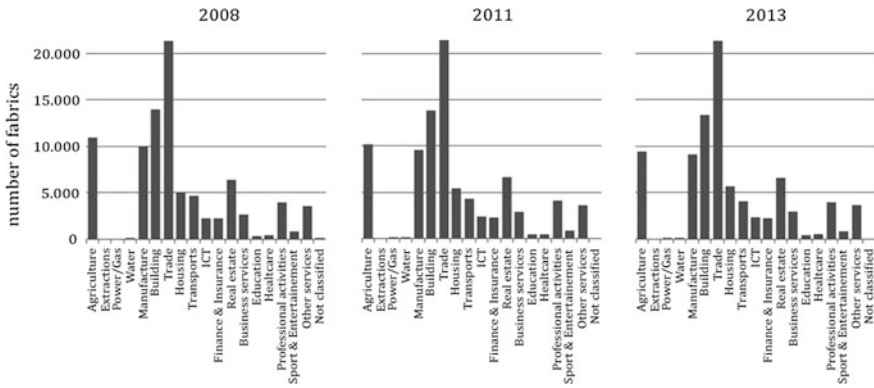
Fig. 23.9 Economic fabric in the metropolitan city of Bologna, divided in sectors. *Source* Camera di Commercio di Bologna, Report 2014
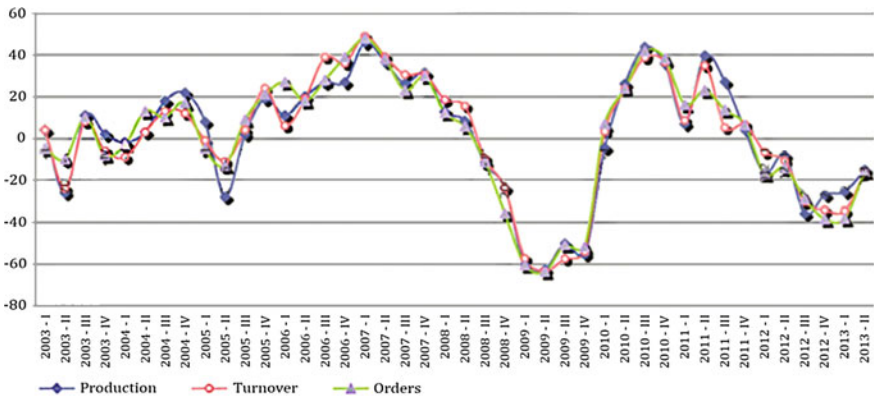
Fig. 23.10 Trend and relationship between production and turnover, by quarters, since 2003–2013 in Bologna. *Source* IRES and Unioncamere, Report 2013

In Higher Education, investment in Emilia Romagna, like in many other regions, lags behind in terms of tertiary education rate and in terms of GDP share allocated to higher education. In order to build a sustainable knowledge society, Emilia Romagna, with the support of national government, needs to boost investment in tertiary education and in its research system.

In term of innovation, available data refers to the region. ESIC's report [35] compares the regional innovation system of Emilia Romagna to the average performance of the EU according to various indicators of the European Service Innovation Scoreboard [35]. Relative performance is measured against the performance of the best performing region of the total 262 EU regions taken as 100 and of the worst performing region taken as 0.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Craft firms	100,6	102,1	103,0	104,7	106,6	106,5	106,6	106,2	105,2	104,7	104,3	103,1
Non-craft firms	100,7	100,7	100,6	101,4	102,1	102,2	101,9	102,7	102,1	102,4	102,7	102,1

— o — Craft firms   —□— Non-craft firms
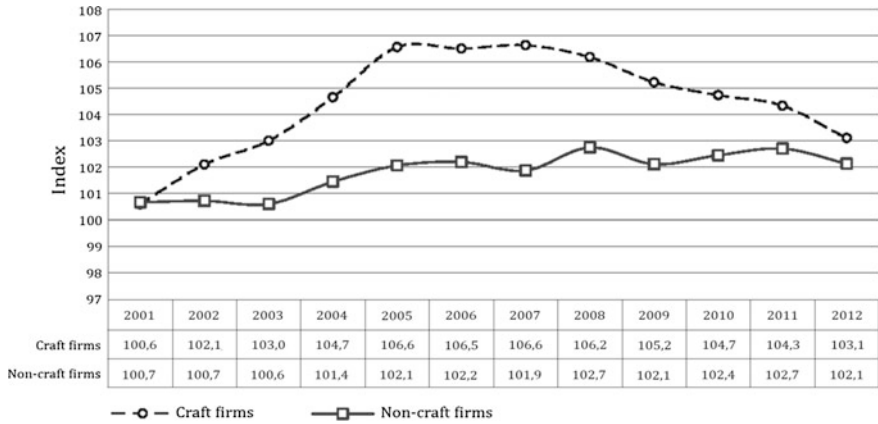
Fig. 23.11 Craft and non-craft firms in the metropolitan city of Bologna since 2001–2011. (Index 2000 = 100). *Source* IRES and Movimprese

The decline of loss value and export between 2007 and 2011 has affected the business world. In particular, craft firms decreased by 2 %, and this trend doesn't seem to slow down. Third sector shows a moderate decrease by −0.1 % (Fig. 23.11).

Figure 23.12 provides an overview of the general socioeconomic situation that frames service innovation. The graphs reflect the importance of service innovation in the region and measure its transformative capacity. Finally, in Fig. 23.13 we can see indicators which capture the five innovation system dimensions such as entrepreneurship, knowledge development, innovation, financing and collaboration.

Emilia Romagna performs about the EU average on the wider framework conditions of service innovation. The only area where the region lags behind the EU27 average is service innovation input [35].

In terms of structural indicators, Emilia Romagna performs close to the EU average on indicators assessing collaboration and networking and financing. While the region lies above average on innovation and business model generation, it lags behind the EU27 average on entrepreneurship, and knowledge development and transfer [35]. This is also reflected in the distance from the best scores. Most strikingly, the region does relatively badly on the 'share of innovators collaborating with others', on employment share in knowledge intensive services and on labor productivity growth. Conversely, the region does relatively well on the share of self-employed people such as potential innovators/entrepreneurs and on the share of innovating firms that have received public financial support, which reflects the ability of the regional government to target innovators. Thus while there are many entrepreneurs and potential innovators and an effective public support structure, there seem to be significant obstacles to commercialization, knowledge transfer and, therefore, growth. The figures above indicate clearly that there are considerable

General socio-economic situation

Service innovation / Transformative power

— Emilia Romagna region   — Europe (27 states)
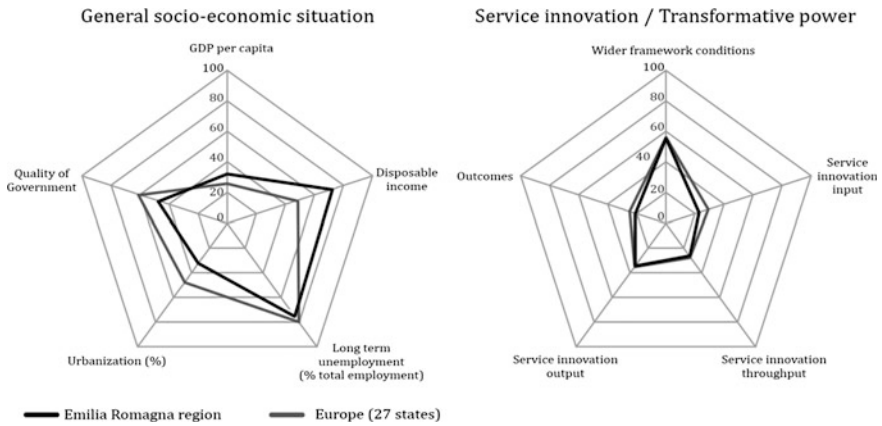
Fig. 23.12 Regional profile of Emilia Romagna region on the European service innovation scoreboard. *Source* European Service Innovation Centre (ESIC). Policy brief for Emilia Romagna, Report 2014

— Emilia Romagna region   — Europe (27 states)
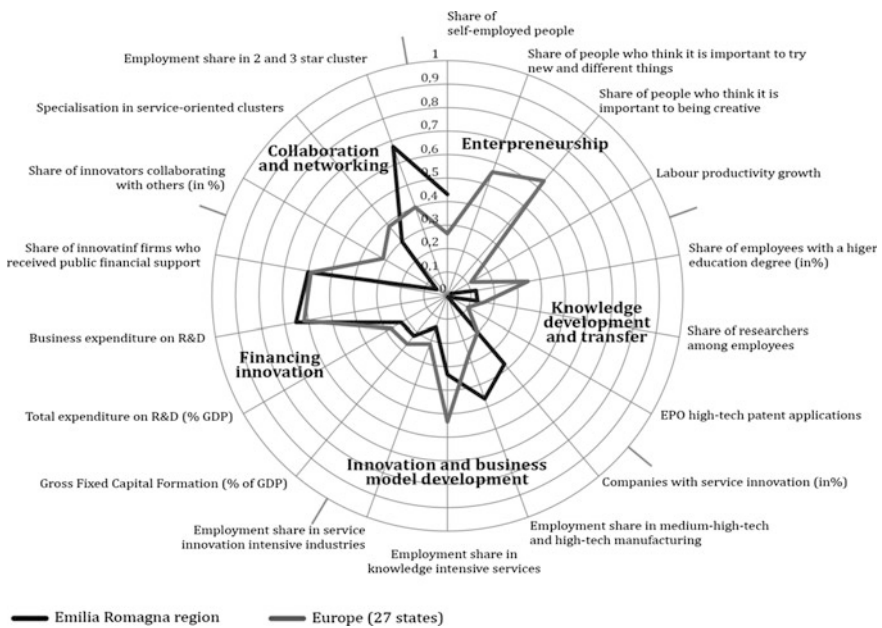
Fig. 23.13 Distance of Emilia Romagna Region from the best performing regions and EU27 average in terms of service-innovation related structural indicators. *Source* European Service Innovation Centre (ESIC). Policy brief for Emilia Romagna, Report 2014. *Note* The *black line* is interrupted due to unavailable data

possibilities for Emilia Romagna to further exploit the potentiality of service innovation [34].

Industrial change, global crisis, economic uncertainty, and variation in demographic patterns have create social friction in labor market. Charts show a general increase of unemployment during the last years (Fig. 23.14). Such a negative trend is particularly pronounced if we look at chart 14d showing unemployment level by age groups. Youth is particularly affected by unemployment.

Socioeconomic uncertainty and demographic and structural change that are occurring in the metropolitan area demand immediate politico-economical choices so to reduce social fracture and financial unsustainability.

About export and import business, data show the difficulty of the metropolitan system in dock economic recovery. In Fig. 23.15 we see the main import export sectors: mechanical industry, transport systems, chemical industry, fashion and agro-food sector.

As shown in Fig. 23.16 the role of the European Union in the dynamic of exchange is predominant. EU covers 67.9 % of import and 47.9 % of Bologna's export.

Export toward other European countries is close to 11 %, with a good trade share with Turkey, whose economy has expanded significantly in the last years.
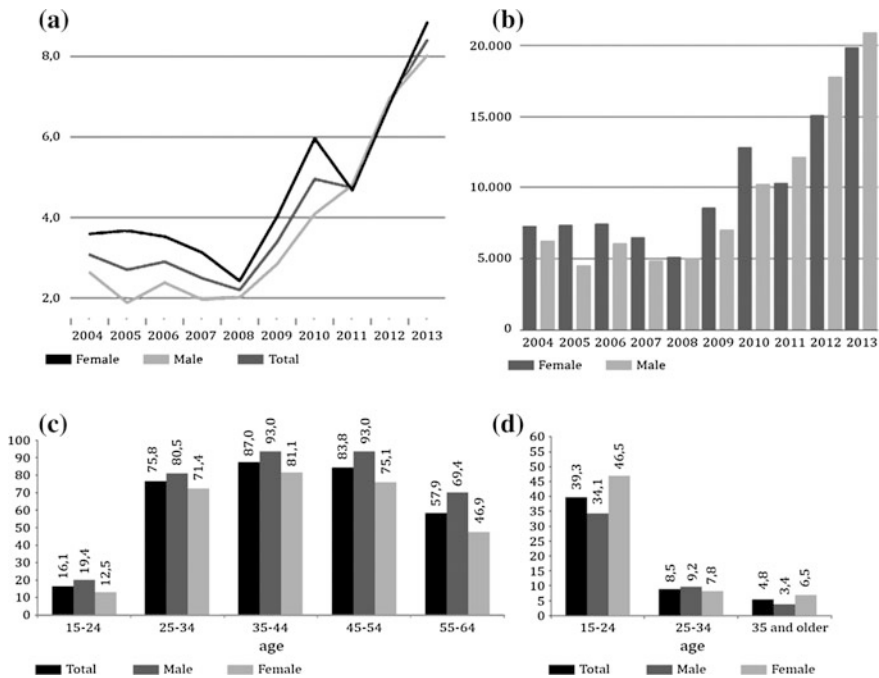
Fig. 23.14 a Unemployment rate (older than 15 years old); **b** Unemployment amount; **c** Employment rate by age groups in the metropolitan area; **d** Unemployed level, divided by age groups in the metropolitan area. *Source* Italian National Statistic Agency—ISTAT
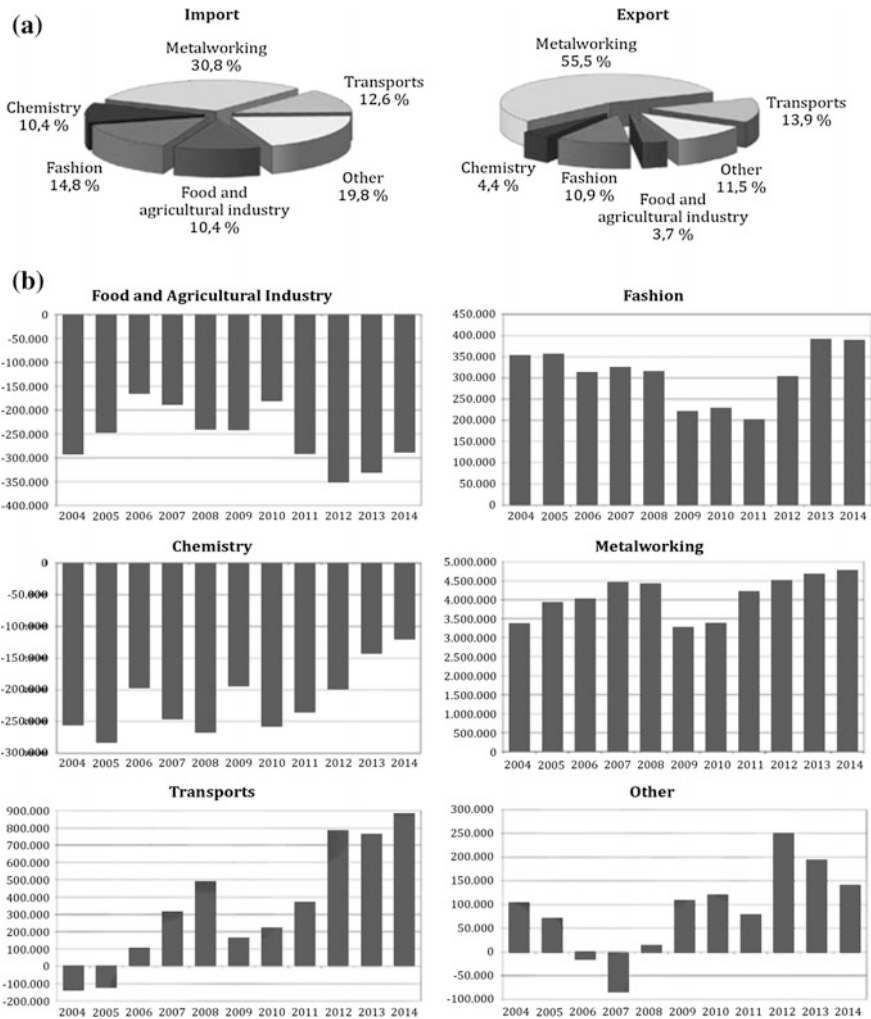
Fig. 23.15 **a** Foreign trade in 2014; **b** Import export balance since 2004–2014 about the main sectors. *Source* Camera di CCIAA, report *Import & export dell'area metropolitana di Bologna—2014*. Retrieved from http://www.bo.camcom.gov.it/statistica-studi/osservatorio-economico/commercio-estero/import-export-a-bologna-2014. Accessed 20 April 2015

Also important is the trade exchange with Asia, where export is close to 21 %, with a particular flow to Central Asia region. Export has significant value toward North America and European Countries outside the EU.

Particularly interesting is Fig. 23.17. It shows the metropolitan export since 2008 and the export collapse during 2009 after the world crisis of 2008. Although there has been a significant increase in 2010, the graph shows a downward trend over the period 2011/2013. 2014 data show a moderate growth of export [34].

Main countries of import

Main countries of export
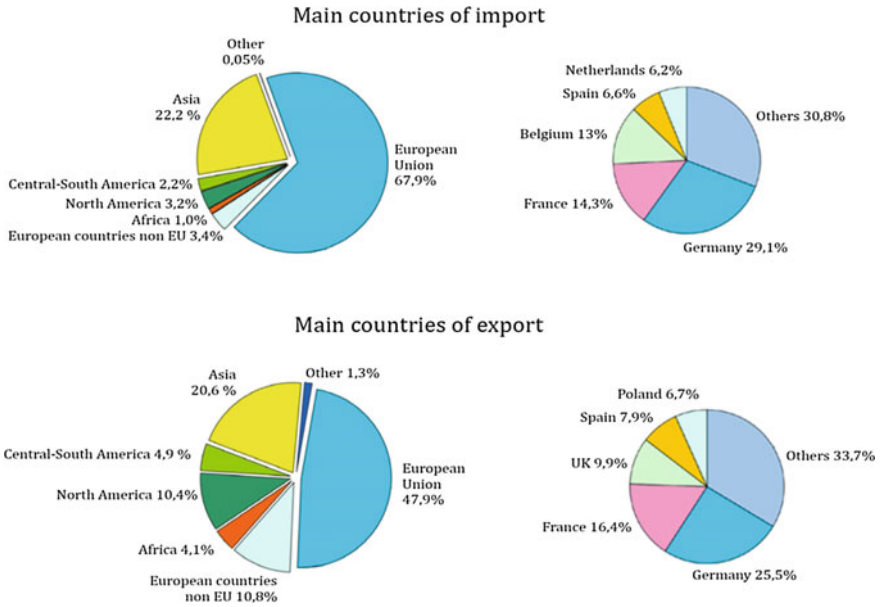
Fig. 23.16 Import Export trend in 2014 and main destination. Source: IRES after ISTAT. *Source* Camera di CCIIAAAA, report *Import & export dell'area metropolitana di Bologna*—2014. Retrieved from http://www.bo.camcom.gov.it/statistica-studi/osservatorio-economico/commercio-estero/import-export-a-bologna-2014. Accessed 20 April 2015
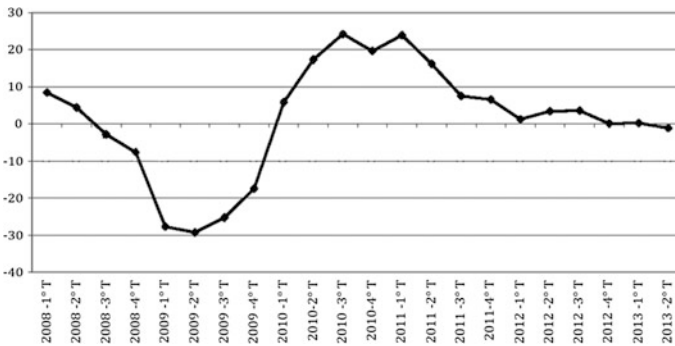
Fig. 23.17 Export trend in 2008–2013 in the metropolitan city of Bologna, by quarters. *Source* Camera di CCIIAAAA, report Import & export dell'area metropolitana di Bologna—2014. Retrieved from http://www.bo.camcom.gov.it/statistica-studi/osservatorio-economico/commercio-estero/import-export-a-bologna-2014. Accessed 20 April 2015

Figure 23.18 shows how the percent of export has changed geographically. Although the export toward UE is decreased by 8.6 % between 2001/2012, EU remains the main market.
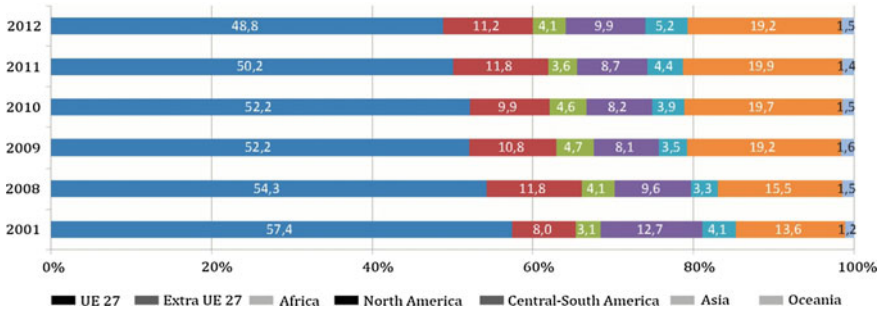
Fig. 23.18 Export, in %, about the metropolitan area with geographical destination of goods. *Source* Italian National Statistic Agency—ISTAT; Emilia Romagna Institute Economical and Social Research—IRES

Fig. 23.19 Income pro-capita of families in Euros. *Source* Urbes Report 2015
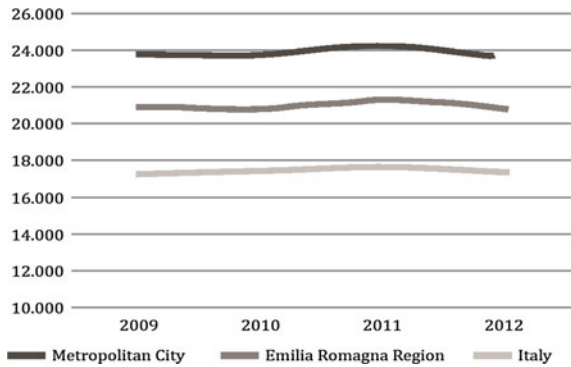
To conclude this paragraph, we would like to analyze the trend of the metropolitan area families' income. Figure 23.19 compares the metropolitan income to the regional and the national income.

23.4 The Smart City Plan and Its Influence on Economy, Society and Land-Use

In this paragraph we introduce the Smart City Plan for Bologna and we try to analyze whether it has generated positive effect on society and economy.

As we know, even though there has been an increased focus on urban development policies during the last years, the very "*smart city*" concept is still in search of a rigorous definition [36].

However, there are two ideas that are relevant in literature: ICT and related new economy. These two attributes appear in the issue "Smart cities in Europe", where

Caragliu, Del Bo, and Nijkamp label a city as smart "*when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory Governance*". [37].

But what do we mean when we talk about ICT and new economy?

The Organisation for Economic Co-operation and Development (OECD) member countries agreed to define the "*ICT sector as a combination of manufacturing and services industries that capture, transmit and display data and information electronically*" [38]. Manufacturing industries refers to: (i) information processing and communication including transmission and display; (ii) electronic processing to detect, measure and/or record physical phenomena or control a physical process.

Services industries must be intended to enable the function of information processing and communication by electronic means. One important feature of the OECD ICT sector definition is that it breaks the traditional dichotomy between manufacturing and services activities.

Although the definition is not yet consistently applied, it is important because it gives a first approximation of the ICT sector. The existence of a widely accepted definition of the ICT sector is the first step toward comparisons across time and countries.

The term *New Economy* (NE) describes aspects or sectors of an economy that are producing or intensely using innovative technologies. This relatively new concept applies particularly to industries where people depend more and more on computers, telecommunications and the Internet to produce, sell and distribute goods and services [39]

An important innovation of NE is the dual use of new technologies: on one hand there is the production of new technologies, and on the other hand there are companies that use these technologies to realize their core business.

In general NE refers essentially to the use of the internet and ICT as fundamental tools in the economical exchange e-business, or the use of digital technology in the management of administrative or financial documents (e.g., invoices, legal documents) [40]; E-commerce, or buying and selling via electronic devices, stock market, marketing of goods and services, etc.; e-learning, that refers the use of the internet to develop courses; e-government, or the use of the internet to improve quality of services for citizens and companies; e-procurement referring the processes of restocking a company in term of services and goods.

ICT economy refers to company that equip, produce or distribute ICT, such as hardware and software, etc. Usually we refer to both these manufacturing sectors as intangible sectors.

The phenomenon of the NE is linked to social transformation and the affirmation of what is called "knowledge society". Usually the term refers to microelectronics, biotechnology, telecommunications, robots and computers companies that enforce innovative skills into economic processes.

NE is characterized by a few common attributes such as (i) globalization, that describes a process by which national and regional economies, societies, and

cultures have become integrated through the global network of trade, communication, immigration and transportation [41]; (ii) growth of dematerialization; (iii) use of technological platforms for commercial and financial brokering.

23.4.1 Smart City Plan

The mission of the Smart City Plan for Bologna is about answering to several questions such as how to create a city oriented to citizens, how to support socioeconomic development, and how to enforce the European strategy 2020. The European strategy wishes to make the European economy more smart, sustainable and inclusive. Deliverables are higher levels of employment, productivity and social cohesion. Concretely, the Union has set five ambitious targets to be reached by 2020: (i) Employment, (ii) Research & Development, (iii) Climate change, (iv) Education (v) Fighting poverty and social exclusion [42]. The smart initiatives are part of the above plan where local governments—municipalities in this case— develop strategies with focus on local community.

The municipality of Bologna started the process to becoming a smart city in 2012 (see Sect. 20.2).

Aim of the Smart City Plan is to pool resources, talents and ideas to make the city more environmentally sustainable, reduce costs, avoid energy waste, improve life quality, guarantee social inclusion and participation, education and health, and promote culture as a means for local community's economic development.

The partnership aims at outlining priorities, strategies and tools for the development of the Bologna Smart City project, including access opportunities to national and European funding.

The project platform also offers an opportunity to experiment a new model of joint work among different institutional stakeholders, as well as between public and private sectors. The aim is to create a context for the development and implementation of actions and projects which have great impact on the local community.

The Bologna Smart City's partners prepared an action plan identifying an initial group of key priorities [31]:

1. Cultural Heritage (requalification of the historical center and its cultural heritage, tourism development);
2. Iperbole 2020 Cloud and Crowd (redesigning the Iperbole Civic Network, based on cloud technologies and an integrated digital identity, joining the contents and services of the PA, businesses and the local community);
3. Smart networks (Smart grid, Ultra-Broadband Fiber to the Home (FFTH) and Smart Lighting);
4. Sustainable Mobility (development of an intelligent mobility network—also electricity based);
5. Safe and sustainable neighborhoods (Redevelopment of the public and private heritage to increase energy efficiency and production, monitor building security,

waste management, social housing, automation systems, co-working, services and new fields for knowledge workers and researchers);

6. Health and Welfare (e-care, e-health, process optimization and business intelligence);
7. Education and technical training (development of projects in the educational field, fostering a new technical and scientific culture).

To understand what kind of impact such actions can have on the socioeconomic structure, it is necessary to illustrate shortly the above actions and their goals.

23.4.1.1   Cultural Heritage

This point wishes to develop a cultural network with all the local cultural structure, such as libraries, museums, theaters, and archives. In addition, the municipality wishes to apply a policy for the rational use of human and financial resources.

For the above projects, ICT play a key role in term of management of the information and data set, in developing a digital network that connects all the cultural institutions.

23.4.1.2   Iperbole 2020 Cloud and Crowd

The new civic network of Bologna (www.comune.bologna.it) aims to offer a new and innovative digital environment for improving a bidirectional communication (local government citizens), services available from local offices, to develop new forum and communities, sharing areas, etc.

Iperbole 2020 will be a digital open platform that will contain three sub-environments [43]: (i) services for citizens; (ii) communication area; (iii) shared area. Each subenvironment calls to: (i) improve digital services for citizens; (ii) develop a more efficient communication from municipality to citizens; and (iii) facilitate the creation of bottom-up contents and peer to peer activities.

Each citizen will have access to several online services through Iperbole, including a personal area, with a personal dossier containing administrative and sanitary information, paid or non-paid bills, and enrollment at courses. About the first point—services for citizens—an important initiative has been the adoption of the digital identity card, a document aimed at several public services—such as sanitary, social and administrative. In addition, every Bologna's inhabitant was endowed by a personal certified e-mail address. Through this e-mail, every citizen can communicate with public offices with an e-mail that has legal value. This service has been created by a joint venture of private firms and public agencies. However, this service was stopped since November 2, 2015 due to lack of funds. Further, bureaucratic issues made more expansive the release of digital cards than the normal paper cards issuing [44].

The necessity to develop a more efficient and incisive communication between municipality and citizens brought the municipality to plan several activities, both internal, where the communication office has been reorganized, and external for a more coherent use of social network, such as Facebook and Twitter, a general reorganization of the institutional websites, and the creation of a social web TV.

Finally, an open digital environment area has been developed for local community to create bottom-up contents and peer to peer activities. The goal is supporting innovation processes and the creation of economic, social and cultural solutions and initiatives directly by the local community. To do this, citizens and non-profit organizations may use a digital platform—called civic network—that supports their activity in developing new services, innovative solutions and new p2p economic models such as crowd-sourcing and crowd-funding.

23.4.1.3 Smart Networks

By Smart Networks action the municipality wishes to improve network infrastructures such as internet, electricity, gas and water.

The scope of smart grids is to provide innovative solutions for the production of electricity and heat, by use of non-programmable renewable resources, such as solar, and existing network infrastructure.

According to the European Digital Agenda, local government in cooperation with public agencies and private companies is developing a plan to ensure by 2020 all citizens to have access to fast Internet and innovative services. Broad band is a key factor for a number of quite specific projects that wish galvanize local economy, and support sociocultural growth.

Educational sector is one of the areas that local and regional governments wish to support through the ICT with a plan called "digital school." The plan is developing a broadband connection that connects all the schools, so to use an innovative pedagogy with double educational environment: one for the teachers and another one for the students. By 2020 all the schools of the metropolitan area will be connected to fast internet and they should access without delay to digital resources such as libraries, museums, etc.

Local and regional governments have also proposed a series of amendments to local legislation in order to implement rapidly new infrastructures.

To measure how important this field is for the city, Fig. 23.20 shows the rapidly growing population's access to broadband, particularly in the inner city.

23.4.1.4 Sustainable Mobility

Sustainable Mobility promotes friendly mobility systems, so to reduce the environmental impact of private vehicular traffic in the urban area.

Strategic actions are both to reduce the use of private cars in favor of public transport but also to improve cycle network, pedestrian safety, and electric public

Fig. 23.20 Proportion of the population access to broadband in 2012. *Source* Istituto Tagliacarne
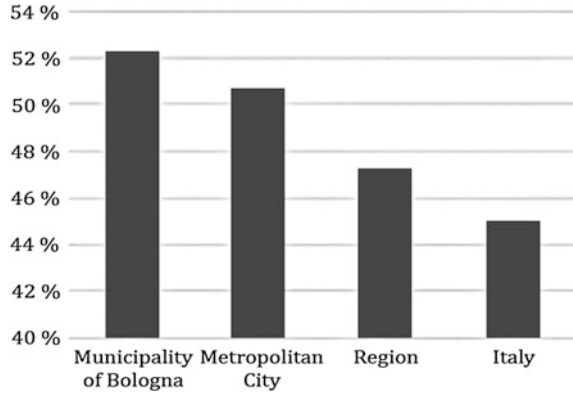
systems of transport. Reduction of 20 % of the urban vehicular traffic has been obtained through the system SIRIO, a check point system that works all around the city center allowing access to all authorized vehicles [45].

In addition, local government supports the private vehicles stocks renewal by financial incentives, circulation facilities for vehicles that do not use fossil fuels.

Other planned projects use the ICT in order to rationalize traffic. In particular, projects such as Insert and Marconi permit the access to intelligent transport systems such as traffic lights coordinate by a software with busses' GPS localization system. This permits to adjust traffic light sequences so that it is given priority to the public transport vehicles.

The Centre for Supervision and Integration of Urban Mobility Information (CISIUM) is a system that shall collect and process any information about mobility in the metropolitan area [46] in order to:

- provide an up-to-date overview of the metropolitan mobility situation making it possible to take adequate action;
- help the users make decisions regarding a journey by presenting various options;
- direct those already on the road in private vehicles, toward the least congested route;
- regulate traffic lights to help ease congestion in the most critical areas.

To communicate the information, variable message panels, radio broadcasts, Internet and text messages to mobile phones are used.

The same strategy has been developed for car sharing service with 11 emplacements where it is possible to take a car.

Figures 23.21 and 23.22 show data about mobility and the result following the local policies for a more sustainable life style. Graphs show light and dark situation where good results, such as increase in cycle paths density or the reduction of pedestrian mortality and reduction of private vehicles is balanced by a high average travelling time or the substantial linear trend of travelling km per inhabitants of the local transport systems.
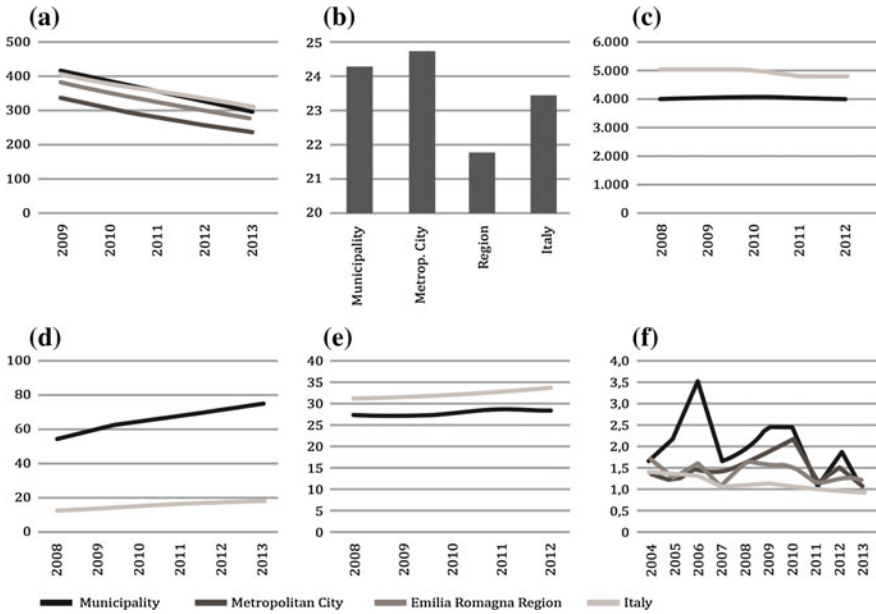
Fig. 23.21 **a** Number of cars Euro 4 standard per 1000 inhabitants; **b** Time spent travelling, year 2011 (in minutes); **c** Travelled km per inhabitants of local transport systems; **d** Cycle paths density per 100 km^2; **e** Available square meters of pedestrian areas per 100 inhabitants; **f** Pedestrian mortality rate every 100,000 inhabitants. *Source* Urbes Report 2015. Dipartimento Programmazione Settore Statistica del Comune di Bologna
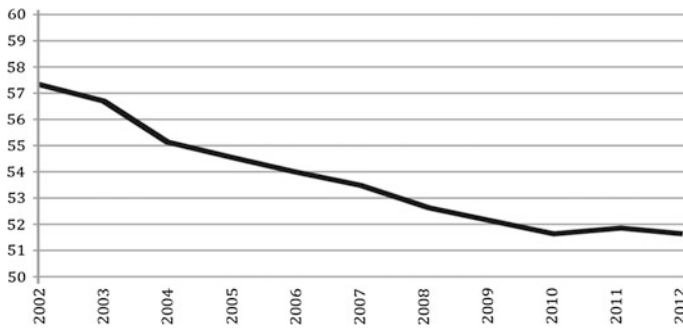
Fig. 23.22 Reduction of vehicles in the municipality of Bologna since 2002 (vehicles/100 inhabitants). *Source* Urbes Report 2015. Dipartimento Programmazione Settore Statistica del Comune di Bologna

23.4.1.5 Safe and Sustainable Neighborhoods

SSN is a plan to promote sustainability and resilience via restructuring public property, promote energy efficiency and green energy production, waste management, social housing, home automation, and co-working.

One of the main goals of the smart policy of the metropolitan city and regional government is to change the urban policy in term of land use.

This is a relevant theme in a country as Italy that has a fantastic cultural and architectural heritage.

As showed by the following images, during the twentieth century there has been an increased use of soil by urban development.

Figure 23.23 shows land use change occurred between 1955 and 1980: urbanized area growth by six times, and fallows and unproductive area growth more than 15 times.

Following Figs. 23.24, 23.25 and 23.26 show urban evolution of the inner city since the first decade of the twentieth century. In the face of a substantial steadiness of the density of m^2 of urban parks and green spaces and availability of m^2 of urban parks per inhabitants, images show that the most important increase in urbanization took place between 1919 and 1971 (Fig. 23.26). The growth of the urbanized metropolitan areas have risen from 25 to 225 km^2 (Fig. 23.24).

Finally, Fig. 23.26 shows that there has been a severe downturn except in the 10 years from 1982 to 1991.

Local and regional governments have taken various measures to address such a situation. Particularly, as a specific measure, a new metropolitan master plan was adopted. It wishes to stop soil consumption and open an innovative urban policy that, through specific rules can promote a sustainable land use discouraging sprawl in favor of compact urban development supported by public transport systems. Furthermore, the plan establishes other relevant options to support an equilibrate
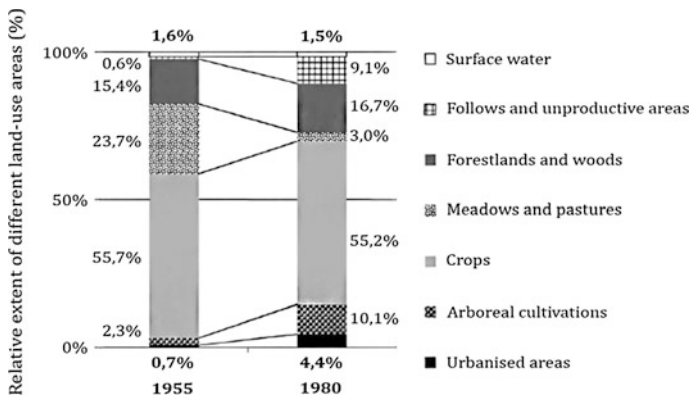
Fig. 23.23 Land use changes in the district of Bologna between 1955 and 1980. *Source* data derived from the National Research Council of Italy

Fig. 23.24 The growth of urbanization in the metropolitan city of Bologna. *Source* Atlante del consumo di suolo, a cura di P. Bonora, Baskerville, Bologna 2013
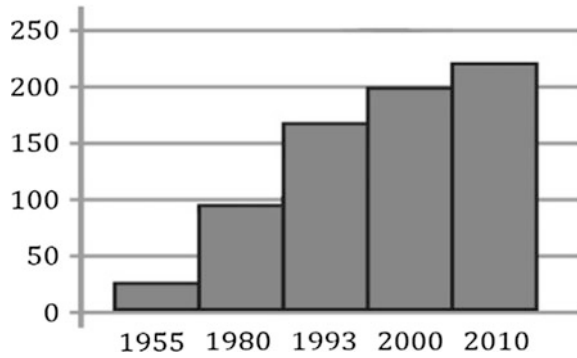
land use, such as the use of tax as way to encourage best practices and discourage financial speculation and new sprawl, soil protection of arable land and monitoring of soil consumption through satellite images, and restoration of the existing built environment.

Another fundamental point of this new urban policy concerns resilience.

As we know, resilience is the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner.

So, to reinforce local resilience, metropolitan government, with the partnership of Emilia Romagna Regional Environmental Agency (ARPA), Kyoto Club and Ambiente Italia, implements the Local Adaptation Plan called BLUE AP (Bologna Local Urban Environment Adaptation Plan for a Resilient City), that will make the city more resilient and prepared to handle the consequences of climate change [47].
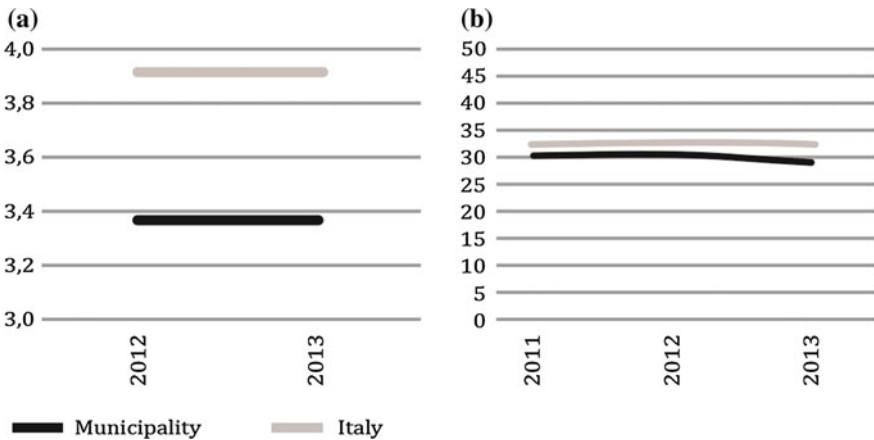
Fig. 23.25 **a** Density per 100 m^2 of urban parks and historic green spaces; **b** Availability of urban parks m^2 per inhabitants. *Source* Urbes Report 2015. Dipartimento Programmazione Settore Statistica del Comune di Bologna

This also occurs through the creation of a Local Climate Profile and the involvement of stakeholders and citizens on the territory.

BLUE AP is a LIFE + project for the implementation of an Adaptation Plan to Climate Change for the Municipality of Bologna, providing some concrete local measures to test.

The BLUE AP planning and testing actions developed in the city of Bologna will lead to the creation of guidelines useful for the definition of similar adaptation plans, that can be adopted by other medium-size Italian cities. Bologna will be the pilot-city that, first in Italy, will face climate changes with the appropriate and creative tools.

BLUE AP develop six pilot actions: (i) Include adaptation measures in the City's Building Code, so that incentives for adaptation to more efficient management of climate change effects may be explicitly foreseen; (ii) Define guidelines for infrastructures at risk, to improve infrastructural reactions during extreme meteorological events; (iii) Launch a green roofs campaign. The Bologna Municipality plans, together with the other project partners and stakeholders and through info points and other communication tools, to promote the spreading of green roofs; (iv) Improve the rainwater harvesting capacity of waterproof areas. To transform paved surfaces, for example a parking place, with less waterproof materials helps draining rainwater, limiting and slowing them down into the drainage system and thereby diminishing flooding risks; (v) Collect rain waters. Rainwater, when collected, may be a resource: filtered and conserved they may be utilized in different ways, from WC drainage to the irrigation of green areas; (vi) Promote insurance schemes, by informing companies and citizens about the opportunities offered though public/private partnerships by insurance policies against extreme climate events.

Every action aims to build resilient communities to raise awareness about the risks associated with climate change.

Built environment is also interested in the action plan for sustainable energy that wishes to reduce CO_2 emission by 20 % in 2020.

It is a collaboration between public agencies and private companies. With an investment of 25 million of Euros, the municipality and Enel Sole company, draw up energy improvement and integrated management of street's lighting and traffic lights. The plan promotes both energy efficiency and a better streets lighting's system through the use of an intelligent control that permit to save 40 % of energy.

We would also like to refer to other interesting projects relating to the efficient management of infrastructural system such as water, electricity, gas, waste, and quality of air, such as PM10 (powders with aerodynamic diameters less than 10 μm), NO2/NOx (nitrogen dioxides and oxides), O3 (ozone) and C6H6 (benzene), noise, in particular traffic and airport noise, and greenhouse effect.
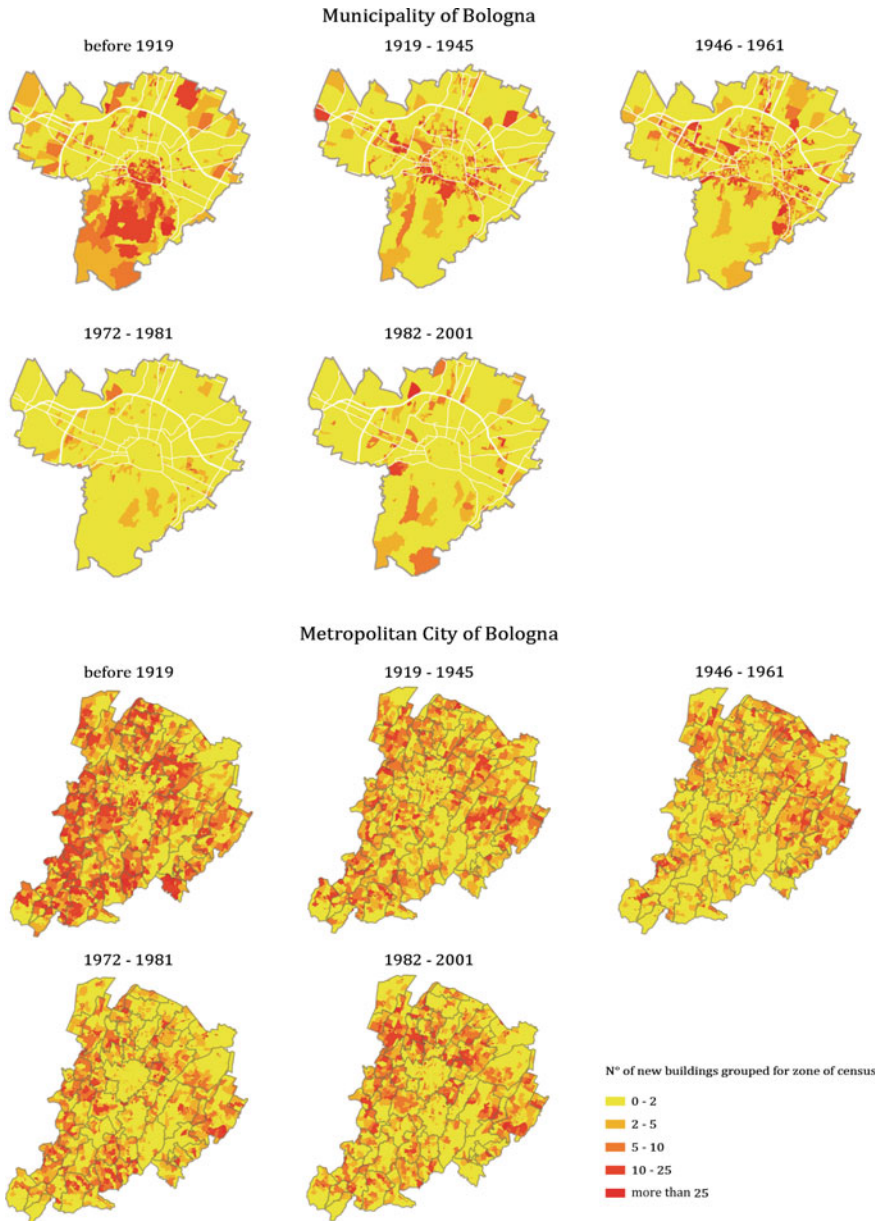
Fig. 23.26 Urbanization of Bologna and its metropolitan area. *Source* Atlante del consumo di suolo, a cura di P. Bonora, Baskerville, Bologna 2013

23.4.1.6 Health and Welfare

This is another important point of the smart plan for Bologna. Local government consider this goal as primary for several reasons. Facing an aging population, it is an opportunity to innovate the health sector, create a more efficient and qualitative service, and become a driving force for innovating also other sectors. For this effort local government sought cooperation of private companies and national agencies.

The goal is to realize a whole plan for the metropolitan area. First action is to reinforce the technological and managerial structure of "Sant'Orsola" General Hospital. It will increase its research program and its cooperation with other sanitary organizations, transforming the hospital in a high specialized environment with international reputation. Similar plans will be developed for the Ospedale Maggiore and for the IRCCS Neuroscience Centre. The plan provides a budget to reorganize the logistics and the organizational architecture and enforcement structures in the ICT framework. In particularly, part of the budget will be used to develop an international center for neurophysiologic research, genetically determined disease and rare disease.

In term of social welfare and health the plan provides the creation of small sociosanitary houses to facilitate assistance, especially for the elderly people.

Particularly emphasis is devoted to the role of ICT in welfare and sanitary assistance. Therefore a ICT sanitary district has been planned, able to develop research for e-health and support for people with disabilities. It creates a lot of content that specifically deals with issues relating to the elderly.

23.4.1.7 Education and Technical Training

Finally, for improving new job opportunities a reinforcement of education and technical skills has been planned. A metropolitan network, will be creating a link between educational structures and labor market.

The plan pays attention also to youngsters. It aims at renovating the educational systems through a metropolitan educational model able to create a whole network of education with schools, libraries, private educational institutes, voluntary social groups, etc. The goal is to reinforce the educational system and the social capital.

We may add that Bologna and in general Emilia Romagna Region have a very good school system. In face of the reduction of enrollment in primary school, reflecting the birth rate drop, there is a growth in terms of people with high school diploma and a degree. Unfortunately, the level of production of specialization in ICT remains constant at both the municipality and the regional level (Fig. 23.27).

In additions to the seven actions of the Smart City Plan for Bologna it is relevant to address the role of geographic information systems for the metropolitan city of Bologna.
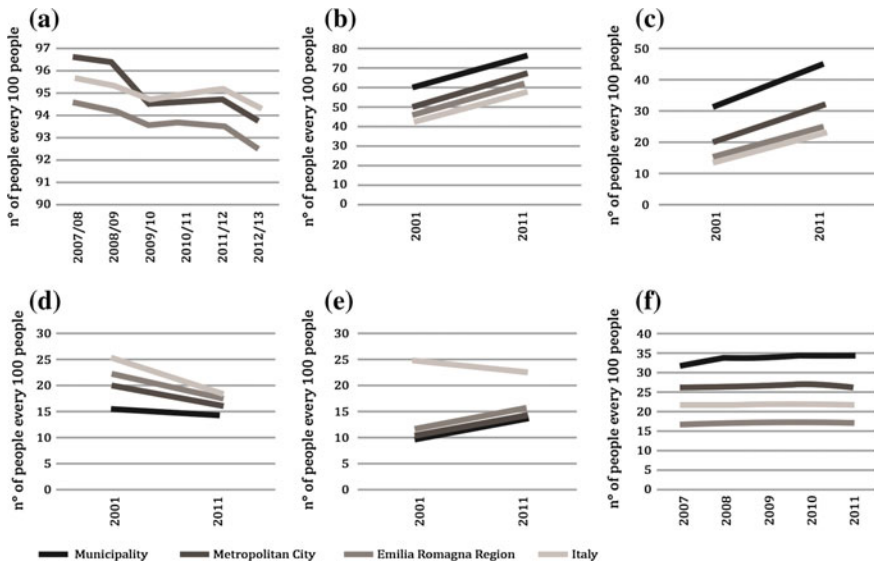
Fig. 23.27 **a** Enrollment to primary schools, per 100 children, 4 and 5 years old; **b** People with high school diploma, per 100 persons; **c** People with a degree every 100 persons; **d** Early school leaving, per 100 persons; **e** People not in education, employment or training; **f** Level of production of specialization in ICT, per 100 workers, between city, metropolitan area, region and Italy. *Source* Urbes Report 2015. Dipartimento Programmazione Settore Statistica del Comune di Bologna

23.4.1.8 Geographic Information Systems

The municipality of Bologna owns a relevant territorial data banks since 1996, and since 2000 the municipality has also set up a data warehouse where data coming from different sources and information subsystems are grouped and integrated, and can be accessed via territorial key [48]. This enables the exchange, the comparison and the evaluation of data using a territorial approach.

GIS are powerful instruments for collecting and processing useful information in order to support choices and planning. Further, Internet is radically changing GIS availability. Internet allows to shift from a hierarchical access reserved to skilled technicians to an open model which allows direct access and participation of citizens and makes them protagonists of the planning process.

The system architecture of Bologna GIS is based on a set of integrated application programs which [48].

- enables the territorial and cartographical data banks of municipality to run and be updated;
- enables the managerial data available in the municipal information system to be correlated with territory;
- enables access and processing of information to users by intranet and/or internet connections.

As said, main goal of municipality has been to facilitate citizen access to the information. For this, innovative instruments have been made available, such as new cartographies and orthophotographs [49].

Particularly interesting is the "Cartographic Forum," based on Web–GIS application and a Web forum.

Goal of this system is to help the citizen participating in the decision process.

In addition, an internet 3D navigable model has been developed from the Web–GIS. Thanks to this, it is possible to navigate flight simulator, having a realistic vision of the city and of the landscape [50].

The system offers to the users the possibility to see and know their city from a different point of view, through an approach more involving and interactive than traditional maps.

We can add to the model thematic layers, for example the map of hospitals, monuments, museums, and city services. This is the highest level of integration between GIS and data banks and 3D model.

These services are in continuous enrichment and they are available also as offline multimedia.

23.5 Sociopolitical Change, and the Role and Use of ICT

This paragraph analyses social and political transformations facilitated by the use of ICT, in the last decade about Bologna. Several social groups and their transformation according to Bologna as smart city will be addressed.

23.5.1 Community-Based Organizations

Bologna invested a consistent amount of resources to implement a well-working system of subsidiary, where increasing social cohesion and reorganising a number of services through the use of ICT played a crucial role. The purpose is to have several networks of relations and more shared visions. To do so, the optimum is a mix of an active third sector (non-profit sector), responsive public institutions, and private companies, which produce tangible and relational assets and a process of dynamic generation of tools and social capital.

The third sector plays a crucial role in this mix; however it is highly susceptible of variations about both quantity and influence. Number of involved actors, effective power, activity on the field and related presence across time, linkage with other sectors, are all variables that make difficult to engage with the third sector effectively, especially by the public administration, which in turn is rarely stable enough on long period of time to carry out an effective program of engagement and development.

Despite such difficulties, the governance of Bologna succeeded in establishing a good relation with the Third Sector that produced significant effects.

Accordingly, with the last census of the third sector [51], in the Municipality of Bologna, at the December 31, 2011, there were 2.868 active non-profit institutions of which 2218 using volunteers, with a total of 44,362 volunteers, 1 every 8.3 inhabitants, where the Italian ratio was 1 every 12.5. The metropolitan city of Bologna has 5694 active non-profit institutions, 4589 of them using volunteers. With a total of 86,748 volunteers, it holds the first position among the 9 provincial administrative territories in Emilia Romagna Region for number of volunteers [51]. Emilia Romagna is the fourth region in Italy for amount of volunteers and has 25,116 non-profit institutions.

At a first glance, the Fig. 23.28 shows as the wider sector of activity of non-profit institutions is about culture, sports and leisure. Second is the education
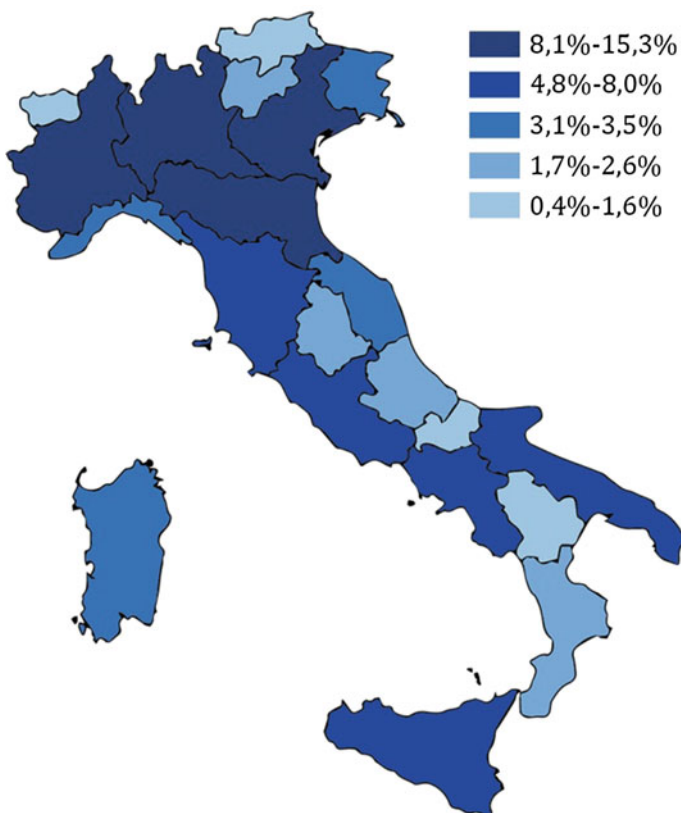
Fig. 23.28 Percentage of non-profit institution by region in 2011. *Source* ISTAT. 2012. 9° Censimento industria, servizi 2011. *La rilevazione sulle istituzioni non profit: un settore in crescita*. http://www.istat.it/en/files/2013/07/05-Scheda-Non-Profit_DEF.pdf. Accessed 10 June 2015
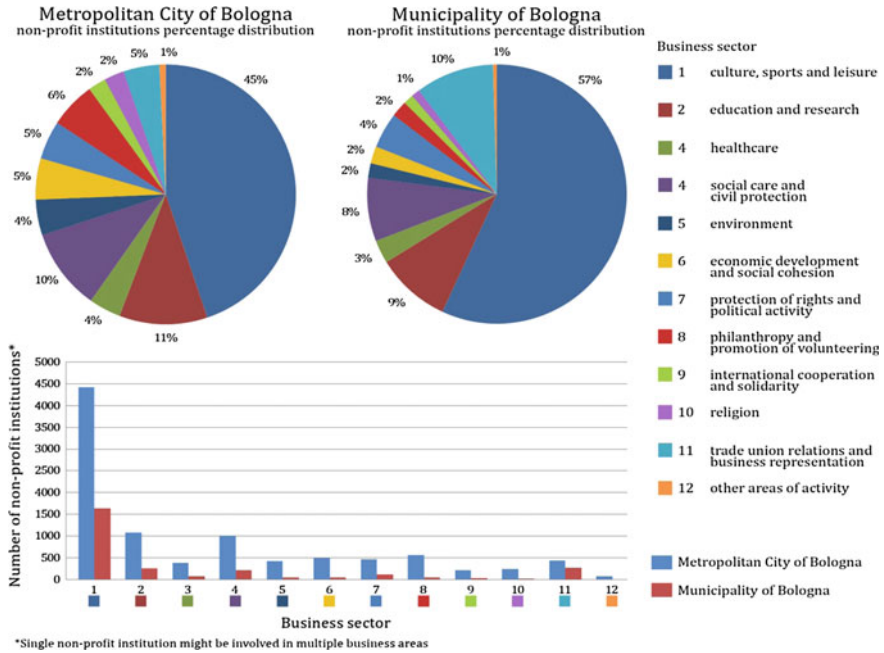
Fig. 23.29 Percentage distributions and number of non-profit institutions about the Metropolitan City, and Municipality of Bologna. *Source* Graphic restitution based on data from http://censimentoindustriaeservizi.istat.it. Accessed 15 Sept 2015

and research sector, followed by social care activities. Generally, the weight of each sector is similar in both the metropolitan city and the Municipality of Bologna. However, the pie charts in Fig. 23.29 show that the sector of trade unions and business is the double in the municipality area compared to the whole metropolitan area. Further, more than a half of institutions are concentrated in the municipality as the bar chart below shows. This means that Bologna is the center of reference of the regional economic activities. Significant is also that the first sector represents, in the sole municipality, more than one-third of the entire number of relative institutions, as shown in the bar chart.

Every year, since ten years, "*Volontassociate*", a feast of civic cooperation (http://volontassociate.volabo.it) take place in Bologna. It is a whole day thought up for all the involved energies about the Common Good. The initiative stems from the desire of non-profit organizations to create new opportunities to promote their values and their activities. They meet each other in several places all around the Bologna's territory.

It is evident that Bologna is particularly rich of volunteer associations and experiences of social cooperation. In fact in Bologna, there also exist a Voluntary Service Centre—*VolaBo*—which supports and qualifies the volunteers and the culture of solidarity within the metropolitan area by offering free services for

Special fund for voluntary work destined to VolaBO (€)

2003	1.212.938
2004	1.212.938
2005	1.091.554
2006	1.091.554
2007	1.891.665
2008	1.891.665
2009	2.605.645
2010	1.640.827
2011	671.691
2012	667.610
2013	613.861
2014	457.590
2015	381.299
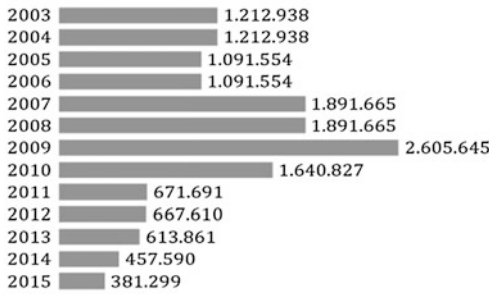
Number of services and beneficiaries about VolaBO's activities

	2008	2009	2010	2011	2012	2013	2014
beneficiaries	1.308	1.135	1.245	1.465	1.706	1.657	1.951
services	3.705	4.160	4.471	5.305	4.077	4.357	5.368

Fig. 23.30 Economic dimension and activities of VolaBO from 2008 to 2014. *Source* VolaBO. 2015. Report sociale 2014

voluntary organizations. The center is managed by an association and offers the following services: secretarial, technical and logistical support (in particular space and equipment), information and documentation, legal and administrative and advisory, training and innovation, orientation to volunteer, promotion of a culture of solidarity and volunteering for the young generation, territorial animation, social planning (www.volabo.it).

Bologna has been affected by the crisis that hit Italy in recent years and that has led to a drastic reduction in economic resources. The Centre for Voluntary Service has seen a progressive reduction of such resources from 2010 to nowadays (Fig. 23.30). Even the national agreement "*Acri-Volontariato*" of 2010, which fixed the resources for the five years from 2011 to 2015, has been revised with a reduction in available resources [52]. Having seen this trend, VolaBO decided to carry on its activity also by looking for adjunctive resources by a special national fund [53].

In 2011, the total amount of non-profit institutions income in the municipality of Bologna was € 948,773,376 and expenditures were € 882,580,081, while, in the metropolitan city the total amount of incomes was € 1,273,426,665 and expenditures were € 1,188,833,288 [51]. The sole municipality of Bologna covers 74.5 and 74.23 %, respectively, of the total amount of incomes and expenditures of the whole metropolitan city, about non-profit institutions.

23.5.2 Cooperation Between Citizens and Administration

Non-profit organizations find in public institutions, private firms, and citizens a significant sensitivity in building relationships that help to identify objectives, actions, and paths toward a common vision. In such a framework, the social capital generates highest standards of trust, especially in those who act.

From more than 10 years, the role of the third sector is widely recognized by the Municipality of Bologna, and nowadays, the duty of promoting and improving it is carried on by the governmental institution of the Metropolitan City of Bologna.

The Statute of the Metropolitan City of Bologna promotes the principle of citizen participation, as individuals or associations, giving value to local knowledge and resources. It pledges maximum transparency about administrative activities, and sets its actions to the principles of impartiality, equity, efficiency and effectiveness [54].

In order to accomplish that principle, several indications are listed in the Statute. Some are following:

- The metropolitan city supports and enhances the participatory tools already activated by the municipalities;
- Special regulations govern the forms of consultation and participation of the population in policy making and monitoring of their implementation. For this purpose they can adopt simplified procedures and information technology. The statute also disciplines the citizen consultation by referendum;
- Citizens, as individuals or associations, can submit to the metropolitan institution instances, petitions, and proposals to promote interventions.

To pursue the aim of cooperation it has been set a project called *Collaborare è Bologna* (Collaborating is Bologna) which works as framework for several initiatives [55]. It is ideated by the Municipality of Bologna and managed with the collaboration of the *Urban Center Bologna* (www.urbancenterbologna.it), to promote the culture of collaboration, continually seeking community involvement to make information, technologies, resources, space, knowledge and skills, more accessible. It is articulated into sub-projects, designed and built by listening and cooperation of citizens and associations. The project is based on the *Regulation on collaborative forms between citizens and Administration* [56].

In May 2014, the Municipality of Bologna approved the regulation on collaborative forms concerning the care and the regeneration of urban common goods. Interventions proposed from citizens and co-designed with the municipality are regulated by specific agreements, *Patti di Collaborazione* (Collaboration Pacts), which explain in detail terms of the agreements such as what and how to do, and with which fund. There are admitted proposals about collaboration for the care and regeneration of assets, non-material goods, and digital goods, that the citizens and the administration recognize as functional for the health of the community and individuals [56]. It is possible to present all proposals through the platform *Iperbole2020*.

Following examples show how the third sector has been involved since 2012, when Bologna decided to implement the Bologna Smart City platform.

23.5.2.1 Contrast and Prevention of Graphic Vandalism

The municipality, through announcements, involves social cooperatives, such as No Tags Bologna, on clean-up projects of graffiti from walls. Citizen groups are supported by the municipality through agreements of collaboration, equipment and materials [55].

23.5.2.2 Shared Care of Open Spaces

Bologna has more than 542,000 m^2 of parks, squares, and gardens, a complex system of public places but with different issues. This high variety makes extremely difficult to take care of it for a centralized institution of limited economic and human resources as the municipality is.

In order to solve the problem properly and valorise such spaces, the municipality started a program of partnership with local organizations, which on voluntary base take care of "their" space, deciding the best way to do so accordingly with local inhabitants [55].

23.5.2.3 Case Zanardi

It is a low-cost welfare network, based on social spaces and projects, realized by associations, cooperatives, and educational institutions to support people with hardships. It is a product of the involvement of more than 100 organizations of the third sector, the university, and other educational institutions, that provide support about knowledge, necessary goods (social markets), basic services, and job seeking [55].

23.5.2.4 Reducing Digital Divide

Since 2013, *Associazioni Riunite*—network of social associations—launched the project "*Sportello Informatico per il Cittadino*" (Digital help desk for the citizen) with the aim of reducing digital divide among Bologna's citizens. All activities, such as basic courses on information technology or the use of software, are free. Actually there are seven "digital points" and in 2015 six municipalities had their digital point. Main users are Italians, Moroccan, Bangladeshi and other 45 nationality [57].

From the private side, many start-ups were born with the aim of providing services for people and their networks by relying on their active involvement. The

municipality launched a call for proposal of € 100,000, especially dedicated to realize and develop the objectives and actions proposed in the Local Digital Agenda (see Sect. 20.2) [27].

23.5.2.5   SO-UP

SO-UP is a co-working project born with the purpose of implementing practices of managing similar to a cooperative, which is based on people aggregation. In particular, the project intends to focus on community rather than profit, where the social process and the informal collaboration are the focus to support start-ups by providing low cost services of high technological value [58].

23.5.2.6   BazzAPP

BazzAPP creates new modality of relation between citizens, the city, and its public and private infrastructures through a system based on two elements [58].

- the *BazzAPP*, temporary mobile app that represents the "bazze," local jargon for bargain, which institutions, organizations, and private firms put on "the market" for interested users;
- the *BazaaR*, a platform which spreads the "bazze" to users at the correct place and time, also through augmented reality.

23.5.2.7   Im-Possible Living

Project dedicated to the management of neglected buildings present on the territory [58]. Through participative process, that use a website and an app, it allows to:

- visualize a map of all mapped buildings;
- signal other buildings by filling an online form;
- propose ideas for such buildings by a free user account.

23.5.3   Political Structure and Organization

The impact of technology on the Italian public local governments is basically positive [59]. However, in 2012 only 17.4 % of Italian Municipalities were equipped with a special office dedicated to ICT, where the data about small municipalities (<5000 inhabitants) are of 6 municipalities every 100 [59]. Small municipalities represent the 70 % on the total of Italians Municipalities. Data show a gap, in terms of ICT, inside the administrative systems of small Italian

Municipalities. Moreover, this gap regards also internal employees in terms of skills, capability, and education. Only 20 % of Italian Municipalities organized a course about ICT in 2012, and 6.3 % of the employees attended a courses in 2011. ICT functions are managed by internal staff in 7 administrations out of 10, while about nine out of 10 resort to private providers [59]. In 2011, spending on ICT by Italian local governments amounted to about 0.7 % of their total expenses, and the average ICT spending per inhabitant is € 28 [59].

As part of the plan for Bologna Smart City, particular attention has been posed on the administrative system. Bologna pinpointed and implemented several actions and strategies to renovate itself, and many of them regard the use of ICT in the government of the city. Some of the most significant, for the topic of this chapter, are highlighted here.

23.5.3.1   Toward a Smart Governance

In 2011, the Municipality of Bologna started a process of dematerialization such a goal—a cultural change for the public administration staff. To pursue such goal an internal formative program was organized. The process of dematerialization is articulated in three levels of intervention: immediate interventions (every three months), intermediate interventions (every eighteen months), and medium period interventions which is about to expect results within 3–5 years. Also revisions and reassessment of all processes were taken in consideration [27].

For example, to facilitate the reduction of paper and the conversion to the digital, the municipality launched the BYOD project (Bring Your Own Device), which aim to utilize personal devices—not bought by the municipality—like tablets and smart phones of last generation. The employee brings its device, and the Administration makes available a number of services like e-mail management services, WiFi connectivity, fully equipped meeting rooms to allow the holding of meetings and the generation of digital documents.

23.5.3.2   Institutional Communication

In the period 2011–2013, the Bologna's Administration decided to develop a communication plan that aimed to define the institutional communication strategy, also for optimizing economic and professional resources already present inside the administration. The main action was to establish a central newsroom, and put out of service all the other communicative functions inside the departments of the municipality, and at the same time, a concentration of related economic resources [27].

Regarding online instruments, the following actions were undertaken in 2012–2013:

- publications and sharing of an internal social media policy;
- formative courses about social media, carried out by community managers internal to the Administration;

- guideline about uses and graphics;
- opening of new thematic channel.

In 2012 the municipality counted on 22 presences on Facebook and 12 on Twitter, in terms of accounts and pages dedicated to general or specific topics. Particular attention is posed on the communication strategy in cases of Big Event and Emergencies. That is because in the 2011–2012 the managing of information during crisis represented a model of resilience about promptness and quality of the information. For example, during the big earthquake in Emilia Romagna in 2012 the twitter account of *Iperbole* received more than 1700 retweet. Also, during the snow emergency, citizens used the hashtag #boneve (meaning Bologna Snow) for 3000 times, and 50,000 visits in one day have been counted at the online page containing the Mayor's ordinance about the closure of schools [27].

23.5.3.3 Bologna Open Data

One of the most significant actions of the municipality was the publication online of its database allowing free access.

In 2011 the municipality decided to start a census of its assets, information, and data with the aim of publishing them in an open access platform (http://dati.comune.bologna.it). It happened in April 2012. It is noteworthy that several citizens spontaneously asked to collaborate at the project, and they helped in the development of the platform, connected applications, and graphics of released data sets [27].

Significant next steps of "Bologna Open Data" will be:

- an active role of the administration in the involvement of other institutions about the publications of data;
- the promotion of hackathon (an event in which computer programmers and others involved in software development and hardware development, collaborate intensively on software projects) and contest dedicated to the invention of apps and innovative solutions;
- the opening of a blog dedicated to the communications of the administrative balance sheet;

Nowadays, the Open Data gate is a metropolitan point of reference, available for all subjects which produce qualitative data during their activities. A 360° opened gate that gives and draws contributions from other subjects—private, public, and from civil society—with an interoperability purpose among different data sources.

23.5.3.4 Digital Services

At regional level, the FedERa service (https://federa.lepida.it) has a crucial role in releasing credentials for personal digital identity. Promoted by the Emilia Romagna Region The FedERa project allows the Region's users to have a federate validation

through which they can access to several online services provided by all public institutions in the Emilia Romagna Region. Signed users have access to all services through a unique digital identity, recognized by all institutions [60].

Before that, there were several different systems of authentication, usually one for each service that they need, services provided by different institutions. Instead of that, users of FedERa can do different things, benefit from different services, on different platforms by using only one credential. On the other side, institutions can provide services without requesting new accreditations, with benefits in terms of less bureaucracy, use of resources, redundancy of data and relative management.

23.5.4 A Metropolitan Vision

Main purposes of the Metropolitan City of Bologna are the pursuit of a more advanced level of sustainable development, and the implementation of necessary institutional requisites to perform a function of active propulsion within the territory of Emilia Romagna Region. The Statute of the Metropolitan City was approved on December 23, 2014, as result of a public consultation, where citizens and stakeholders produced 500 proposals, observations and advices useful for the reduction of the statute (www.cittametropolitana.bo.it).

According with the statute, the new metropolitan city has two significant functions that go toward a simplified and organized governance. One is the coordination of activities of all municipalities. The second is a full collaboration with other local and regional institutions, avoiding in this way overlapping of functions and apparatus [54].

High consideration is given to the ICT in the new metropolitan administrative dimension. In fact, the statute provides an article about digital citizenship which specifically states the following:

1. All citizens have equal right of access to the Internet, on equal terms, in technologically appropriate conditions, that remove all obstacles of economic, social and territorial kind. The metropolitan city is committed to developing appropriate projects to ensure the exercise of this right;
2. Data produced by the Metropolitan City of Bologna are made universally available as open data;
3. The metropolitan city is committed to give priority in using free software or open source.
4. The metropolitan city, in order to organize the dissemination of homogeneous and shared information technology procedures on territories that compose it, promotes and coordinates systems of computerization in the metropolitan areas;
5. The metropolitan city for the above described purposes, assures wide resort to consultation forms, and participative online-based modalities, promoting the elaboration and the development of forms of digital democracy.

23.5.5 E-Government

Another crucial point about Bologna Smart City is the process of modernization of the administrative system. A digital administration helps to govern the processes of technological development. The new ICT allows to develop high-speed network infrastructures (broadband) on which make to travel innovative services tailored to users. The users of public administration can access services in different ways, but also the institutions themselves, for culture, size, and economic resources may be able to provide services at different levels of technology.

In 2010, in order to pursue the policy and strategies of e-government and ICT in the metropolitan area, the Metropolitan City of Bologna created the *Ufficio Comune Federato* (Mucipality Federated Office) for e-government [61].

Already before the establishment of the metropolitan city, the institutions promoted processes of e-government through several activities such as the project, funded by the State and co-financed by all the Institutions of the territory, about the development of the *Piano Telematico dell'Emilia Romagna* (Telematic Plan of Emilia Romagna Region), which led to the implementation of the Community Network Emilia-Romagna—CNER (network of the public institutions of Emilia Romagna Region) [62] which was relevant to encourage the development of innovative online services for the simplification of internal processes, and to improve services for citizens and businesses.

23.6 Conclusion

The chapter has investigated the metropolitan area of Bologna, Italy. Our goal was to understand how and what changes smart economy in smart cities brings to social, cultural development and ecological management. More in particular, research has tried to understand some interrelated questions, such as (i) identify the key factors and their role in making smart economy in smart cities; (ii) understanding the inter-linkages between smart economy in smart cities and social development, cultural preservation, heritage conservation, and ecological management.

Smart economy is characterized by: (i) innovation and new approach to economic activities; (ii) capacity to generate entrepreneurship; (iii) aptitude of the city to create new economic imaging, branding and trademark; (iv) productivity of labor and capital; (v) labor market flexibility; (vi) international embeddedness; (vii) transformations led by economy in the transformation of smart city.

Our study shows that the metropolitan city of Bologna has a good economy as its levels of per capita income at € 34,000 are well above the EU27 (European Union of 27 states) averages of € 24,500. However, there is an obvious weakness in the quality of governmental policies and practices that appears to be hindering innovation in the region.

According to the Regional Innovation Scoreboard 2014 [63], the metropolitan area is an "innovation followers" area. This is a discrete position in Europe and a leader position in Italy.

As illustrated, Bologna is the regional capital of Emilia Romagna, a region that aims to increase the competitiveness of the service sector and to turn it into a real leader of service innovation in Southern Europe and also into one of the main innovation actors at European level. Thus Emilia Romagna policy-makers intend to reinforce the service sector and the proactive integration of services into the manufacturing sector and so boost the region's competitiveness and its capacity to face the societal challenges of the future.

Regional economy show strong entrepreneurial activities with many start-ups mostly located in clusters, and regional assets and baseline with strong manufacturing sector, such as automobile, food production, ceramics.

There are, however, several challenges that the region of Emilia Romagna has to face, as suggested by ESIC's report 2014. Particularly, the ESIC study identifies some key challenges [64], such as the size of the start-ups that remain small and the fact that the smallest service companies are highly dependent on the region's manufacturing sector. The market for services is fragmented with numerous micro-enterprises that provide low-value added services to local manufacturing firms. On average, a service firm in Emilia Romagna employs the equivalent of only 3.5 workers. Only a few services companies in these complementary industries have managed to move up the value chain to provide innovative services to clients beyond Emilia Romagna itself. The region remains a net importer of business services and productivity and wages in the services sector are relatively low compared with those in manufacturing. There is no services cluster in the region with the exception of a tourism cluster situated on the Adriatic coast [64].

Emilia Romagna is currently not providing the best possible environment for innovation, as it is performing at a below average level in four of the five dimensions of structural indicators. The only exception is in 'innovation and business model generation' within the region. In particular, its levels of high-tech patent applications and of innovators collaborating with others are very poor. However, in business R&D expenditure and employment in strong clusters, the region is performing very well.

About the metropolitan area of Bologna the result can be summarized as follows.

The entrepreneurial activities have many start-ups, high share of small and very small businesses, wide-spread entrepreneurial attitude.

Many start-ups remain small and are highly dependent on large manufacturing companies

In terms of knowledge development and transfer we have identified as strengths/assets the fact that sharing of GDP spent on research and development has risen sharply, and a high number of patent applications. On the opposite side, the weaknesses/challenges concern the low number of high-tech patents, and the share of employees with higher education still lower than comparable regions and EU27.

Innovation and business model generation show an assets with strong local demand for innovative services from an internationalized manufacturing base.

Several challenges have been identified, such as the fact that many services are characterized by very low barriers to entry, which has increased pressure on wages and makes the development of brands and a competitive market position difficult due to the relatively high labor costs in Italy.

The outsourcing is a good starting point for developing the services sector. Where delocalization of the area's manufacturing firms occurs, such outsourcing might help in keeping part of the value added of the manufacturing sector in the metropolitan area.

Another important challenge concerns the weaknesses of employment in service innovation intensive industries compared to Italy and EU27. In the area of IT, metropolitan area does not have large companies that could attract investment or become the focus for the development of a cluster. Also before the crisis, there was less of a need for smaller companies to develop their client bases and engage in innovation due to the benign competitive environment. With this environment now gone, some companies are struggling and others are adapting.

Financing innovation and growth has an asset with high share of private R&D expenditure although there are weaknesses about the significant fluctuations in R&D over time with a particularly marked effect in the first years of the economic crisis.

As with for the regional economy, collaboration and networking show a strong asset of clusters in manufacturing demanding services, strong demand for services from manufacturing, network of universities and research institutions, although there is a weakness about the dependency of service companies on manufacturing companies.

The metropolitan area is part of the high-technology regional network created with the aim to boost the supply of qualified industrial research, increasing synergies between regional universities and research centers. The Network stimulates the development of a critical mass of high level industrial research and of more efficient method for the transfer of new technologies from the research system to the industrial system. In the intentions of the policy maker the network combines the expertise of several research institutions in centers of excellence whose aim is to promote the shift of production systems, districts and value chains toward a greater technological dynamism and a stronger commitment in R&D.

As innovation policy instruments at present, the metropolitan government is developing a strategy along two dimensions: development of high technology network, and stimulation of demand for innovation. These two dimensions are integrated by some measures addressing the upgrading of the regional industrial system and other actions addressing human capital development, innovation awareness and mentoring.

In term of *Innovation Policy Governance* [64] the metropolitan government in cooperation with the regional government is doing several efforts to plan actions and opportunities for innovation. Innovation policy revolves around an early acknowledgment of the importance of the implementation of the high-technology network, a very ambitious initiative that is turning one of the most industrialized

regions in Europe into a knowledge economy, strengthening linkages between industry and research institutions and fostering business innovation activity [65]

In the near future the metropolitan government aims to gradually increase the level of specialization of competencies available in the high-technology network in order to better respond to innovation needs. The regional administration needs to continue to rationalize the network, conjugating demand-based self-sustainability to a technology-push approach, promoting the identification of technologies that are becoming relevant in the international scenario but that are not yet used in Emilia Romagna because of some technological lock-ins.

The metropolitan administration needs to continue to invest in the upgrading of the regional industrial base stimulating demand for innovation. There is a large base of potential innovators that must be made aware of the necessity to innovate and the opportunity offered by the Network to meet industry needs. It is especially necessary to increase demand for innovation supporting firms' absorptive capacity. The employment of graduates is still low, and without an effective upgrading of the human capital it will be much harder to stimulate demand for innovation.

The territory has a long tradition about third sector, and regional legislation [66] supports non-profit organizations with several benefits, such as fiscal benefit, use of public buildings, and the possibility of establishing memorandum of understanding with public bodies for social promotion.

Bologna is developing a strategy in order to build strong relations between "social world" and the governance of the city by using ICT [27].

Actually it emerges that the ICT is being used as a tool to highlight and release the potential of this sector, with good results [55, 58]. These results are also due to the parallel e-government process of modernization of the municipality. Relying on a e-government strategy, which made efficient the administrative processes, was crucial to get the collaboration of social organizations. In fact the use of ICT allowed to solve many problems linked to the high complexity of third sector. For example, people engagement is just the first step and the chance of a proper engagement is based, before all, on credibility. A good government might be enough to make an administration credible, but to guarantee effectiveness in working on projects and producing results on the long run it is crucial to have efficient tools, and a feedback process which take into account the role and responses of citizens, like in the case of *Iperbole2020* [43]. The ICT if utilized properly can do the job. The case of Bologna seems to confirm that, awarding the city a position among the best cases in Europe [32]. Bologna case shows that when e-government and ICT share the same path they can have positive effects also on social field. The aspect that emerged more is that ICT helps the smart city process because of its capability to act strongly on the field, with the result of raising up local microeconomies spread on a very wide territory and related to non-profit organization [55]. When such organizations are many and form a strong network, like in the case of Bologna, there is the potentiality to act on great energies and leading them, by the use of ICT, in support of the whole city, with large benefit in terms of economy and social capital.

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Part X
Kenya-Nairobi

Chapter 24
Smart City Foundation, the Core Pillar for Smart Economic Development in Nairobi

Dennis Mwaniki

Abstract A smart city foundation is the collective of the core physical and policy components that a city is built upon, and without which it cannot function. The key elements of a smart city foundation include urban planning and design, basic infrastructure and policies. The degree of provision of these elements, their quality and their interlinkage defines how well a city functions, how much time its citizens spend on economically productive activities and in turn the city's level of and potential for productivity. This chapter discusses the evolution of the various components of Nairobi's city foundation and highlights how the existing and future patterns are defining the city's prospects for smart growth. The key finding is that Nairobi's rapid population and spatial growth have happened without adequate planning, which has greatly affected the basic services provision. The distribution of the services is also unequal, with better access and reliability being evidenced in the wealthier neighbourhoods and limited access coupled with unreliable supply witnessed in the poor settlements. These distribution patterns mean that the poor spend more time and resources accessing the services, thus limiting their productive hours and also reducing their disposable income that can be invested in income-generating and wealth-creating opportunities. The chapter also identifies that as a fast technology consumer, Nairobi can leverage on various emerging approaches to basic service provision, which have already been tried and proved to work in the poorest parts of the city, the slums. The integration of some of the emerging smart technologies in addition to more core investments in the development of various city foundation components will promote equitable growth for all residents, creating the required framework for smart economic growth.

Keywords Nairobi · City foundation · ICT · Basic infrastructure · Urban planning · Smart city · Production of goods and services leveraging ICT capabilities

D. Mwaniki (✉)
Global Observatory linking Research to Action (GORA), Nairobi, Kenya
e-mail: dmwaniki@gora4people.org

24.1   Introduction

A smart city foundation is the collective of the core physical and policy components that a city is built upon, and without which it cannot function. The key elements of a smart city foundation include urban planning (sustainable and inclusive land use) and design, basic infrastructure (connection to water and sewerage facilities, storm water drainage, solid waste management and electricity) and policies (particularly institutions and laws on land tenure). Each of these integrates information and communications technologies (ICTs) into its developmental and operational architecture and uses such technologies to leverage for improved efficiency and to also create seamless linkages between the three core elements, and other dimensions of a smart city system. The degree of provision of these three core elements together with their embedded and integrated ICTs, their quality and their interlinkage defines how well a city functions (as a spatial and as a socio-economic entity); how much time its citizens spend on economically productive activities; how people are involved in planning and policy making; and in turn the city's level of and potential for productivity and economic development.

Smart urban planning and design considers sustainable land use practices, ensures inclusive growth, promotes connectivity among various parts of a city, promotes interaction, encourages equitability in service provision among all city residents and utilizes various ICT technologies to achieve its objectives. Adequacy of smart basic infrastructure further promotes interaction, enhances quality of life and is a prerequisite to a healthy human capital. On the other hand, just and inclusive policies regarding land use attract investments to a city. Collectively, all these components create a suitable environment for productivity at both the individual and city level and in turn promote economic development. ICTs play a key role in promoting equitable basic infrastructure development, improving efficiency of the available services, and are at the centre of promoting smart land policies, such as through ICT enabled land management and governance. On the contrary, a poorly developed city foundation hinders/limits productivity and largely ignores the opportunities created by ICTs for improved production and income generation. A smart city is inclusive from the onset; anticipates its long-term growth and makes adequate preparations for it; understands and appreciates the role of a sustainable foundation on its growth; makes deliberate efforts to develop the various components of the foundation through adequate investment; and is flexible enough to adopt new technologies and approaches and to adapt to emerging challenges to its foundation.

In this chapter, we discuss the evolution of the various components of Nairobi's city foundation and highlight how the existing and future patterns are defining the city's prospects for smart growth. We also identify the adjustments needed to further unlock Nairobi's potential for growth as a smart, sustainable, inclusive and prosperous city. The chapter begins by giving a general overview of the city of Nairobi, moves on to explain the concept of a smart city foundation and then discusses two components of the foundation—urban planning and basic

infrastructure—and how they define Nairobi's potential for smartness. Although ICT is mentioned throughout the chapter, ICT infrastructure development and its role in Nairobi's smart growth are discussed in Chap. 25: Infrastructure development in Nairobi—widening the path towards a smart city and smart economic development.

24.2   Overview of Nairobi City

Nairobi, Kenya's capital city and the country's largest city, is situated at 1° 09′ S 36° 39′E and 1° 27′S 37° 06′E and occupies 696 km^2. Established in 1899 as a railway stop for the Kenya–Uganda railway, Nairobi's population of 3,138,369 in 2009 was more than three times that of the country's second largest city, Mombasa (population 939,370) [1]. In terms of spatial coverage, Nairobi's 696 km^2 is more than double Mombasa's land coverage of 294.7 km^2.

Most of Nairobi's growth happened after independence in 1963, with the city's population increasing almost tenfold from 342,764 people in 1963 to 3,138,369 in 2009 [1, 13]. With limited planning, development control, investment in basic infrastructure and in job-creating ventures by the independent government, most growth during this period has been haphazard. Today, about 50 % of the city population is estimated to be living in slum-like conditions [2] and about 70 % of the jobs are estimated to be in the informal sector [3].

Nairobi is the engine of the Kenyan economy. It occupies a pivotal place in the trade sector both nationally and internationally. Nairobi contributes between 45 and 60 % of the national gross domestic product (GDP) [4, 5]. It is the 14th largest city in Africa by population, has impressive links with the rest of the world, is home to hundreds of international companies and was the eighth most visited city in Africa in 2014 [6]. The city also presents the advantage of high population densities which are associated with economies of scale, agglomeration of economies and ease of connection to basic infrastructure. At the population dynamics level, Nairobi's youthful population gives it the potential of a massive active population that can sustain long-term economic growth as opposed to an ageing population that poses enormous problems to cities in the developed regions.

However, Nairobi is also a very unequal city, with a recorded income Gini coefficient of 0.59 [7]. Despite this urban divide, Nairobi has huge potential for smart economic development. In 2014 and 2015, it was named the most intelligent city in Africa by the Intelligent Community Forum, which views "intelligent communities" as those that have taken "conscious steps" to create an economy that can prosper in the "broadband economy" [8]. Nairobi has created various opportunities to foster its smart economic growth, some of which are related to investment in the city foundation, creation of enabling policies and promotion of innovation. Nairobi equally faces serious challenges to achievement of such growth, which are infrastructure deficits, insecurity and inequality.

24.3   The Concept of Smart City Foundation

A smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centric approach based on three core components—*smart city foundation, information and communications technology (ICT) and smart institutions and laws.* These three core components are the pillars of the seven dimensions of a smart city: infrastructure development, environmental sustainability, Social Development, Social Inclusion, Disasters Exposure, Resilience, and Peace and Security. The collective of these components and dimensions constitute a smart city economy (Fig. 24.1).

A smart city foundation is composed of three elements: urban planning and design, land policies and basic infrastructure, all of which integrate ICT into their developmental and operational architecture. For a city foundation to be smart, it must be inclusive at the onset of the urban planning and promote mixed neighbourhoods where social clustering is discouraged. Having all the poor living together creates slums and fuels instability and insecurity. Inclusive urban planning eases access to basic services (water, sanitation, housing, education and health) and to decent employment for all. A key element of smart urban planning is a smart street network that reduces travel time and encourages walking and social interactions. Smart urban planning also enhances infrastructure development, environmental sustainability, economic and social development; makes cities resilient and prepared to overcome natural disasters; and promotes development of mixed neighbourhoods where services are walking distances from people's residences.

Fig. 24.1 Smart city conceptual framework. *Source* Adapted from [9]
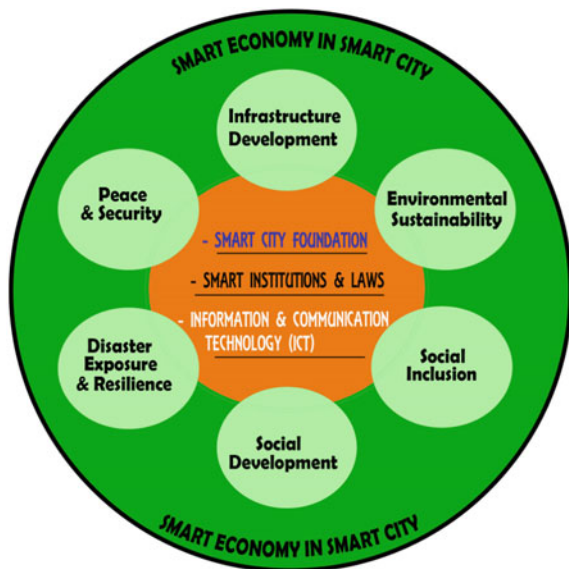
ICT plays a crucial role in promoting a smart city foundation, by enabling inclusiveness in planning, policy and infrastructure provision processes such as public participation, as well as creating enormous non-physically limiting opportunities to all city residents. Basic infrastructure constitutes access to urban basic services such as water, sanitation, housing and energy. Smart institutions and laws appreciate the role of policy and regulation in urban development (development control enforcement and attracting investment) and create a framework for growth within national and international goals and trends (Fig. 24.2).

The smart city foundation is the key pillar to the other seven dimensions of a smart city. **Infrastructure development** complements the basic infrastructure services under smart city foundation and extends to actual investment and advancement of services such as transport, ICT, industrial energy, education and health. **Environmental sustainability** is comprised of elements of energy, transport, building and pollution. **Social Inclusion** includes aspects of participation in decision making as well as according all city residents equal opportunities for growth and prosperity. **Social Development** encompasses elements of education, health, public space, social inclusion and social capital. **Disaster Exposure** incorporates elements of mitigation and adaptation to various disasters such as flooding, droughts, storms and earthquakes. **City Resilience** is composed of elements of city foundation, environment, social capital and social development. **Peace and Security** deals with all forms of violence and conflicts, including domestic violence, violence in public places, crime, armed conflicts and terrorism. An insecure city limits opportunities for investment and economic growth and cannot be a smart city.

Fig. 24.2 Smart city foundation. *Source* Adapted from [9]
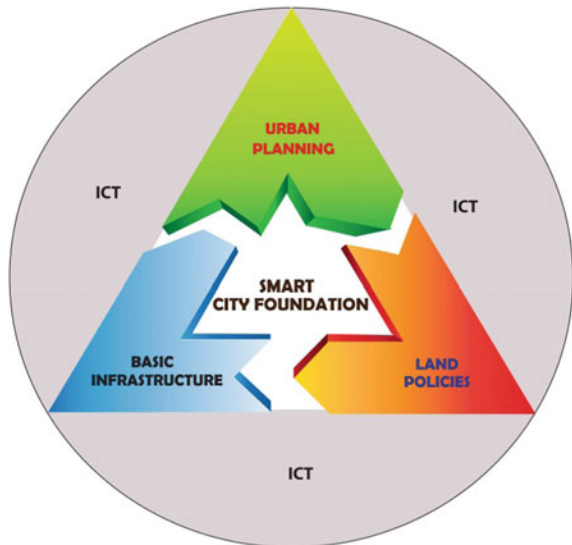
A smart city foundation creates the right framework under which a smart city system with its six key building blocks develops. Its three major components create a firm base for development of smart mobility, smart environment, smart living, smart governance, smart city economy and smart people (see Chap. 1—Kumar and Dahiya—Smart Economy in Smart Cities).

24.4   Urban Planning for a Smart Nairobi

Urban planning plays a key role in shaping a city's foundation, both in terms of identifying a city's needs and in terms of allocating adequate amounts of land and resources for development to address these needs. Resource allocation through planning agencies includes: directing growth through development/zoning guidelines; advising and working with other relevant authorities to allocate the necessary resources for such development; and developing policies and regulations to achieve such development. Cities can utilize urban planning's inherent technical and political processes to control the use of land and encourage responsible design and development of various components within the urban environment (e.g. transportation, communication, natural environment). This can be achieved through applying techniques such as zoning, as well as calculating, predicting and modelling demand for various services. Equally, there is a strong relationship between how a city is planned and its economic productivity, as broadly discussed in various works on urban economics and sustainable development approaches [10]. As discussed in Chap. 1 (Kumar and Dahiya—Smart Economy in Smart Cities), the smart city approach advocates for the integration of design and aesthetics with economic attractiveness and human capital development as a means to achieve rapid economic development. The place of urban planning and its role in the development of seamless urban systems is central in the definition of a smart city system.

The development of Nairobi as a city originated from the construction of the Kenya–Uganda railway in the late nineteenth century to the early twentieth century. The area Nairobi currently occupies was before 1898 largely a brackish swamp occupied by the Maasai pastoralist group and the agriculturalist Kikuyu people [11]. While constructing the Kenya–Uganda railway, the British built a supply depot at the current railway station. Nairobi was selected for the camp because of its central location between Mombasa and Kampala, the presence of fresh water and a high elevation that would make it cool enough for the British settlers. Six years after the British settlement, Nairobi grew to become the capital of the British East Africa Protectorate in 1905 [11] and became the capital for independent Kenya in 1963.

Over the more than a century of growth, various urban planning interventions have been made in Nairobi, each with varying impacts on the city's foundation and its economic productivity. Today's foundation is largely attributed to the planning

practice developed and enforced during the colonial era rather than to interventions made post-independence. Whereas the colonial regime envisioned and developed Nairobi as a planned African city with adequate provisions for basic infrastructure, the independence regime has not had a clear vision for the city and has been faced with numerous urban growth and development control challenges. These obstacles, alongside poor governance and lack of political will, have encouraged haphazard urban development and lack of investment in development of the city's foundation.

The pre-independence planning approach however largely promoted zoning and development based on race (favouring European settlements while ignoring areas settled by the Africans), which resulted in unequal and/or selective basic infrastructure development. The emerging development and service delivery models continue to shape the city's landscape to-date, and are propagated by guarded rights to the city among the various income classes that settled in various parts of the city post-independence.

Whereas urban development during the colonial era happened against a clearly defined master plan and proper enforcement structures (even though segregationist), urban development during the independence era has been haphazard, with lack of adequate development guidelines and blatant ignorance of existing ones. A rapid influx of immigrants to the city immediately after independence was associated with a lifting of an immigration ban enforced during the colonial period. With a limited capacity among the city authority to enforce development control, development in most parts of Nairobi has been haphazard over the last 50 years. Some of the basic infrastructure laid out during the colonial days has barely been expanded, and most of it has remained poorly maintained. The population utilizing these facilities has, on the other hand, grown over tenfold, resulting in serious overload of most of the city's basic services.

24.4.1   Racial Zoning of Nairobi During the Colonial Period

Urban planning during the colonial era was aimed at sustaining Nairobi as a planned African city, a goal that would be achieved through enforcing planning regulations, mostly borrowed from city and county ordinances of the UK. Colonialism in Kenya had defined class cadres in which Europeans were first class citizens, Asian traders second class, and Asian labourers and Africans at the bottom [12]. The ensuing urban planning approaches and related policies and laws throughout the colonial period were oriented towards spatially reflecting these classes [13]. Between 1899 and 1963, Nairobi was zoned into four distinct sectors: north and west which were European reserves; north and east defined as the Asian sector; east and south-east defined the African sector; and south-east to south which was a small Asian enclave especially for the Asian labourers [13] (Fig. 24.3). This kind of segregation and zoning was articulated in the major colonial Nairobi city plans of 1905, 1927 and 1948 and supported by very high development standards
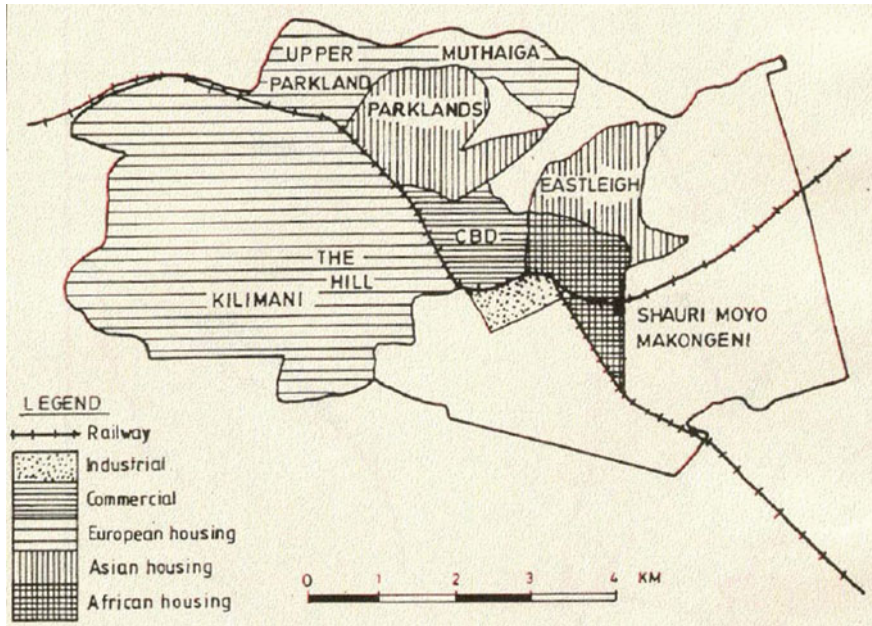
Fig. 24.3 Racial zoning of Nairobi during the colonial period. *Source* [15]

that were unattainable to the African city builders/residents at that time, given the prevailing economic conditions facing them [14].

Whereas the European zones were carefully planned with layouts and aesthetics in conformity to accepted standards and densities, the African areas were left to develop spontaneously with very little attempt to provide them with basic infrastructure [16]. As a result, the conditions in which the Africans were living during this era were characteristic of congestion and poor service provision, which are indicators of slum proliferation. The situation continued to worsen throughout the colonial period as more Africans continued to immigrate into the "African sector". This was despite various laws put in place to restrict mass movement of Africans into the city. The emerging framework from this planning approach has continued to shape Nairobi's spatial pattern to date.

The first plan of Nairobi was drawn as a town layout for a railway depot in 1898. The city's first plan, which measured 18 km^2, demarcated space for a railway station, defined a few streets and defined trading spaces for the first and second class citizens (European and Indian traders). The plan also identified areas for construction of houses for both the senior government officials and the railway workers, with more emphasis being put on the settlement areas for the Europeans and Asians [17]. The plan strikingly resembles the town layout of Nairobi CBD and its environs today and created the framework for spatial segregation by race that would be experienced throughout the colonial era. These development patterns

would result in the physical and social imprints formed by selective development in Nairobi's city foundation.

In 1919, Nairobi became a municipality and the city population continued to grow rapidly. The second plan for Nairobi the "Plan for a Settler Capital" was drawn in 1927 under the British East African Rule [17]. The plan focused on drainage improvement, swamp clearance, and building and density regulation. Among the plan's major provisions was the expansion of the city's area to 77 km^2, in order to accommodate the growing population. The introduction of traffic regulations was based on a desire to safely and efficiently reach the expanded land area [17]. The plan furthered the racial segregation defined in the 1898 plan and proposed new land use zones, which were based on race.

The third plan, "Master Plan for a Colonial Capital", was drawn in 1948 as an experiment in town planning. The city's population had grown from only 11,512 people in 1906 to 118,976 people in 1948 [13]. The plan introduced functional spaces in the form of zones. The major zone classifications were to house official buildings, business and commerce, industry, railway, residential, official housing, open space, forest reserve and parks. The plan aimed at furthering the segregation already outlined in the previous plans by creating neighbourhood units for the working class, as well as making Nairobi more attractive for industrial investments. A few adjustments were made, with the alignment of the railway being changed to flow along the western part of the city and conversion of the area to the south of the railway station to an extensive industrial zone. The 1948 plan also expanded the city spatial limits to 83 km^2 [17, 18].

24.4.2   Rapid Population Growth and Haphazard Growth Post-independence

Independence in 1963 came with a relaxation in policies and laws that had been put in place to control the movement of Africans to the city. The outcome was a major shift in population to the city, without concomitant investment/development in basic infrastructure and housing by the independence government [19]. The city's population changed from 342,764 in 1963 to 827,755 people in 1979 and has since grown to 3,138,369 in 2009 [1, 13]. Whereas during the colonial period a change in population was accompanied by extension of the city boundaries, the city boundary post-independence has remained at 696 km^2 since 1963. This implies an average city-wide increase in settlement density from 493 persons per km^2 in 1963 to 4510 persons per km^2 in 2009. Over the same period, the city has experienced marginal increases in its infrastructure, putting immense pressure on the existing networks.

The fourth development guideline for Nairobi and the first development framework in independent Kenya, The Nairobi Metropolitan Growth Strategy 1973,

was formulated as a long-term structure planning tool. It gave recommendations on policies, directions, strategies, possibilities and guidelines for the development of Nairobi City to the year 2000, with an intermediate target of 1985. The plan set out population projections, outlined development priorities and phasing, which would be implemented throughout the planning period, and suggested action for development of short-term strategies [20]. Conditions set out in the strategy, such as creation of short-term strategies, development of financial capabilities to implement the plan and strengthening of the city authority for the plans implementation, were rarely met throughout the planning period. As a result, the plan did not do much to improve on the city's basic foundation. Throughout the plan implementation period, Nairobi's growth happened without short-term frameworks and a physical development plan and was mostly driven by profit-oriented private speculation and investment. This method of growth was in total disregard of the available basic infrastructure in the city. By 2000, when the framework expired, little had been achieved both in terms of development in the city's foundation and also in terms of development control as envisioned in the framework.

Between 2000 and 2014, when the current growth strategy was drawn, Nairobi grew without a development framework. Not only was it difficult to guide the city's growth, but there was no formal framework for development control.

The Nairobi Integrated Urban Development Master Plan (NIUPLAN) is the sixth major development guideline formulated for the city of Nairobi. The master plan was launched in 2014 and is expected to guide urban development in the city until 2030. The development of short-term strategic plans which will be used to operationalize the master plan is currently ongoing. Unfortunately, even this plan does not give much hope for improvement in the city's foundation, as it may not be legislated as the city's ultimate and legal growth document whose violation (by both its administrators and developers) will be punishable by the law. The plan's approach of rectifying what has already gone wrong in the city (reactive versus proactive development) is also its major set back to achieving sustainable urban development. In addition, the plan requires localization and action from many actors which has proved to be a challenge in the past. Lack of a city-wide spatial development framework to align with the master plan and national development goals, as well as budgetary deficits in developing various components of the plan, may also prove to be a huge challenge in the implementation process.

Other planning interventions made since independence, such as revisions to zoning regulations, have equally been more reactive than proactive to development. In many cases, the regulations are made to comply with the development trends already experienced on the ground. The revisions have focused more on guiding densities and less on encouraging infrastructure development to accompany such density changes. An example is the revision of zoning regulations to enable a change in land use from residential to commercial developments in the Upper Hill neighbourhood in 1993. While the regulations during re-zoning made suggestions for improvement in the area's infrastructure, little change has happened. However,

the development densities have greatly increased. This is putting massive pressure on the existing basic services (water, sewer, transport), which is adversely affecting other surrounding neighbourhoods. Similar revisions to either include commercial developments or intensify residential housing were undertaken in 2004 [21] for neighbourhoods such as Westlands, Kilimani, Parklands, Woodley and Kileleshwa. Although neighbourhoods such as Upper Hill, Westlands and Kilimani have become important secondary commercial nodes for Nairobi, providing a much overdue alternative to the congested central business district (CBD), they still remain highly reliant on the CBD for many services. Additionally, they are barely linked to one another through efficient transport networks. This lack of interlinkage is a hindrance to Nairobi's rapid economic growth.

The other development concepts which have been developed for Nairobi and which have limited implementation include the Nairobi Metro 2030 (prepared in 2008) and Spatial Planning Concept for Nairobi Metropolitan Region (prepared in 2013). Some recommendations from these two have been integrated into the NIUPLAN. The Kenya Vision 2030 strategy [22], on the other hand, is the overall national development guideline under which both the NIUPLAN and other sectoral plans fall.

Whereas the provisions of the three plans formulated during the colonial era were enforced with strict investment in basic services in the areas demarcated for the first and second class citizens, guidelines formulated post-independence have not resulted in much change in the city's foundation. Not only does the spatial colonial planning approach stand out throughout the city, but the social segregation practiced then still continues to shape Nairobi's land distribution and housing development. Areas zoned as African settlements in those days are today low-income residential zones and informal settlements experiencing poor planning and low levels of infrastructure provision [16]. Unfortunately, these are also the areas where roughly 50 % of the city's population lives [2]. This outcome is as a result of the city's complex planning legislation and skewed city foundation development priorities, for which basic infrastructure development and land regularization have been biased towards the more organized and higher-income neighbourhoods at the expense of the poor settlements and slums. The speculative nature of tenureship in the informal settlements has also made it very difficult for the city to undertake proper planning administration and infrastructure upgrading. Various attempts are, however, being made to correct this situation, such as through communal land tenureship alternatives where entire communities own a stake in the land, giving them proper impetus to allow redevelopment and/or upgrading. Partnerships between the city government and informal settlement associations have also been playing a key role in improving service delivery and enhancing quality of life in various settlements in the city (see some examples in Sect. 24.5.1).

24.4.3 Streets as Key Prerequisites for Basic Infrastructure Installations

Towns and cities have historically been organized around their streets, which have largely determined the mobility, strength of commerce and ability to socially interact in an area [23]. Thus, streets and street patterns are key components of a city and typically define a city's form and structure. As key elements of urban planning, streets and street networks not only determine circulation within a city, but also provide space for reticulation conduits for other basic infrastructure in the city. In most cities all over the world, the basic reticulations for water, sewer, storm water drains, power, internet cables, etc. run alongside the streets. The level of development of a city's streets is directly related to its endowment in these basic facilities, and even where the services are not well developed, the level (density and intensity) of street provision defines a city's options for developing the infrastructure reticulation. Cities with wide roads and proper reserves are more equipped to expand their basic infrastructure systems as opposed to those with narrow streets in which buildings occupy the road reserves. Therefore, streets have commercial, social, economic, civic, ceremonial, political, cultural and social values that are integral to a city. A connected street network connects neighbourhoods, brings people closer to amenities, increases safety, reduces travel time and encourages walking and social interactions. It enhances infrastructure development, environmental sustainability, and economic and social development. It makes cities resilient and prepared to overcome natural disasters. A sustainable, inclusive and prosperous city expands multimodal transport systems with sidewalks and bicycle paths, ensures eco-efficiency of infrastructural systems and supports density through integrated infrastructure development, thereby enhancing efficiency and access [23]. In addition to accommodating all kinds of users (pedestrians, cyclists, motorists), sufficient land allocated to streets promotes connections to services that contribute to good health and productivity, such as clean water, sewerage facilities, drainage systems, power supply, and information and communication technologies. Streets that provide space only to motorists are characterized by congestion and high CO_2 emissions. All these aspects directly and positively impact on a smart city economy and when properly integrated into the urban system contribute to development of a smart city system.

Nairobi allocates only 11.5 % of land to streets in the city core [23]; this space is supposed to hold the city's motorized and non-motorized traffic, act as basic infrastructure and storm water drainage wayleaves, provide on-street parking, accommodate city beautification and landscaping attributes (including trees, benches and dustbins), host adverts, act as social spaces and informally act as street vending grounds. With streets estimated to comprise more than 80 % of the public spaces in cities [24], an allocation of about 20 % of land to streets is considered an optimal minimum for a functional city [23]. In turn, this means Nairobi is missing out on the many benefits associated with a well-connected network, which range

from improved productivity due to efficiency in the mobility network to a healthy population to a socially inclusive city to environmentally solid settlements.

It has been established that a city's level of land allocated to streets (LAS) influences its level of and/or potential for prosperity [23]. While comparing a city's level of street connectivity to its level of prosperity, UN-Habitat has established that cities with high connectivity indices also score highly on the other aspects of prosperity, particularly infrastructure development, environment sustainability, productivity, quality of life and equity and social inclusion [23]. Compared to cities like Manhattan, Barcelona and Hong Kong which allocate more than 30 % of land to streets, Nairobi's performance on the indicators of infrastructure development, environment sustainability, productivity, quality of life and equity and social inclusion is very marginal (Fig. 24.4).
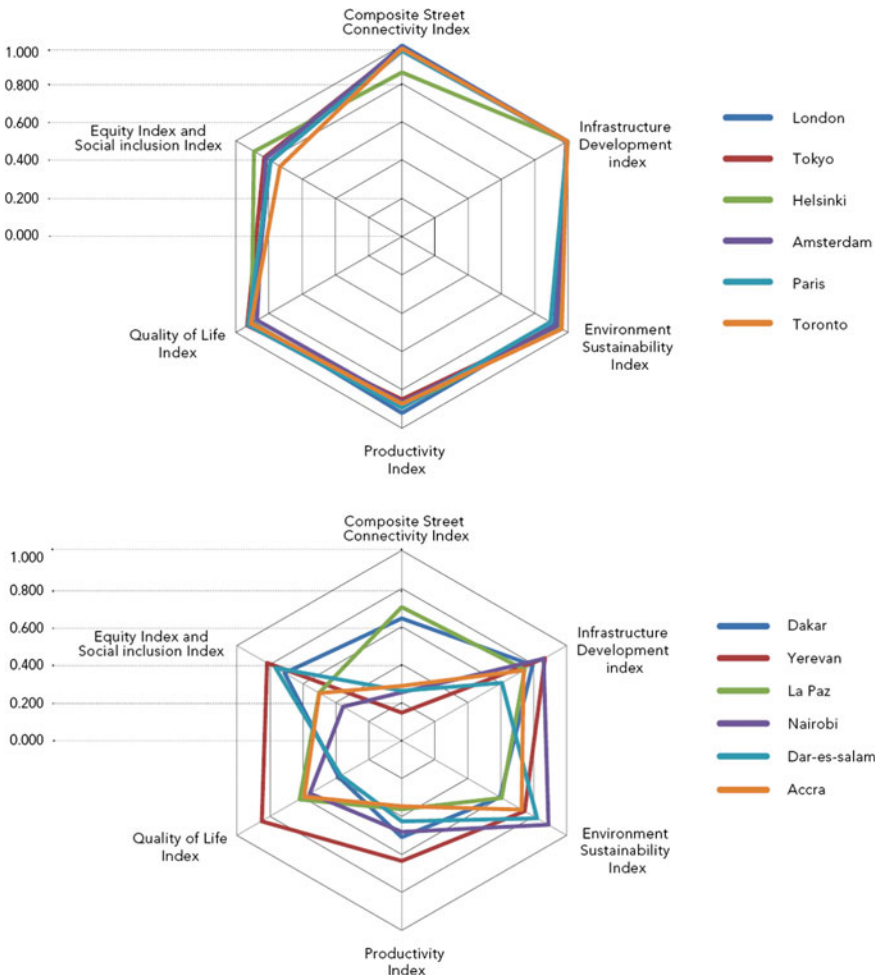
Fig. 24.4 Street development and city prosperity. *Source* [23]

Since many basic infrastructures rely on street networks for their lay out, many parts of Nairobi are not well connected to the city's water, sewer and storm water mains. In addition, infrastructure for non-motorized transport (e.g. pavements or sidewalks for walking and bicycle lanes for cycling) is often lacking, poorly developed, on the decline or does not appear to rank high among city planners' priorities. The areas that are most affected by this under provision of basic services are the poor neighbourhoods which are home to over half of the city's population. A good example of the role of the street in promoting access to basic services in Nairobi and the inequality that can result from the same is demonstrated by comparing one of the affluent neighbourhoods (Muthaiga) with one of the poorest slums in the city (Kibera). Whereas the two settlements have an equal amount of land allocated to streets (3 %), Muthaiga has a population density of only 576 persons/km^2 against Kibera's 56,693 km^2 [1], indicating a higher per capita land allocated to streets in Muthaiga. Equally, Muthaiga has a near universal access to all basic facilities, while these facilities are barely existent in Kibera. This scenario points to marginalization of the already vulnerable population living in the slums.

Outside aiding in infrastructure development, Nairobi's poor street connectivity limits its economic productivity in several ways:

- Increasing amount of time spent in commuting to work, thus reducing/wasting productive hours. Poor street connectivity is the source of massive traffic congestion in the city of Nairobi, and this has a negative effect on the economy. A 2012 study by IBM identified Nairobi as having some of the world's worst traffic congestion—a problem that costs the city approximately USD 500,000 per day in lost productivity and excess fuel consumption [25, 26]. The current level of traffic congestion is unsustainable, and if Nairobi is going to become a smart, sustainable, inclusive and prosperous city, there is an urgent need to improve the current traffic situation.
- Increasing amount of fuel spent due to traffic and in turn, increasing pollution which negatively affects the environment and affects citizens' health, reducing efficiency of the human capital.
- Competition for space along the streets among various users, sometimes resulting in disruption of normal economic activities (e.g. conflict between hawkers and city authorities) and traffic accidents.
- Limited amount of public spaces associated with streets and thus limited social interaction and identity.

The commercial and economic value of streets in Nairobi plays a critical role in the city's productivity, particularly since most income generation happens within the informal sector. Many informal activities in Nairobi are street-based activities and vary from street vending, small industrial activities such as welding and vehicle repairs, water vending, to the privately run public transport sector. The amount of space and freedom of operation within the street space is thus key for income generation by the larger share of the approximately 70 % of city residents who are in informal businesses outside of agriculture [3].

Nairobi has among the most well-established informal sectors in Africa, but the lack of adequate space allocation for the informal activities is dragging the city's prospects for rapid economic development. Street vending, for example, is a way of life for many youths and women in the city, who line up their wares (ranging from second-hand clothes and shoes to food items and small electronics) along the city streets during the rush hour. However, the city is yet to achieve much of the economic growth from these economic activities, since the city's bylaws do not permit street vending. Every so often, the city enforcement officers engage in running battles with street vendors over the use of street space in the central business district. With a consumer market that is not very accustomed to dedicating time to visit several dedicated markets, vendors in Nairobi opt to take the goods to the consumers, and the best place for this is the CBD. Due to the illegal nature of this trade, street vendors do not contribute much to the city's revenue base, leaving a lot of untapped economic potential for the city (Box 24.1).

Box 24.1: Street Vending in Nairobi Street vending is increasingly becoming an important urban aspect, with some cities encouraging it as a way of adding vibrancy on downtown streets. Various cities are developing guidelines to "legalize" street vending, while others already have a well-established street vending culture, which not only adds vibrancy to the streets, but also complements other retail activities.

About 20–25 % of informal sector employment in Nairobi is estimated be people who engage in various street vending activities spread throughout the city [3]. Although no studies have been carried out in the recent past, 2004 statistics indicate that more than 6000 vendors were estimated to line up a daily capital stock worth US$1 million in the CBD streets [3]. This number has greatly grown over the past 10 years. The high number of vendors who often concentrate along the two major commercial streets of Tom Mboya and Moi Avenue causes massive chaos and scramble for space between the vendors and their wares, pedestrians, and passengers boarding or alighting from the many "*matatu*" (bus) stops along the streets. Some sections of the Tom Mboya street where most of these activities are found are so congested that it is practically impossible to walk by without brushing other peoples' shoulders, a trend that has also attracted petty crimes such as pickpocketing. The street vendors also make out loud noises describing the variety and indicating prices for their wares, as a way of advertising their products in the highly competitive business. The level of noise in some sections is often unbearable and often worsened by "matatus" hooting and touts calling on passengers to board in equally high voice pitches.

Despite the chaos created by street vendors, a unique street vending culture and identity has developed within the city. This vending culture does not only inform *fashion* through supply of unique second-hand clothes and shoes especially for the youth, but also supplies food products for those rushing home to prepare their dinner. The product uniqueness and convenience of

easy access to various basic services at reasonable prices in the rush hour attract many customers. Some customers have even established personal relations with the vendors for supply of particular items such as shoes, fruits and vegetables.

Being an illegal activity, street vendors are often forced out of the prime CBD business spots by city enforcement officers. There have, however, been reports that the vendors pay daily trading fees. In appreciation of how street vending can contribute to revenue generation for the city, the city county of Nairobi has slowly been moving towards allowing street vending in selected parts of the CBD. Occasional conversion of a section of Moi Avenue from street parking into an informal market is a good case for which street vendors who previously engaged in running battles with the city authority can trade their wares without the fear of being ambushed. Conversion of one of the parking lots within the city into an informal market (*Maasai Market*) over the weekends is another example of how flexible street planning can contribute to economic development.

With Nairobi's well-developed informal street vending culture, developing similar approaches in other parts of the CBD can open new opportunities for revenue generation by the city, while at the same retaining the city streets vibrancy and generating steady income for the vendors. Discussions are already ongoing towards achieving this goal, and there is much anticipation on the policy and real economic implication of the emerging decisions.

24.4.3.1 Smart Streets for Smart City Systems

In its path to become a smart city, a city that accommodates everyone and creates and promotes a diversity of income-generating opportunities, Nairobi needs to invest more in the development of well-connected and open streets where multiple uses are allowed. The city must prioritize streets as the basic element of social interaction, mobility and accessibility and develop them as wayleaves and support systems for basic infrastructure reticulation systems and organize them to accommodate multiple street vending activities which despite the existing chaos greatly contribute the city's vibrancy and create income-generating opportunities for thousands of youth and women. Better streets will boost the city's productivity and contribute to economic growth through reduction in the amount of time and resources wasted in traffic jams or in search of basic services such as water, improved health of the human capital associated with supply of quality basic services and increased income generation through various street-reliant economic activities. Creation of alternatives for non-motorized transport should also be emphasized as a means for promoting smart mobility, smart urban environment

through reduced CO2 emissions and smart living in which the city residents adopt and value healthy habits such as walking and social interactions. However, investment in street development needs to happen within the framework of the city's long-term development plan and demand projections, so as to avoid regular and sometimes unnecessary digging up of the city streets for additional infrastructure networks.

24.5   Basic Infrastructure for a Smart Nairobi

Availability of basic infrastructure is the key to attainment of a smart city system. A city cannot claim to be smart when a large share of its population does not have access to the basic provisions for water and sanitation, solid waste management systems, storm water drainage and energy. A city that lacks adequate provisions for water and sanitation, for example, puts its population at risk of waterborne diseases and in turn affects the quality of the human capital which is a key prerequisite for production of smart people. Lack of solid waste management systems results in polluted environments, and lack of storm water drainage systems results in flooding which negatively affect development of smart living and smart urban environments. On the other hand, a city that has a well-established human capital and all necessary information communication technology components such as computers, internet, mobile phones and does not have adequate and reliable energy (electricity) cannot achieve smart economic development.

As discussed in depth in chapter one of this book [27], a smart city, among other things,

- makes strategic investments on its strategic assets
- has high-quality public services
- has an integrated system to manage its water resources, water supply system, wastewater, natural drainage, floods and inundation
- has an efficient management system for the treatment and disposal of wastewater, and reuse of treated wastewater
- has an integrated and efficient management system for the collection, transfer, transportation, treatment, recycling, reuse and disposal of municipal, hospital, industrial and hazardous solid waste.

Investments in human capital and infrastructure interact, each increasing the returns to the other [28]. Human capital which is directly related to a healthy population also plays a key role in economic development in a city. A city population's health crucially depends on its basic infrastructure network, such as water and sanitation. According to the World Bank, one in six people worldwide, mostly the poor, has inadequate access to water, more because of limited access to infrastructure than because of water scarcity [29]. In addition, basic infrastructure services are also closely associated with poverty reduction, improved nutrition,

education and employment creation. These services allow the urban poor to live under conditions that facilitate their income-generating activities so that they can maintain a good nutritional level and participate in the normal activities of society [28, 30].

Basic infrastructure provision in Nairobi is widely unequal, with efficient and reliable access to most services available to the wealthy and widely erratic among middle-income group, and barely existent in places where the urban poor live. This equally determines and affects the economic performance among the groups variedly, with the wealthy having more time to engage in economically productive activities and the poor spending more time in search of basic services, or spending a large share of their income to purchase the services or undergo treatment from health challenges originating from poor services.

24.5.1 Water and Sanitation

Access to water and sanitation as a basic service plays a crucial role in a household's productivity and contributes to improved health associated with less exposure to the risk of waterborne diseases. There should be a balance between access to basic services and the cost of such services. This balance enables households to invest their extra income in economically beneficial activities. If a family spends more time searching for potable water, it reduces the amount of time it spends on income-generating activities. Alternatively, if a family spends most of its income on basic services such as water, it also substantially decreases its share of disposable income that could be used to invest in income building activities.

Every US$1 invested in water and sanitation provides a US$4 economic return [31]. A 2012 study by the World Health Organization (WHO) estimated total global economic losses associated with inadequate water supply and sanitation at US$260 billion annually, or 1.5 % of gross domestic product of the countries included in this study. It further identified that attaining universal sanitation would more than triple the benefits to US$220 billion annually. The main contributor to overall benefits of sanitation is the value of time savings which accounts for more than 70 % of total benefits in all regions, and is as high as 80–90 % of total benefits in most regions. In Sub-Saharan Africa (SSA) and South Asia, an important contribution comes from health benefits, especially the value of saved lives. The main contributor to overall benefits of drinking water systems and services is the value of time savings which accounts for almost 70 % of total benefits in all regions, and is as high as 80 % in the Caucasus and Central Asia (CCA), Latin America and the Caribbean and North Africa regions. In SSA, health improvements contribute to at least 35 % of overall benefits. Health care savings account for more than 10 % of total benefits in all regions. In terms of overall value, the global picture of drinking water benefits is dominated by the SSA region, with over US$3.2 billion, followed by N Africa with US$1 billion, West Asia with US$0.6 billion and LAC with US $0.5 billion [31].

24.5.1.1 Water Supply

About 78.2 % of households in Nairobi have access to piped water (into the dwelling, yard or neighbours tap [7]). This level of access, however, greatly varies among the city's income defined neighbourhoods [32] (Fig. 24.5). While most middle- and high-income neighbourhoods have almost universal connections to piped water (85–95 %), coverage in the lower-income areas is far from universal (estimated at 70 %) and at the very low-income areas, coverage is nearly non-existent (estimated at 12 %) [32]. Issues of inconsistent supply are experienced in all income categories, though more acutely in the low to poor neighbourhoods, forcing residents to rely on alternative sources such as tankers, water kiosks, hand carts and private boreholes, whose water quality and cost vary significantly.

These supply inequalities are also reflected on the per capita consumption and the cost of the utility with the average consumption in the wealthier neighbourhoods averaging between 200 and 300 L of water per day per capita (lpcd) against only 15 lpcd in the slums [32]. This can be closely related to the cost of water, in which the lower-income earners pay more for the utility than their higher-income counterparts. With their limited supply by the city network, the lower-income neighbourhoods have to rely on alternative sources, which have emerged as profit-driven enterprises to make money out of the failure of the water utilities in the city and whose water tariffs are not regulated. Whereas the Nairobi Water and Sewerage
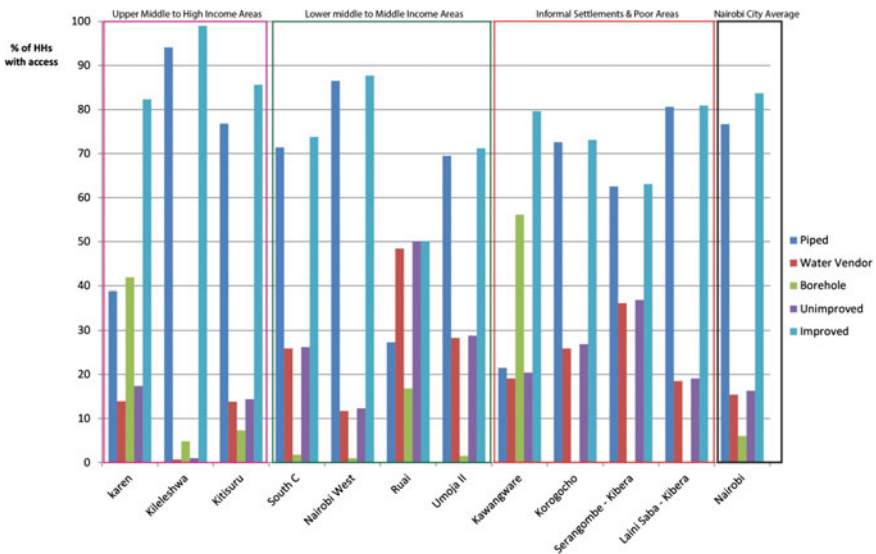
Fig. 24.5 Water source for select wards (a ward is the smallest political unit in Kenya) in Nairobi (protected water sources include spring, protected well, borehole, piped into dwelling, piped, rain water collection. Unimproved water sources include pond, dam, lake, stream/river, unprotected well, Jabia, water vendor). *Data source* [33]
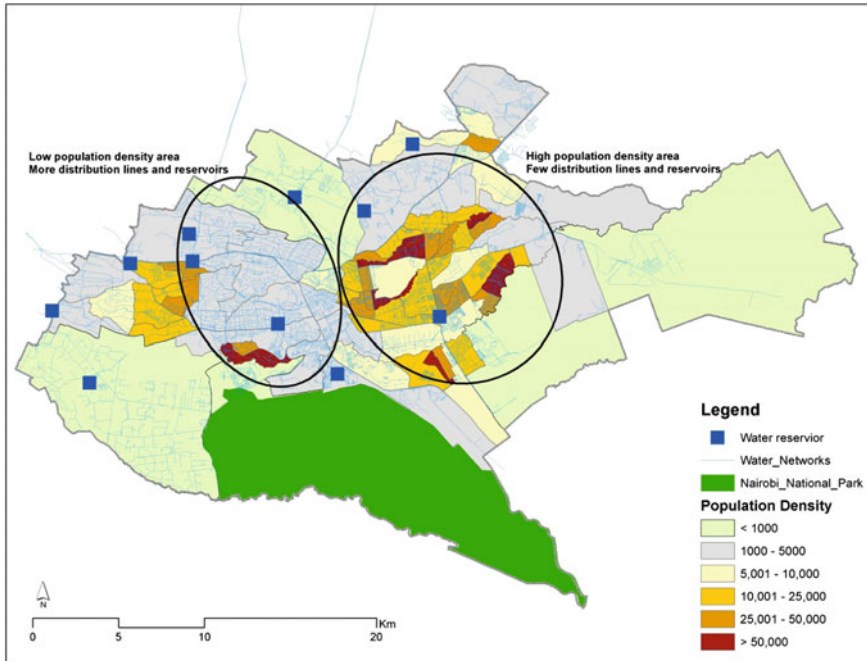
Fig. 24.6 Nairobi has unequal water reticulation infrastructure. *Source* Representation by author using data from NCWSC [1, 18]

Company (NWSC) delivers water through increasing block tariff (IBT), with the block prices ranging from 18.71 Kenyan Shilling (KES) for each of the first ten cubic metres (m^3) to a maximum ceiling price of 53.80 KES/m^3, water kiosk tariffs are around 400 KES/m^3 and handcarts around 1000 KES/m^3. Tankers and private boreholes are even more costly. Given that most slum dwellers rely on kiosks (82 %) and handcarts, their water costs range from 200 to 400 KES/m3 [32, 34]. In extension, slum households spent a disproportionate share of their income on water (11 %), twice as much as the average population in Nairobi (6 %) and almost 40 times more than high-income earners (0.3 %) [32] (Fig. 24.6).

The challenges in Nairobi's water supply network are rooted in three key aspects: (a) rapid urbanization putting pressure on the available supply, (b) lack of investment in expanding the catchment and storage quantity and expanding the supply network particularly to the poor settlements which lack adequate streets where reticulation lines can be laid down and (c) unaccounted for water. Rapid urbanization in Nairobi has happened against non-expanding water network expansions, leaving many newly developed areas unserved with water. Equally, the growing population densities have also put a lot of pressure on the existing supply capacity per line, which has generally remained constant over the years. Neighbourhoods within a line where water was accessible in the 1990s do not

receive the same flow, since so many other new developments have come up along the line, and tap into the same quantity main distribution line. In the informal settlements, lack of formal water connections has given birth to an illegal connection network where cartels tap into the main water networks and supply to the other slum dwellers for prices as high as 20 KES per 20 L jerry can (equivalent to 2000 KES/m^3).

24.5.1.2 Sanitation Facilities

Like water, access to sewerage systems in Nairobi is very inequitable, with more access in the wealthy neighbourhoods than in the poor ones. Only about half of Nairobi's households dispose their human waste through the main sewerage system, leaving the rest of the population to rely on other forms of sanitation services. Whereas households in the wealthier neighbourhoods which are not connected to the main sewer can afford to install other improved sanitation facilities such as septic tanks, the urban poor in Nairobi are left with no option but to rely on unimproved sanitation provisions such as uncovered pit latrines and open defecation (Fig. 24.7). In the poor settlements which are often located in environmentally sensitive areas such as along river banks, open defecation in rivers is a common occurrence.

The total length of existing trunk sewers in Nairobi is about 162 km, serving an area totalling about 208 km^2. This accounts for approximately 40 % of the total area
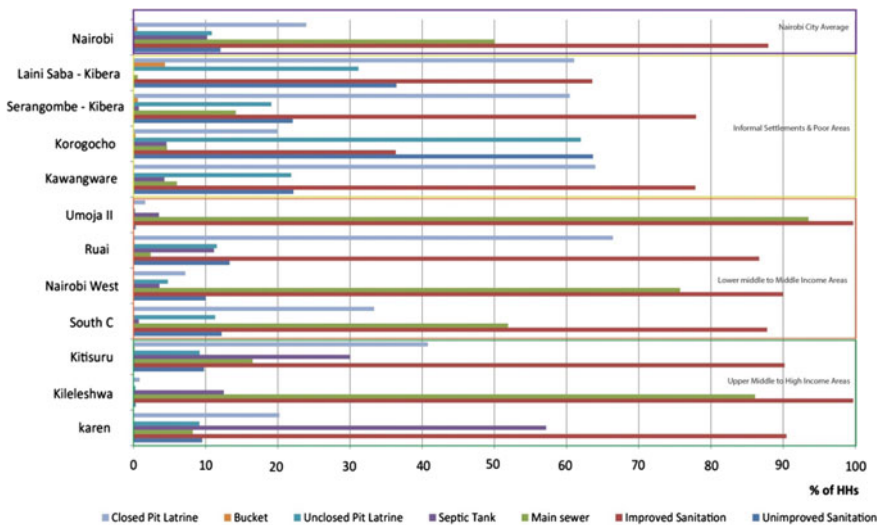
Fig. 24.7 Type of sanitation facility for select wards (*improved sanitation facilities include main sewer, septic tank, cess pool, VIP latrine, pit latrine. Unimproved sanitation facilities include uncovered pit latrine, bucket, bush, others*). *Data source* [33]

covered by the water supply network (Fig. 24.6). Within the covered areas how-
ever, there are many missing secondary sewers to connect houses to the trunk
sytem, making it difficult to estimate the actual level of the service coverage within
the city [35] (Fig. 24.8).

The challenge is not only from lack of adequate coverage by the sewer network,
but also from limited capacity for the existing sewerage treatment plant to handle
the amount of generated waste. There are 24 existing sewerage treatment plants
(STPs) in Nairobi City, but most of them are localized STPs with a capacity of less
than 2000 m^3/day. The major STPs are the Dandora STP (capacity 120,000
m3/day) and the Kariobangi STP (32,000 m3/day). A report by the Nairobi City
Water and Sewerage Company (NCWSC) indicates that these STPs are not
well-functioning in terms of actual sewerage treatment volume and water quality of
treated outflow. In particular, the Kariobangi STP suffers from deterioration and
mechanical troubles and is not substantially operational [35]. The majority of
existing sewers are equally combined sewers for both storm water and wastewater,
and are majorly only well-developed in the CBD, wealthier neighbourhoods and
newly emerging secondary commercial hubs such as Westlands and Upper Hill.

The cost of accessing sanitation facilities is highest in Nairobi's informal set-
tlements where charges range from 5 to 10 KES per use. This means that for an
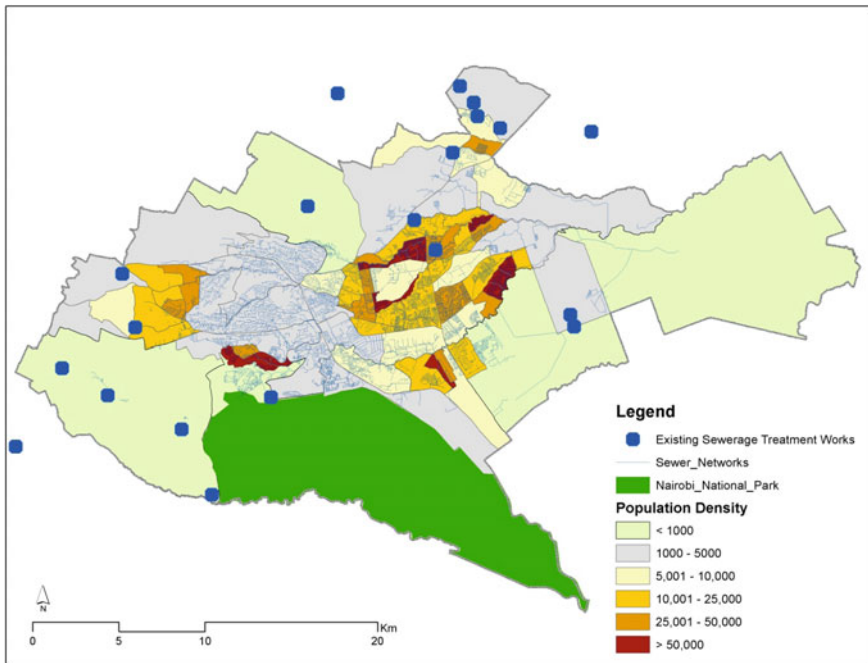
Fig. 24.8 Distribution of sewer lines in Nairobi. *Source* Representation by author using data from
NCWSC [1, 18]

average household with five members, each using a toilet (shower facilities are charged separately) once per day, a daily average of 25–50 KES is needed. This is a largely an unsustainable figure, given that most households in these settlements live below the poverty line [36]. These high costs of access to improved (and in other places unimproved) sanitation facilities are a major cause of open defecation within the slums.

24.5.1.3 Emerging Smart Alternatives for Affordable Water in Nairobi's Informal Settlements

As a means to promoting equitable access to water among the poor neighbour-hoods, various smart initiatives have been developed in various informal settle-ments. Water *kiosks* which are privately run water vending points were among the first innovations developed by the then Nairobi City Council in the late 1990s to improve water supply to the informal settlements. Over the years, the kiosks have expanded to cover many informal settlements and their operation model has been expanded to cover other basic services. Through the years, however, the cost of water in the kiosks has remained high (200–400 KES/m^3), despite the NCWSC's efforts to supply water to the vendors at subsidized rates of 15 KES/m^3 [32].

Partnerships between slum communities, their federation called Muungano wa Wanavijii (federation of the urban poor), a savings and loaning network called Akiba Mashinani Trust and the NWSC have expanded the supply system beyond the water kiosks to dwelling and plot connections in the Mathare Slums of Nairobi. Through the connections made in 2011, households can easily access water and pay lower prices costed at the city rate. This approach has been possible in one section of Mathare slums called Kosovo, where households are properly organized and where streets (albeit narrow) are present for the water reticulation networks. The pilot project in Kosovo has started to affect policy around water supply in informal settlements and is being expanded to other parts of Mathare slums.

In August 2015, NCWSC in partnership with Grunfos launched water dispensers in Mathare slums in which residents pay for water using prepaid cards (Fig. 24.9). According to NCWSC, the cost of water in the dispensers is about 0.50 KES per 20 L of water. This system is providing the cheapest water supply in any part of Nairobi's slums and is a true indication of how uptake of technology can be integrated in the provision of basic services at affordable rates to the most disad-vantaged urban dwellers.

Various sanitation improvement programmes have also been developed in var-ious informal settlements in Nairobi. A key player in the sanitation improvement is a Kenyan civil society agency, Umande Trust. The organization has partnered with Bankable Frontiers, a strategic international private sector consultancy firm to create biocentres in Kibera, Mukuru, Korogocho and Mathare slums in Nairobi. The biocentres serve as multi-purpose service points, designed to improve access to decent and affordable sanitation, convert human waste into clean energy (biogas) and fertilizer for urban greening and provide income generation and access to

Fig. 24.9 Water dispenser installed in Mathare Slums, Nairobi. *Source* [37]

information to community-based enterprises. Pricing for the biocentres has shifted from the pay-per-use model often adopted by other privately operated sanitation centres to a household-based payment approach. In this approach, the cost of using the sanitation facilities is about $0.05 per household per day [38]. Digital payment services such as cashless cards and mobile money payment have also been integrated in the centres in which households top up their cards and are able to enjoy the various services offered at the centre through a card swiping system. This has

Fig. 24.10 Front view of Gatwekera biocentre, Kibera Slums, Nairobi. *Source* [39]

greatly improved efficiency in the service delivery, eased family budgeting and reduced cash handling and thus insecurity in the centres. The biocentres also act as community centres with halls for hire, provide cheap alternative cooking energy through biogas technology, provide water services and also provide office space and Internet services (Fig. 24.10).

24.5.2   Storm Water Drainage, Flooding and Economic Development in Nairobi

Streets play a central role in promoting access to other basic services such as storm water drainage and sewerage. With more land allocated to streets within the Nairobi city core (including the CBD) calculated at 11.5 % against only 5 % in the suburbs [23], storm water drainage is more developed in the city core area as opposed to the suburbs. In the lower-income and slum areas where very little land is allocated to streets, storm water drains are barely existent. Given that most of the slums are located in environmentally sensitive areas, they are prone to the regular flooding experienced during the rainy seasons. In recent years, lack of development/expansion of storm drains, poor maintenance of the drains, poor coordination between relevant institutions, coupled with other factors, has resulted in regular flooding of the city core areas which were traditionally better drained. The lack of records and maps showing the existing storm water drains in the city has worsened the situation, and made flood monitoring very difficult [18].

Owing to the prevailing situation in under development of proper drainage infrastructure, Nairobi has often experienced flooding and flood-related catastrophes, including loss of life, and loss and destruction of property worth millions of dollars. Flooding during the 2015 short (March–May) and long (October–December) rains period caused death of several people in Nairobi, resulted in massive damage in the city, disrupted traffic flow and resulted in collapsed buildings. At least nine people died after a building collapsed as a result of heavy rain and flooding in May 2015 [40].

In order to achieve smart and sustainable economic development, Nairobi needs to address its flooding challenge that twice a year paralyses the city's usually bubbly economic activities, manifested through, among other things, traffic congestion, blockading of sections of commercial spaces such as parking lots, washing away of roads and flooding of houses in many parts of the city.

24.5.3   Solid Waste Management

Solid waste management is both an opportunity for economic development through recycling and also a challenge in neighbourhoods through creation of unsightly

garbage dumps and associated health risks to people living in such neighbourhoods. There has been a huge failure by the Nairobi City County to effectively collect waste in different parts of the city. To bridge the gap in collection, the lower- to middle-income neighbourhoods have gotten into agreements with private companies for waste collection at a fee. The same arrangements are also present in the informal settlements where groups collect waste from households at a fee and dispose it in nearby rivers or along the roadsides [41]. Narrow streets, biased service delivery, lack of operational capacity and adequate resources among other factors limit the city authority's ability to efficiently collect the waste in all the city neighbourhoods.

Approximately 1848 tonnes of waste is generated per day in Nairobi, with 60 % of the waste generated from residential areas. The majority of the generated waste (60 %) is food waste, and high-income areas have the highest per unit waste generation rate at 0.621 kg/day against only 0.36 kg/day in low-income areas [42]. Only about 33 % of this waste is collected leaving the majority of waste in illegal dumps [35]. The city authority collects a mere 29.6 tonnes/day, with the Nairobi City County (NCC) contractors collecting 446.5 tonnes/day, and private service providers collecting 132.2 tonnes/day [18]. The cost of waste collection varies widely, with some of the highest collection costs being levied in the low-income neighbourhoods and informal settlements. Before privatization of the city water supply network to NCWSC in 2003, ten KES of waste collection service charge was levied with the water supply service [18]. This has changed now, and households and businesses pay varying charges to private collectors ranging from a few hundreds to several thousand shillings. There are no price controls among the private collectors, and thus, payments depend on agreed upon rates between the collectors and the residents. In some informal settlements, for example, households pay between KSh 30 and 50 per week for their waste collection, amounting to between KSh 120 and 200 per month, which is equal or more than what the lower-income neighbourhoods pay for the service on a monthly basis [41]. The private service waste collection is, however, concentrated in the middle- to high-income neighbourhoods which can afford such services, and for which the private providers can make profits.

Formal settlements initially well served with basic infrastructure started experiencing challenges with access to the same as a result of changed densities within the neighbourhoods, as well as new developments tapping into the same services without a proportional increase in the infrastructure capacity to accommodate the increased demand. Years of negligence and non-maintenance of the services have also increased this challenge.

The other key infrastructure aspects of a smart city foundation, ICT and broadband development and electricity supply are discussed in Chap. 25: Infrastructure Development in Nairobi—widening the path towards a smart city and smart economic development.

24.6 Conclusion

As discussed throughout this chapter, there is a huge economic value attached to basic infrastructure provision in a city. This economic value relates to aspects such as (a) time savings in access to various services, (b) health sector benefits due to avoided illness, (c) patient's expenses avoided, (d) deaths avoided and (e) productive work days gained through avoided illness. A smart economic system understands the benefits of investment in basic infrastructure and makes deliberate efforts to develop them.

Nairobi is still performing marginally in some aspects of basic infrastructure development, and if it is going to achieve smart economic development, there is a need to invest more in achievement of equitable access to water and sanitation, solid waste management systems and storm water drainage, as well as in energy access by all income groups. By doing so, the city will not only enjoy the benefits of a heathy human capital, but will also greatly improve its urban environment through enhanced security, increased social inclusion and engagement and increased disposable income among households which will be ploughed into investments, all creating a smart city setting for which smart and inclusive economic development can thrive.

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Chapter 25
Infrastructure Development in Nairobi: Widening the Path Towards a Smart City and Smart Economic Development

Dennis Mwaniki

Abstract Empirical evidence from both developed and developing countries point to a positive correlation between development in the physical, social and policy and regulation aspects of infrastructure and economic development. The synergetic development of these components creates smart city systems which promote smart mobility, smart environments, smart living; sets the platform for smart people and smart governance; and ultimately results in smart economic growth. The emergent smart systems further promote inclusive growth, reduce natural disaster vulnerability and exposure, and improve resilience among the urban poor. Infrastructure development in Kenya, particularly investments in information communication technologies (ICTs), electricity, and transport infrastructure have been in rapid positive transition. These developments, which have been promoted by a friendly policy framework and hugely benefited from foreign assistance, have largely been beneficial for Nairobi, Kenya's capital. In just under two decades, Nairobi has grown to near universal mobile phone penetration and Internet connectivity is above 60 %. The city is now one of the most important ICT innovation cities in Africa, with several incubation centres, a growing number of ICT professionals and a youthful population that is technology savvy. These developments have opened Nairobi to many economic growth opportunities. This chapter discusses the level of infrastructure development in Nairobi and Kenya in general, particularly developments in ICT, energy and transport and how these are giving the city a comparative advantage against other African cities for smart growth. The key findings are that, with the exception of ICT, growth in other infrastructure sectors has been slow and largely unequal. The chapter also identifies that adoption of ICTs has been working towards improving efficiency in the existing and although the progress is slow, the future prospects for high efficient ICT integrated systems are high.

Keywords Nairobi · Infrastructure development · ICT · Energy · Transport · Smart city system

D. Mwaniki (✉)
Global Observatory Linking Research to Action, Nairobi, Kenya
e-mail: dmwaniki@gora4people.org

25.1 Introduction

Infrastructure covers the physical aspects of transport, water and sanitation, energy, information communication technologies (ICTs), as well as social components such as schools and hospitals. The role of infrastructure development in economic growth is a subject that has formed a significant part of development economics in the last several decades. Empirical evidence from both developed and developing countries indicates a positive correlation between investment in infrastructure and economic development [1, 2]. The infrastructure-based or infrastructure-driven economic development school of thought which combines growth models from various world regions holds that in order to stimulate long-term economic growth and efficiency, particularly in economically lagging regions, a substantial proportion of a nation's resources must be strategically invested in long-term infrastructure assets, such as transportation, energy and social infrastructure [3]. Empirical studies based on long-term analysis of the United States economy also point to a positive and statistically significant correlation between investment in infrastructure and economic performance [4–8]. Similar evidence has been reported in China, Norway, Singapore, Indonesia and South Korea.

Through the 1990s and 2000s, China invested roughly 9 % of its gross domestic product (GDP) in infrastructure against 2 % for Western economies, and 4 % for non-Asian emerging economies [3]. This level of investment enabled the Chinese economy to grow at very high rates through the 1990s and early 2000s, while most of the other economies which made little investment continued to suffer from infrastructure related bottlenecks such as unreliable power supply, poor and ageing transportation networks and limiting social infrastructure [9]. Infrastructure deficits in Africa, for example, which are estimated at US$75 billion per year are said to depress firm productivity and profits by around 40 % and hold back per-capita growth by 2 % [10, 11].

Achievement of maximum impacts from infrastructure development for a country/city, however, requires proper integration of the physical and social aspects with the soft components of policy and regulation [9, 12]. The synergetic development of these components creates smart systems which promote smart mobility, smart environments, smart living; sets the platform for smart people and smart governance; and ultimately results in smart economic growth. The emergent smart systems further promote inclusive growth, reduce natural disaster vulnerability and exposure, and improve resilience among the urban poor.

In Kenya, infrastructure development has happened in three major phases: (a) a period of targeted and discriminatory urban infrastructure development during the colonial era (late 1800s to 1963); (b) a period of dormancy (1963–2002) and; (c) a period of rapid investment through overseas development assistance (ODA) and foreign direct investment (FDI) (2003 to date). Key urban challenges facing Nairobi today and which modern physical infrastructure development efforts are aimed at addressing have their roots in the dormancy period spanning about 40 years. The main infrastructure sectors that have received a huge boost from both budgetary

allocations and foreign assistance since 2003 and which have largely contributed to shifting the country's economic growth from negative to positive figures include ICT, transport and energy. Upon identification of the role these infrastructure components play in boosting economic growth, and through different targeted policy interventions, the Government of Kenya has not only invested in their development, but has also been working towards improving their efficiency, particularly through integration of ICTs into all sectorial developments. This is happening concurrently with improvements in the education and health sectors, which is generating more knowledgeable and healthy human capital.

This chapter highlights the state of infrastructure development and how the emerging patterns influence Nairobi's prospects for smartness. The discussions surround key physical infrastructure provisions of transport, energy and ICT that have traditionally been identified to affect productivity and which directly contribute to a smart city system as discussed in Chap. 1 of this book. The chapter puts more emphasis on ICT development in Nairobi, particularly mobile telephony and the Internet as they are paramount in the achievement of a smart city system. The chapter further discusses electricity and transport infrastructure as inputs in the production chain, and highlights aspects of infrastructure financing in Nairobi. Various smart initiatives that have come up as a result of development in the various infrastructure components, or which have been adopted to improve efficiency within the sub-sectors are also highlighted. Although some components of social infrastructure are briefly highlighted in this chapter, in-depth analysis of the social infrastructure components of education and health and their contribution to Nairobi's smart economic growth are discussed in detail in Chap. 26 of this book. The policy and institutional framework within which the infrastructure development has been happening in Nairobi is discussed in Chap. 27.

25.2   ICT Infrastructure for a Smart Nairobi: From "City in the Sun" to "Africa's Silicon Savannah"

Access to, and availability of information is a high-value resource for a city. A city that is rich in information creates opportunities for informed decision making, influences positive collaboration, promotes public engagement, identifies various opportunities for its citizens, and has more prospects for growth than one that does not. Advances in digital technologies over the past few decades have greatly expanded the information base, lowered information costs and created high-value information goods. This has facilitated searching, matching and sharing of information and contributed to greater organization and collaboration among economic agents (e.g. by influencing how firms operate, people seek opportunities and citizens interact with their governments), widened options for city residents (for both commerce and recreation) and also promoted inclusion of the previously disadvantaged groups [13]. The presence of efficient and affordable communication

systems further promotes collaboration among the various parts of the population, improves access to markets for products, and creates an informed society.

Investment in ICT Infrastructure has been identified as having a positive and significant correlation with economic development, particularly due to its ability to [14];

(a) create jobs within the service sector itself;
(b) improve efficiency in the production sector; and
(c) improve local and international connectivity, creating new opportunities and widening markets for products.

This relationship has been tested in various OECD (Organization for Economic Co-operation and Development) countries where empirical studies have identified that a 10 % point increase in broadband penetration raised annual per-capita growth by 0.9–1.5 % points [15]. Advance in ICTs is also identified as having increased female participation and inclusion in labour markets (through e-commerce, online work, business process outsourcing) and created massive opportunities for the disabled who can now lead more productive lives. Digital identification systems are also providing better access to public and private services through development of formal identification records [13]. As broadly discussed in Chap. 1 of this book, investment in, and adoption of ICTs is a key prerequisite to the development of a smart city and is at the centre of the smart city system.

25.2.1 Brief History of ICT Development in Kenya

From the time of introduction until 1977, telecommunication (ICT) services in Kenya were managed as part of a regional network under the East African Community which comprised of Kenya, Tanzania and Uganda. When the community collapsed in 1977, the Government of Kenya established Kenya Posts and Telecommunications Corporation (KP&TC) to run the telecommunication services [16]. Major reforms in the sector, however, began in 1998 with institutional reforms which culminated in enactment of the Kenya Communications Act 1998 and the splitting of KP&TC into three legal entities, namely Telkom Kenya Limited (TELKOM), Postal Corporation of Kenya (POSTA) and the Communications Commission of Kenya (CCK). This policy reform, which came 6 years after introduction of the mobile phone and 5 years after introduction of the Internet in Kenya, was aimed at (a) separating roles of the various ICT sector players, (b) liberalizing the market through encouragement of multiple operators and (c) reducing the operational role of government in the sector through privatization. The new entities would take lead in promoting growth in the various ICT sub-sectors as follows:

– POSTA, established through the Postal Corporation of Kenya Act 1998 would ensure universal access to postal services;

– Telkom Kenya Limited, established as a public operator under the Companies Act would provide interconnection through various kinds of telecommunications; and
– The Communications Commission of Kenya, established through the Kenya Communication Act 1998, would be the regulatory body for the sector. The National Communications Secretariat was also formed under the Act to serve as the policy advisory arm of the government on all matters pertaining to the info-communications sector.

Mobile phones were introduced in Kenya in 1992 but only became widely available and affordable after establishment of the Communications Commission of Kenya (now Communications Authority of Kenya—CA) and licensing of two service providers, Safaricom and Kencell in 1999 [16]. The number of mobile phone subscribers has grown from only 127,404 in 2000 to 37.8 million in 2015 representing a penetration rate of 88.1 % [17, 18]. Innovations in the mobile phone sector, especially on mobile money since 2007, have further promoted mobile phone penetration and by 2015, there were 28.7 million mobile money subscribers [18]. Mobile money is a service that allows mobile phone users to transfer or receive money through their mobile phones. Recent innovations through partnerships with banking institutions has enabled creation of "virtual accounts" through which registered mobile phone users can access banking services such as savings and loans.

The Internet first became available in Kenya in 1993, and full Internet access was established in 1995 [19]. The African Regional Centre for Computing (ARCC), an NGO based in Nairobi became the first provider of Web-based Internet service. The first commercial ISP, Formnet began operating in 1995. Through the late 1990s Internet Service Providers (ISPs) would lease analogue or digital data lines from Kenya to the United States to access the Internet backbone [19]. The number of Internet subscribers has grown from practically zero in 1995 to about 200,000 in 2000 and exploded to 21.6 million subscribers in 2015 [18].

25.2.2 Bandwidth Is Increasing, Subscribers Are Increasing, Costs Are Going Down

Internet uptake and mobile phone subscriptions have grown over 100 % in just about two decades. The recorded ICT explosion in Kenya has been as a result of several factors:

– Increasing investments in Internet infrastructure
– Increasing mobile phone penetration
– Reducing data costs
– Favourable policy environment

Kenya has experienced an explosion in the ICT sector over the last two decades. This boom has been significantly influenced by global trends but has also largely benefitted from local investments, and an enabling policy environment. Liberalization and privatization of the ICT sector in the late 1990s and through the 2000s opened the market for investors and created the ICT foundations that are experienced today. Some targeted government efforts to increase investment in development of the sector have included;

– Privatization of the ICT sector system.
– Licensing of operators—mobile cellular operators have increased from 2 in 1999 to 5 in 2015 when the registered operators included Safaricom, Airtel (formerly Celtel International and Kencell Communications Ltd), Orange, Yu-mobile and Equitel. The number of registered Internet Service Providers (ISPs) has also increased from 73 in 2004 (16 of which were active) to 185 in 2014 [16, 18].
– Liberalization of supply and installation of Fixed Satellite VSAT terminals from Intra-corporate communication in the early 2000s.
– Incorporation of computer training in education system—although computer training was ongoing through the 1990s at higher levels of training, the government introduced computer training from 2001 in all levels of schooling, and became an examinable subject in secondary schools.
– Setting goals on ICT growth for the country—By understanding the role ICT would play in the country's economy, the government set targets to improve uptake of various ICT aspects. Key among the governments' targets in 2004, which have mostly been surpassed included [16]:

  • Increasing the number of mobile subscribers from 2.8 million in 2004 to 10 million by the year 2015;
  • Expanding the current international Internet bandwidth from 35 Mbps to 1 Gbps by the year 2015;
  • Ensuring that all secondary schools and tertiary institutions have Internet access by the year 2007; and
  • Encouraging Internet service providers to establish Internet access nodes at all districts and local exchange areas.

These deliberate government efforts to attract investment in the ICT sector have borne fruit and created a well-developed ICT market in the country, which is the envy of many other African nations. Since the sector reforms started in 1998, mobile phone and Internet penetration as well as the sector governance has greatly changed.

By opening its ICT sector to private investors, Kenya has, for example, seen a tremendous shift from satellite Internet to undersea Internet. The construction of four undersea fibre optic cables (SEACOM, TEAMS, EASSY, and LION cables) since 2009 has greatly improved the country's bandwidth, and in turn, Internet connectivity [20]. Kenya's international bandwidth has increased from a mere 28 Megabits per second (Mbps) in 2004 to 193.58 Gigabytes per second (Gbps) in 2015 [16, 18]. The increased bandwidth has greatly reduced the cost of accessing the service, and in turn enabled better communication both locally and internationally and has created

Table 25.1 Internet subscription per kind of subscriber

	2010	2015	% share of subscriptions 2015
Total Internet subscriptions	4,716,977	21,628,271	
Mobile data/Internet subscriptions	4,684,473	21,511,638	99.461
Terrestrial wireless data/Internet subscriptions	26,137	13,221	0.061
Satellite data/Internet subscriptions	447	720	0.003
Fixed DSL data/Internet subscriptions	4305	2500	0.012
Fixed fibre optic data/Internet subscriptions	3824	100,192	0.463
Fixed cable modem subscriptions	25	25	0.0001
Estimated total Internet users	10,199,836	31,985,048	

Source [21, 18]

many opportunities for economic growth within the country. Internet usage tariffs in commercial access points such as cyber cafes have fallen from Ksh 15 per minute in 1998 and Ksh 1 per minute in 2003 [16] to less than Ksh 0.5 per minute in 2016. Most cyber cafes are actually struggling to be in business due to the high number of people accessing internet services on their phones, and have had to diversify into other activities such as printing and graphic design.

Some of the emerging ICT-related economic growth opportunities/areas are highlighted in the subsequent sub-sections. High-mobile phone penetration, coupled with decreasing costs of data, has also greatly contributed to Internet penetration in the country. As of 2015, about 99 % of all Internet subscriptions in the country were mobile data/Internet subscriptions (Table 25.1).

As an economic sub-sector in itself, ICT-related economic output for the country has been on the increase, and reached a peak in 2010 when the sector contributed 2.2 % of the country's GDP, before dipping to 1.2 % in 2014 [22]. In addition to its direct economic output, Kenya's ICT sub-sector has become a major link and input in almost all other economic sub-sectors, hugely increasing efficiency in productive systems and contributing to the country's GDP growth. The sector growth has happened concomitant with a rapidly increasing human capital in the country and has happened within the framework of an equally changing policy framework as is discussed in Chap. 27 of this book. Although not discussed in this chapter, other ICT sub-sectors such as the mass media and postal services have also grown, with postal services experiencing the least growth over the years.

25.2.3   ICT Advancement Is Promoting Smart City Growth: The Era of "E" and "M" Systems in Nairobi

Nairobi city, Kenya's capital, has been the centre of all the ICT-related action described in the preceding section and has been reaping the highest benefits of the

country's investment in ICT development. Today, Nairobi boasts of the highest connectivity speeds in Kenya and the larger East African region [23], and is estimated to account for 80 % of Kenya's Internet users [23]. As the seat of government and the country's commercial hub, and as the hub for national and international convergence, Nairobi creates all the necessary conditions for ICT innovations in Kenya and the larger East and Central African region. Some of the emerging trends over the past decade, which are putting Nairobi at the international scene as Africa's Silicon Savannah include:

- **Establishment and growth of innovation incubation hubs**—to tap on the increasing bandwidth and growing development expertise, incubation centres which use the co-working space ideology have become the epicentre of Nairobi's burgeoning tech scene. Examples include iHub, 88MPH, iLab, iHub, Nailab, C4DLab. The Konza Technology City is an ongoing development 60 km south of Nairobi which is expected to grow into a smart ICT city and become Africa's Silicon Savannah. The proposed technology city is expected to support development of Business Process Outsourcing (BPO) companies, telecoms, and education industries.
- **Establishment of regional hubs by multinationals**—many multinationals have also established their regional or continental headquarters in Nairobi due to the strategic location of the city as well as the talent pool available. IBM is one such multinational that has established its Africa research laboratory in the city. Google, Cisco Systems, Intel, Nokia and Microsoft have also founded their hubs as centres for expanding their business operations in the larger East and Central Africa region [23]. Thanks to the growing investment by these multinationals, Nairobi already has a super-computer which can process high volumes of data [24].
- **Increasing funding for local ICT development**—the various innovation hubs in Nairobi have created a fast growing pool of developers who are attracting funding for various applications with socio-economic benefits. For example, Kenya's leading mobile operator Safaricom set up a US$1 million fund in late 2014 to invest in the emerging ICT start-ups either by purchasing equity or through debt instruments [25].
- **Growth in E-Commerce**—with the improved communication and Internet connectivity and penetration, e-commerce has become a major part of the Kenyan life. Almost all banks in the country have linked their operations with various utility companies, which enables consumers to access and pay for services with ease. Almost all major stores in Nairobi are now using Internet platforms to advertise their products, and new online businesses have emerged targeting a rapidly growing Internet-based market. Online market research has also followed suit. The emerging patterns have largely resulted in economic inclusion for the previously marginalized groups such as youths and women.
- **Growth of E-Governance**—thanks to the advances in ICT recorded in Kenya, e-governance has become entrenched into the various government processes [26]. These systems have been adopted in the various ministries, such as national tax systems, immigration information system, legal information system,

the integrated financial management system and education system. The new systems are facilitating registration of businesses, application for and renewal of permits and licences, promoting transparency in the tendering processes and taxation systems, among other benefits. The Nairobi County government has introduced an electronic public tendering process that is open and easily available for all to see and follow. Digitization of applications and payments has already streamlined operations and increased parking payment rates, and collection of various rates for the city county government. These systems are being hailed for reducing duplication of governance and public service processes, enhanced efficiency and effectiveness of resource utilization, enhanced transparency, creating a public participation framework, and generally increasing the ease of doing business in the country [27]. Products such as "I paid a Bribe 2025" are used to expose and curb corruption.

- **Open Data access for enhanced decision making**—capitalizing on the expanded Internet bandwidth, the government has since 2011 been releasing key government data and statistics through the Kenya Open Data Initiative. All government ministries also have websites through which information is passed to the citizens and reports on various socio-economic aspects posted. The free dissemination of data has opened previously non-existent opportunities for informed decision making, transparency and governance.

- **Growth in E-Learning**—advances in ICT are also fast reducing the physical distance between learning institutions and students as e-learning is fast becoming popular in the country, not only for local but also international universities. The Africa Virtual University which was founded in 1997 is, for example, headquartered in Nairobi with a regional office in Dakar, Senegal. It is a Pan African Intergovernmental Organization whose aim is to significantly increase access to quality higher education and training through the innovative use of Information and Communication Technologies [20].

- **Growing partnerships between training institutions, the private sector and civil society organizations**—university-based innovation centres established in partnership with private enterprises are becoming popular in Nairobi. These centres are aimed at promoting practical learning and for training people to become job creators instead of job-seekers. Multinational and regional tech corporations such as Huawei, Intel, Microsoft, SAP, Oracle, Google and Samsung are some of the companies that have university programs [28]. The partnerships result in certifications, internships and even job opportunities for students.

- **Financial inclusion through mobile money platforms**—since the launch of mobile money transfer services in 2007, 28.7 million subscribers were registered for the service in 2015 and 135,724 agents were providing the service [18]. In 2014, cash deposits via mobile money agents were recorded at KSh 1269 billion and cash transfers were KSh 2372 billion [22]. In addition to enabling quick and convenient money transfer services, which have greatly contributed to financial and social inclusion of previously marginalized sections of the population, the mobile money platforms have been incorporated in many service utility

payments. Users can now pay for bills such as water and electricity without having to walk long distances to the service centres. Various banking alternatives have also emerged through collaborations between mobile operators and various banking institutions.

Box 25.1: Mobile Banking as an Opportunity for Smart Economic Growth in Nairobi

Nairobi is a pioneer in mobile banking, whereby mobile technology is used to transfer money between people, to pay bills, to make purchases, withdraw/deposit money to bank accounts among other transactions. The trend, which started with one of the mobile phone operators, Safaricom, in 2007, has spread throughout the country and has been adopted by the other operators. It has further expanded to other licensed content service providers. Safaricom's M-Pesa accounts for about 82.4 % of subscribers to mobile money in the country [29] and handles more than US$320 million (Ksh 29 billion) in payments monthly, equivalent to a quarter of Kenya's GDP [30].

The mobile money transfer innovation has revolutionized Nairobi's economy, and Kenya's, in general. It has driven mobile phone penetration upwards, activated various economic activities, eased business operations, triggered growth in the banking sector, and greatly improved financial inclusion [20] (savings and access to credit) to a previously marginalized population.

Today, almost all banks and utility companies have incorporated mobile banking into their architecture, greatly reducing the amount of time spend in banking halls and also for paying for utility bills. This service has also been a great complement for e-commerce, particularly by enabling consumers to order for goods online and pay for them using mobile money services.

The success of mobile money services in Kenya is globally acclaimed and has now been adopted in parts of Europe and Asia [31].

25.3 Electricity Supply Supports Smart City Growth

For the development and maintenance of ICT infrastructure, it is important to have other infrastructure like electricity, water, road, rail and air transport systems in place [32]. In particular, electricity is a key driver of ICTs as it affects the ICT penetration rates in a city. In addition, the availability of reliable and well-priced electricity is a crucial factor in the production chain and has multiplier effects at the household level where it contributes to prolonged productive hours and human capital development.

25.3.1   Overview of Electricity Supply in Nairobi

Reliable power supply is at the core of smart economic development in any city. Power supply is the backbone of the manufacturing sector, which forms the bulk of productive activities in urban areas. Although Nairobi fairs relatively better in power distribution as compared to other towns in Kenya, there is still a lot to be accomplished in the development of power as a tool for improving productivity, and in turn promoting smart economic development. Outside the industrial sector, reliable power supply is a crucial asset to commercial establishments as well as for households. Without reliable power, businesses would find it hard to operate, and a major prerequisite for 24-h economies in cities is the availability of power, which ensures smooth flow of night activities, as well as promotes security. At the household level, availability of power prolongs the number of productive hours, as household members can engage in other productive activities (including personal development) even after darkness sets in. While access to power contributes directly to economic production in the manufacturing and commercial sectors, it has both direct and indirect benefits on economic development at the household level. The direct benefits relate to the labour force ability to deliver at the work place, and the indirect benefits, which are equally if not more important, relate to the role of power supply in human development. Both aspects contribute to development of smart people, who are the most important component in a smart city system.

88.6 % of households in Nairobi have access to electricity [33] though the levels of access vary between neighbourhoods and on income levels. The wealthier neighbourhoods have higher electricity connection rates than the poor neighbourhoods (Fig. 25.1). Power reliability also follows a similar trend, with the least supply interruptions reported in wealthier neighbourhoods and the highest interruptions in the poorest neighbourhoods. In the informal settlements where access to electricity is largely below 50 %, various informal power connections have emerged through which illegal connections are made from the main lines. The illegal power connections are undertaken by very powerful cartels who charge prices as high as ten times the formal rates. This trend, however, is slowly being curbed through partnerships between the Kenya Power Company and informal settlement dwellers, which are resulting in legal power connections. Sections of Mathare slums have already benefited from this kind of arrangement, resulting in mutual benefits for both the power distributors who have reduced non-revenue electricity, and the slum residents who are assured of quality, safe and affordable power supply.

Power supply and pricing at the industrial and commercial establishments are important aspects of production. In Nairobi, power supply to industrial establishments has relatively stabilized since 2002 when the country experienced some of the worst power shortages in history. Although the Kenya Power Company has put deliberate measures in place through policy directives to ensure that power supplied to Nairobi (and the major industrial area) remains as uninterrupted as possible, the region still records very high blackout rates, greatly affecting the city's economic
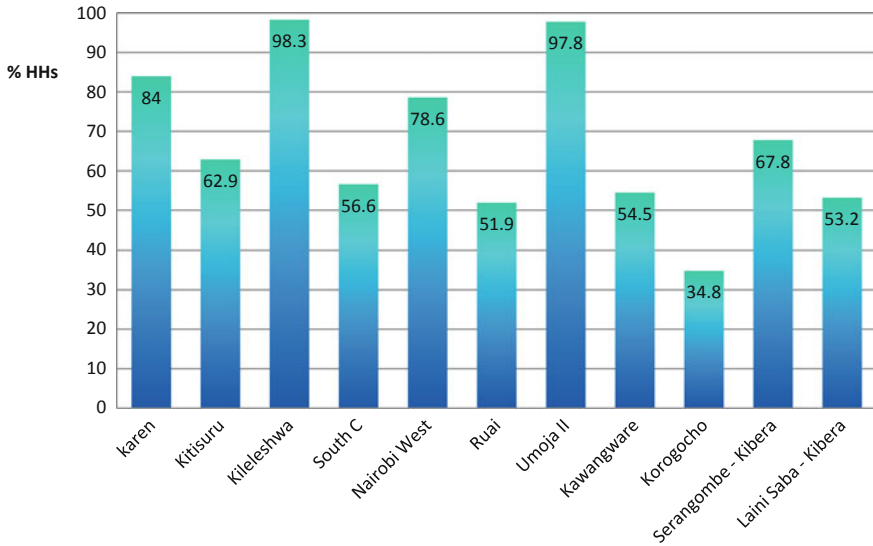
Fig. 25.1 Household access to electricity as the main source of lighting for select wards in Nairobi. *Data source* [34]

productivity. According to 2013 statistics, Nairobi's electricity supply is very unreliable and experiences about 10.77 incidences of blackout per 1000 customers, which is the highest among all regions in Kenya [35]. Since 2013, the government of Kenya has put in place plans to add 5000 MW of electricity to the national grid by 2017, which power will be absorbed in new, ongoing or proposed projects in Nairobi and other parts of the country (e.g. the planned Konza techno city, new railway and port systems, etc.).

The cost of power is still a major challenge in Nairobi and has already been associated with relocation of several industries from the capital to places like Cairo where the cost of production is much lower. In Kenya, the electricity tariff is calculated against a schedule pre-defined by the Energy Regulatory Commission, and includes a fixed charge, energy charge per kWh and other surcharges which are applied on all tariffs depending on consumption. A comparison between the electricity charges before and after 2013 when tariffs were revised indicate that there has been a marginal increase in the cost of electricity per kWh in all user categories (domestic, small commercial and heavy industrial and commercial). Besides these charges, customers need to pay for connection charges, which vary significantly between voltage demand and distance from existing transformers. The power increase coupled with other factors resulted in the departure of some manufacturing companies from Kenya to places like Egypt where the power costs are lower. In a bid to reduce the power cost and promote productivity, a 40-month tariff evolution target (2013–2017) has been set by the government of Kenya, which will result in a 47 % reduction on domestic tariff and a 37 % reduction in industrial tariffs [35].

25.3.2 *Investing in Electricity Supply for a Smart Nairobi*

Connection to electricity in Nairobi influences uptake of ICTs, contributes largely to the output from productive sectors such as manufacturing, and affects other sectors of the economy such as education, health, financial services among others. As an economic sub-sector, electricity supply contributed about one per cent to Kenya's GDP between 2010 and 2014 [22]. A net increase of 8.2 % in electricity generation between the periods 2013 and 2014 led to stabilization of power supply in the country and a slight drop in electricity prices. This in turn reduced the input cost and positively influenced growth in the manufacturing sector, which grew by 3.4 % in 2014. The current electricity prices are, however, still relatively high compared to economies with more efficient technology of electricity generation [22]. Rapid economic development through manufacturing and increased uptake of ICT at the household and business levels in the next decade will largely rely on increased electricity generation and reduced prices. To achieve this, the government of Kenya, through donor funding and grants has been undertaking massive investments in cheap, renewable and reliable sources of electricity.

The power sector in Kenya is divided into three components—generation, transmission and distribution—with each component managed by independent, yet interlinked fully owned government agencies. Each agency runs its own projects for improving power supply in the country, often based on a national or city-wide energy development plan.

Whereas major investments in the energy sector in Kenya happened in the 1970s when the World Bank approved two loans for development of hydropower facilities, the aid agency's focus significantly shifted from the 1980s to supporting institutional reform and geothermal energy exploration. Given that the government was reliant on external aid to expand the country's power generation capabilities; there were huge investment deficits in the sector through the 1990s. Lack of expansion in power generation against a growing demand, coupled with a prolonged drought experienced in the country between 1998 and 2000 resulted in a power supply crisis which majorly affected the country's economy. As a result, a negative economic growth of −0.2 % was recorded in 2000 and poverty increased from 48 % in 1990 to 56 % in 2003 [36, 37]. During this period, the quality of delivery of energy and other infrastructure services declined, agriculture grew by just about 1 %, the manufacturing sector experienced negative productivity and by 2004 only about 15 % of the country's population had access to electricity supply [36].

The Economic Recovery Strategy for Wealth and Employment Creation, which was formulated in 2004 by a newly elected government to reverse the negative economic growth identified development of energy infrastructure as a key factor for increased productivity. The key aspects to be addressed were availability, reliability, and affordability of energy services and development of relevant legal, regulatory and institutional frameworks for achievement of these goals [37]. This strategy document sets the framework for subsequent investments in the energy

sector, which has grown immensely over the last decade, creating a large net positive contribution the country's economic development. The major investments in the energy sector have been through donor-aided projects. Key projects relevant to Nairobi include

– the energy sector recovery project (2003–2013)—a US$375.07 million project aimed at enhancing the policy, institutional and regulatory environment for private sector participation in power development; supporting efficient expansion of power generation capacity; increasing access to electricity in urban and peri-urban areas in and around Nairobi and Mombasa while improving the efficiency, reliability and quality of service to existing infrastructure. The project was implemented through a co-funded loan between the World Bank (international Development Association—IDA), the European Investment Bank (EIB), the French Development Agency (AFD), Nordic Development Fund (NDF), and the Government of Kenya (GoK). Its results included policy formulation (National Energy Policy and Energy Act), addition of 280 GWh to the main grid in 2012, connection of 526,000 additional customers, substantial improvements and extensions in the transmission lines, and reductions in total monthly outages from 11,000 in 2004 to 5771 in 2008 nationally [36].
– Electricity expansion project (2010–2016)—the US$1.39 billion project has components on power generation, transmission, distribution and institutional development and operational support. So far, an additional generation capacity of 280 MW has been released to the main grid from geothermal sources, displacing alternative sources from thermal plants, creating environmental benefits, saving on fuel and contributing to marginal reduction in power costs. 4452 km of distribution lines have been constructed or rehabilitated, and a further 76 km of transmission lines have been constructed or rehabilitated, and over 1 million new households connected to the main grid [38].
– Mombasa-Nairobi Transmission Line project (2012)—the US$269.4 million (214 million Euros) for construction of a 450 km long 400 kV double-circuit power transmission line from Mombasa to Nairobi, construction of a 19 km 220 kV double-circuit line in Nairobi area, and expansion of substations in both Nairobi and Mombasa. The project aims to transfer power generated in the coast area to the main load around Nairobi and to contribute to the country's growing power demand [39, 40].
– Nairobi ring project (2012–)—the US$162.76 million (EUR145 million) project aims to improve power distribution around Greater Nairobi region. It includes construction of about 100 km 440 kV double-circuit transmission line, a 220 kV spur line, construction of sub-stations, construction of switching and monitoring devices in the sub-stations, and long-term capacity building for Kenya Electricity Transmission Company (Ketraco) on design, construction, operation and maintenance of 400 kV transmission networks [41]. It will help bring additional power to the Nairobi region at reduced transmission losses, improve reliability of power supply, and in turn contribute to reduced power costs.

– Ethiopia-Kenya Electricity Highway project (2013–2019)—the US$1.26 billion project is a 1045-km 500 kV high-voltage electricity highway aimed at increasing power volume and reducing cost of electricity supply to the tune of US$31 million by 2019, while generating revenue for the Ethiopian government [42]. The project is funded by the African Development Bank, the World Bank, Governments of Kenya and Ethiopia, and the French Development Agency [43].

Effects from some projects such as the energy sector recovery project are already being felt in the city, with improved power reliability and reducing costs. This is positively affecting the production chains in the manufacturing industries and resulting in connection of more households to the grid. Incorporation of ICT technologies in the projects such as for monitoring devices in sub-stations (e.g. the Nairobi ring project) is likely to improve efficiency in the overall sector operations.

In addition to the investments in power generation, the power service provider in the city, Kenya Power Company, has incorporated various ICT-based strategies to both improve efficiency of the distribution system and reduce non-revenue electricity. The major strategies include:

– **Introduction of pre-paid power meters and mapping of their locations**—starting in 2009, the Kenya Power Company started installation of pre-paid meter systems which allows customers to monitor their own power consumption while removing the traditional paper billing system which often led to late bill deliveries and supply disconnections due to delayed payments. Through the pre-paid meters, customers have the option to top-up their power credits by purchasing power *tokens* from a vendor or through mobile money platforms. The pre-paid meter system also allows consumers to know how much power they have used over a specified amount of time, and in turn helps reduce energy wastage.
– **Integration of mobile money into electricity payment**—through partnerships with various mobile service providers, the power company has since 2009 also introduced mobile money payment systems for electricity bills. This is in addition to licensing many agents spread throughout the city to sell pre-paid power tokens. These options for paying power bills have improved efficiency in the system. Mobile money power payments are charged a fee ranging from KSh 10 to KSh 25 depending on the amount being paid.
– **Okoa Stima**—this is a collaborative initiative between the Kenya Power Company and Safaricom, Kenya's largest mobile phone service provider. The service allows Safaricom customers to borrow any amount of power based on their relationship with the power company. The loan attracts a 10 % fee and is payable within 7 days and borrowed amount is deducted from the customers mobile money account (M-Pesa) [44].
– **Power outage reporting**—Kenya Power Company has also developed various ICT-based power outage systems through which customers can call, send a text message through a short code indicating their power meter number. Reporting can also be done through facebook and twitter. The mapping of power meters

carried out in 2015 allows the company to geo-locate power outages as outage reports come in. Data on reported outages is also available through a tweet map (http://poweralerts.kenyapower.co.ke/tweetmap) and can be useful for investors or even individuals who want to understand the frequency of power outages in certain parts of the city before establishing businesses or renting residential properties.

Investment in power supply and incorporation of ICT systems in the energy sector has no doubt improved efficiency in Nairobi's power distribution network, and in turn created benefits for both the power company and the customers. Extension of power supply to new areas within the city also encourages ICT penetration. This symbiotic relationship paints a good picture of how energy and ICT develop complement one another in improving service delivery to Nairobi's residents, and in turn promoting smart city growth.

25.4 Inefficient Transport Infrastructure Hinders Productivity and Smart City Growth

The connection between transport infrastructure, ICT and economic development in a city is incredibly strong. Efficient transport networks add value to the production chain through improved connectivity and reduced production costs, provide access to local and international markets, improve accessibility to other production facilities, provide employment for thousands of city residents, and enable connections to key household social facilities [9]. By linking populations to social infrastructure, such as schools and hospitals, transport systems greatly contribute to improvements in human capital, which is a prerequisite to smart economic growth. Transport infrastructure also provides the relevant space for laying down of ICT infrastructure and provides a means for their maintenance.

The transport and storage economic sub-sector recorded a growth of 5 % in 2014 surpassing wholesale and retail trade to become the third largest contributor to Kenya's GDP with a share of 8.3 % [22] Transportation, both in terms of infrastructure and service, in Nairobi is perhaps one of the greatest hindrances to the city's smart economic growth. Not only is the city's transport infrastructure poorly developed (poor street connectivity), but the transport services are also privately run without appropriate regulation. Nairobi lacks major link roads and most of the city's traffic leads to the central business district, where connections are made to different destinations. This convergence of traffic, coupled with a lack of better alternatives, creates unpredictable gridlock all over the City. Bus Rapid Transit (BRT) systems or non-motorized transport options could result in reduced traffic congestion throughout the City. A 2012 study by IBM identifies Nairobi as having some of the world's worst traffic congestion—a problem that costs the city approximately US $500,000 per day in lost productivity and excess fuel consumption. As a factor of

unreliability of the privately owned public transport system, the study further identified that 75 % of the city's 1.5 million commuters drive alone [45, 46]. It has further been established that transportation in Kenya accounts for 40 % of the costs of doing business [23]. Working with the estimated cost of congestion per day, the overall cost of investing in an efficient network would save the city at least US$120 million per year, which can significantly improve the city's economic standing both locally and internationally. These costs are too expensive for the city and are largely unstainable. In its path to smart economic development, Nairobi needs to invest more in expanding its transportation modes, as well as in policies to promote non-motorized and mass public transport.

25.4.1   Road Transport

The high-traffic congestion in the city is a result of poor urban planning that has not allocated sufficient land to streets, and a radial kind of development for which all routes converge in the city centre. Nairobi allocates only 11.5 % of land to streets (LAS) in the city core and has an intersection density of 36 intersections/km^2, against a recommended LAS of more than 20 % and intersection density of 100 intersections/km^2 for a properly functioning city [47]. Compounding the problem are the city's narrow streets that are mostly designed for cars. Based on distribution of population density and the axis of location of most work and residential areas, the city's transport network paints a picture of an unequal city. The general lack of a reliable mass transit system in the city further increases this challenge and results in massive economic losses.

In addition to the unequal street distribution pattern, Kenya's two main international roads, classified as class "A" roads form the city of Nairobi's major arterial streets which carry most traffic during the rush hours. The first international road, the Northern corridor which connects Kenya's port city of Mombasa to Uganda and Tanzania forms the major arterial street of Mombasa Road, Uhuru Highway, Chiromo Road, Waiyaki Way and Naivasha Road. The second road, Thika Road, begins at the Nairobi city centre and links the capital to Thika Town to the northeast and connects further to Ethiopia (Fig. 25.2). This pattern in interconnection has resulted in massive inflow of unnecessary traffic through Nairobi's city centre, causing huge traffic congestion.

Over the last decade, the government of Kenya, through donor funding and loans, has invested in some key missing links/bypasses within the city of Nairobi, with an aim to improve traffic flow and improve connectivity. Millions of dollars have been invested in improving the road and railway networks passing through the city. Although the effect on traffic congestion has been marginal, there has been a significant increase in connectivity. Construction of the Nairobi–Thika Super Highway, as well as the Eastern, Northern and Southern bypasses constitute some
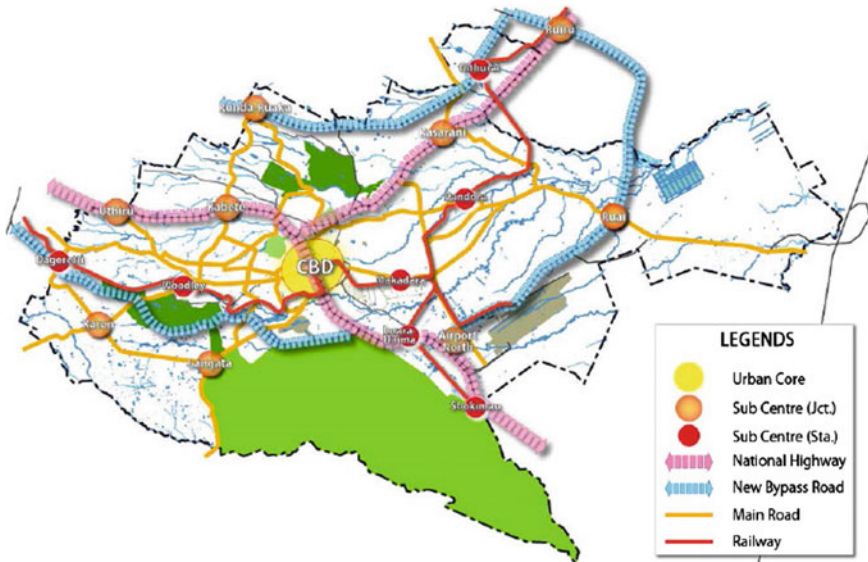
Fig. 25.2 Major roads in Nairobi. *Source* [48]

of the greatest infrastructure development achievements by the government of Kenya in the last decade. Major road improvements in Nairobi are however barely undertaken; the existing roads are in poor conditions due to deferred maintenance; many major roads are narrow and do not allow for multimodal configurations; and most arterial streets have feeder roads joining them in many places causing disruption in traffic flow. Most roads lack pedestrian walk ways and where these sidewalks do exist, they are narrow and poorly developed. All these inefficiencies have a negative effect on the city's economy, both in terms of production and competitiveness. The existing scenarios are constraints that limit development of a smart city mobility, smart environment, smart living and limit development of a smart city economy.

To reduce traffic congestion in Nairobi, the Nairobi City County in 2014 initiated talks with Chinese automaker Foton for the financing and supply 266 buses as part of a long-term plan to acquire 2000 modern buses [49]. The deal, which was supposed to bring sanity to the city's public transport like several others before it, never saw the light of day due to massive opposition and lobbying from the private sector groups running the public transport system. Given that the most important trip in Nairobi—the trip to work—is dominated by privately operated matatus and buses (46.5 %) against a largely insignificant share using the railway network (less than 0.5 %) [48], much needs to be done to bring sanity to this kind of public transport, and ultimately give reliable alternatives for city residents.

25.4.2 Railway Transport

Nairobi is currently developing a mass rapid transit system under the Nairobi Commuter Rail Service (NCRS), which is being developed as part of Nairobi Metropolitan Transport Master Plan. The KSh 24 billion project, whose aim is to modernize and expand the under-utilized railway infrastructure and reduce the city's reliance on roads, is projected to reduce congestion and create an efficient and affordable mass rapid transit transport system for the city. It will integrate rail transport with the road and air transport modes [50] (Fig. 25.3).

The project is being implemented in three phases and is aimed at increasing passenger capacity from 5 to 15 million, and ultimately to 60 million passengers. The plan includes modernizing the track infrastructure, creating new modern stations and lines, and upgrading of the rolling stock. Since 2009, various achievements have been made towards achieving this goal, with the construction of three functional stations (Syokimau, Imara Daima and Makadara), construction of a 2 km line connecting the Syokimau station to the old line at Embakasi (and subsequently the CBD), and introduction of new passenger trains to the network [50]. The new stations are now better integrating bus stations with rail transport for effective transport. It is believed that at completion, the project will create both economic and social benefits to Nairobi by providing a dependable transport service that reduces
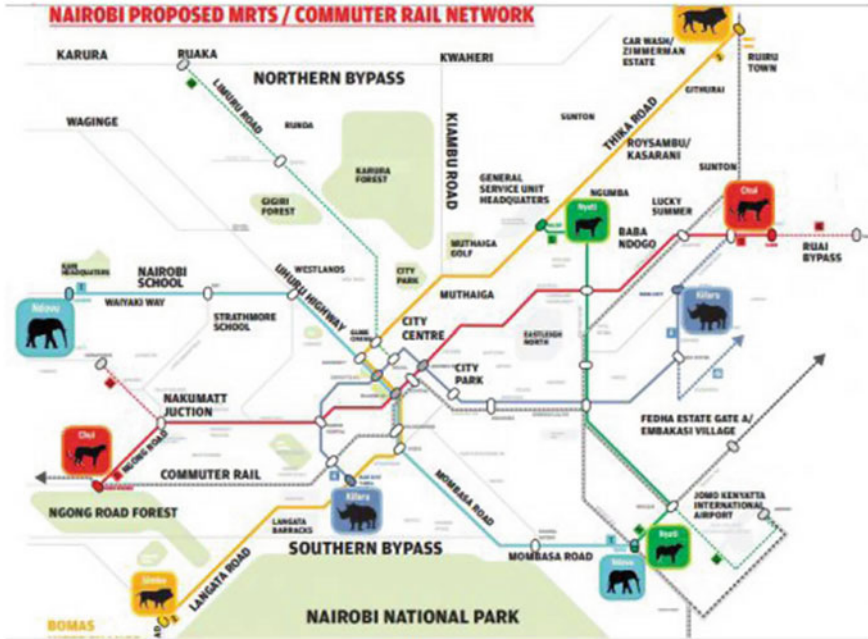
Fig. 25.3 Nairobi commuter rail service plan. *Source* [51]

travel time, creates employment opportunities, and facilitates a development environment for transit-oriented housing developments (which may benefit lower income groups in the city). The improved transport efficiency will also open new parts of the city to development and improve property competitiveness throughout the region.

25.4.3   Air Transport

Air transport, which is headquartered in Nairobi with two airports, the Jomo Kenyatta International Airport (JKIA) and Wilson Airport, is perhaps the most well-developed transport sector in Kenya. In 2014, air transport and its support services contributed about 0.3 % to the GDP [22]. JKIA, located about 15 km to the South–East of the Nairobi CBD is Kenya's largest aviation facility and the busiest airport in East Africa. The airport serves a daily average of 19,000 Passengers from Africa, Europe and Asia [52]. The airport, which was designed and constructed in 1978 serves as a hub for most airlines operations in the Eastern Africa region. Its operating capacity has increased from the about 2.5 million passengers per year it was designed to serve to over 6 million passengers per year currently. The number of flights handled at the airport has also increased by almost 45 % in 7 years, and the airport handles over 72,700 aircrafts per year, a number that is predicted to grow further to over 195,000 aircrafts per year by 2030. Equally, the cargo handling capacity has increased by over 50,000 tons over the last years to an estimated average 252,000 which is an increase of over 50,000 tons over the last 7 years [53].

The national carrier, Kenya Airways, has a network of 63 direct or connecting passenger destinations [54], greatly linking the city of Nairobi to many international capitals and hugely enhancing competitiveness. One of the terminals under the ongoing Nairobi Commuter Rail Service will be located at the Jomo Kenyatta International Airport, improving linkage between air and road transport within the city. In early 2016, the airport got category one status after audit by the International Civil Aviation Organization on the Kenya Civil Aviation Authority and Kenya Airports Authority [55]. This has brought closer the country's long-term dream of having direct flights to the United States of America, an achievement which would open immense opportunities for economic growth and collaboration in other growth sectors.

To handle the increased aircraft and passenger traffic and accommodate future growth, Kenya Airports Authority, under the guidelines provided by the National Airports Master Plan 1993 and the Kenya Vision 2030 strategy for growth is expanding the terminal facilities, renovating the existing runway and plans are underway to construct a second runway. Ongoing construction of a new Greenfields Terminal with a floor areas of 178,000 m^2 on four levels is expected to increase the capacity of the airport from the current 6 million passengers per year to about 18.5 million passengers annually by the year 2030 [53].

The increased capacity of passenger and cargo handling will create more linkages between Nairobi and other global cities, creating numerous chances for economic development.

25.4.4 ICT Integration in the Transport Sector for Increased Efficiency

Although it is difficult to achieve maximum efficiency in the road transport sector within the prevailing operational arrangements in Nairobi, there are ongoing efforts aimed at integrating ICTs into the city's transport systems. Currently, the major ICT integration in the public transport system is an ongoing exercise to adopt cashless payment system for bus and railway trips. Although not fully operational, particularly in the road transport system where the proposed systems have been opposed by the private operators, use of cards has been adopted in the railway transport system where digital gates have been installed.

On the city roads, digital traffic lights with timers and traffic cameras (Fig. 25.4) have also been installed, although their full operationalization has not been achieved due to the city's complicated traffic flow pattern and road user behaviour for which motorists and pedestrians do not obey traffic rules.

ICT has also been adopted in access to transport services such as renewal of driving licences, which can now be done through an online portal. In places outside the city such as border points, ICT has been incorporated into the transport sector to improve efficiency and monitoring through single window clearing systems. ICT has also been fully incorporated in the air transport sub-sector. Passengers are able to book flights online, buy tickets online, change flights and receive email or text message notifications on their flight schedules. Within the airport, check-in machines have been installed, reducing the length of queues and greatly easing the check-in process.

Fig. 25.4 Digital street light (*left*) and traffic/security cameras in Nairobi streets. *Source* Author

25.5   Conclusion

Investment in infrastructure plays many roles; it affects both the production cycle and income improvement down to the household level. A city that invests properly in development of transport networks will also create a proper baseline for development of other basic services, such as a water, sanitation and drainage. This improves access to such services by poor households and also reduces household expenditures on basic services and reduces risks associated with inadequate basic service access. With better transport comes more connectivity and expanded opportunities for all parts of the city; with improvement in telecommunication comes wider collaboration and markets for products; with improved electricity supply comes increased productivity, lengthened operating hours and more secure neighbourhoods. Improved productivity leads to more jobs and better incomes, all of which ultimately create the right baseline conditions for economic growth, access to other related services, poverty reduction, and inclusive urban growth.

Nairobi has made substantial improvements in development of its infrastructure, and the ICT sector has enjoyed a huge growth in the last two decades. A fast growing human capital with ICT training from a young age will add to the growing ICT-related innovations. The continued incorporation of ICT into other economic sectors such as transport and energy will also contribute to Nairobi's growth as a smart city.

To enjoy the benefits created by the expanding ICT market and innovation, Kenya, however, needs to invest more in developing its energy and transport services, which complement ICT at the production chain and increase its uptake at the household level. The challenge to such development is projected to be lack of funding.

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Chapter 26
Social Development and Security for Smart Economic Development

**Robert Ndugwa, Romanus Opiyo, Dennis Mwaniki
and Omondi Odhiambo**

Abstract A city's future sustainable growth and prosperity depends upon its investment in education, health, peace, security and other social capital stocks. Successful cities create a peaceful and secure environment for investment and encourage high human capital development through well-educated and healthy citizens; such cities report lower levels of inequalities and poverty. Advances in information and communication technologies in the past few decades have enabled globalization, which is itself associated with urban growth and development. Recent studies have, however, also noted that globalization is making cities vulnerable in new ways, especially by opening them up to destructive networks that undermine security and development. Therefore, smart cities must continuously make efforts to raise the competencies and quality of its citizens and thereby improving its competitiveness, increasing innovations and overcoming other challenges such as unemployment, insecurity and lawlessness. This chapter highlights the enormous efforts that Nairobi city has made in addressing and improving its safety and the social capital of its citizens through investments in technological advancements in health, education and security services as part of its developmental pathway to achieving a smart city status. The chapter discusses insights, challenges and opportunities presented by Nairobi's demographic dividend, its growing human capital and improving security status alongside its emerging economic opportunities, which together are expected to turn the city into a globally competitive and smart city.

Keywords Health · Education · Smart city · Smart economy · Nairobi · Globalization · Urban security

R. Ndugwa (✉) · R. Opiyo · D. Mwaniki · O. Odhiambo
Global Observatory linking Research to Action, Nairobi, Kenya
e-mail: ndug2000@gmail.com

R. Opiyo
e-mail: romanop2000@gmail.com

D. Mwaniki
e-mail: dmwaniki@gora4people.org

O. Odhiambo
e-mail: odhiambo@gora4people.org

26.1   Introduction

A city's smart social development agenda should focus on improving the well-being of every individual in the city and ensure that their rights are protected and that they can reach their full potential in a safe and secure environment. The prosperity of a city is linked to the well-being and safety of each and every citizen. Therefore, achieving social development in the city requires continuous investment in the people and residents of the city. It requires the removal of barriers so that all city residents can work towards the achievement of their dreams with confidence and dignity. In any city, social development is about refusing to accept that people who live in poverty will always be poor and working to ensure that services are provided to people to help them move forward on their path to self-sufficiency and grow, or develop their own skills and contribute to their families and communities in a meaningful way. This compels a city as a duty bearer to create opportunities for city residents that guarantee reliable security, good health, education and skills development that will prepare the city workforce to be able to make a decent wage and meet their basic needs.

For any smart city, education systems of the current and next generations must deploy the latest technologies and also ensure that learning starts early in life. By investing in early learning initiatives, we can ensure a greater degree of success and increased opportunities for our citizens. Making sure that children get a good start in their education goes a long way to increase their success later in life. A city with good social development infrastructure, quality institutions and security provides a nurturing environment for the young ones to develop and achieve their full potential. When employers have good and high-quality breed of employees, their enterprises are more likely to succeed or innovate. When enterprises succeed, the economic situation of a city is improved. Hence, an investment today in a quality city health or education system can provide many long-term economic benefits for the city, including lowering inequalities, breaking social barriers and reducing the overall petty crime rates.

In this chapter, we explore the social development opportunities that make Nairobi a smart city. Specifically, we examine the status, challenges and opportunities of the nexus of health, and education sectors and the role they play in creating a peaceful and secure city which is responsive to ideals of a smart city.

26.2   Health at the Centre of the City's Smartness

Urban health has several meanings ranging from the health of the urban settlements in terms of how well it functions as a community and as an ecosystem or the health of the human population that lives within the urban ecosystem, and also encompasses governance, the institutions and processes through which societies manage the course of health events that affect them [1]. In some cases, urban health is used

to refer to the urban health care or health care system. Elsewhere, the urban health concept integrates the notion of health cities where the intention is on health promotion which is out of the streets, and addresses more of the everyday life and health needs of the population and participation in the decision-making processes that affect their health. So the notion of healthy cities is mostly about the process which touches on governance, health promotion, health systems, etc. that aims to achieve health equity and inclusiveness especially for the poor. But what exactly is a healthy smart city? To fully understand this notion, one needs to breakdown further the urban ecosystem. This mostly refers to the governance systems and the built environment and how these interact with the social, economic, cultural, safety and political environments, regions, humans and other biota and behaviours.

Our world and the entire ecosystem are urbanizing rapidly and whereas there are evident regional differences, living conditions are deteriorating in many cities. If one compares sub-Saharan African region with the fully developed world, it is evident that the developed world is nearly 70–80 % urbanized compared to the 41 % average for sub-Saharan African (SSA). But the rate of urbanization, measured as the average annual rate of change of the percentage urban, is highest in Asia and Africa, where currently the proportion urban is increasing by 1.5 and 1.1 % per annum, respectively. Interestingly, in SSA, citizens spend 20 % of their time indoors compared to nearly 90 % among the developed world citizens, with 5 % of time spent in cars [2]. So in the developed world, the built environment is the natural habitat while in SSA this is not the case. But with growing urbanization, this will certainly be the case several years from now. The above trends show some variations in urbanization measures; however, all humans live on a planet which is within one natural ecosystem, and as a result we are all subject to the same global and bioregional changes in the ecosystem of health. For humans, the predominant form of community in the twenty-first century is the city—we are now more urbanized—making the city the dominant ecosystem for humans. The smart health city concept should aim to achieve a good balance in maximization of the benefits of keeping good health in cities for all residents, while offering the best urbanized ecosystems. It should also strive for creation of certain preconditions such as a peaceful and secure environment, access to information, possibilities, mechanisms and opportunities that can better the city residents' health outcomes [3]. Nairobi being an international hub faces several global security health challenges that have great potential for affecting the critical role of the city if its level of preparedness for and response to serious health incidents that are cross-border in nature are not up to international standards. These challenges pose a risk of destabilizing its security, economies and social cohesion.

However, the fact that we interact as social animals means that the city is in health promotion terms, a setting where both the physical place and the social space are constantly changing. Cities exist as part of local bioregions and global ecosystems, or regional, national and global economies, or ethno-racial and natural cultures and systems of values and politics [4]. Ultimately, human development and human security are very interconnected and closely linked to the production

capacity of the ecosystems in which we live. Our future urban social sustainability thus lies on the continued viability of these ecosystems in which we live.

A failing city ecosystem manifests in the health of the population in terms of their physical and mental well-being including the distribution of the health across the various segments of the community (equity), or the resultant mortality and morbidity outcomes, and life expectancy. Sometimes the failures emerge as a surge in the prevalence of non-communicable diseases such as diabetes, cancer, etc. Smart cities are those that work on delivering the health needs of the populations by integrating the social capital, natural capital, economic capital and human capital in delivering healthy city populations. When these aspects are well managed and functional, all the sectors of the city economy benefit including the health and life insurance companies, tourism and recreation industries, sports and fitness industries, etc. since the productivity of the city employees would be ranked highly. Hence, the main determinants of a functioning health city include good governance, information sharing, peace, food security, high levels of human capital (educated population), shelter, education, stable ecosystem, sustainable resources, and social justice and equity. A healthy smart city population is more productive and contributes to higher household earnings, better livelihoods and higher levels of innovations and economic growth for the nation.

26.2.1 Good Health Fosters Smart Social Development and Smart Economic Growth

There are increasing concerns that current "urban lifestyles" practices among populations in many cities such as Nairobi, particularly the poor-quality diet and sedentary behaviour, lead to increases in the prevalence of chronic illnesses and health disparities which are socially and geographically patterned. The poor and the most vulnerable tend to be more affected as they have few opportunities to choose or change their environment. Systematic review evidence derived from cross-sectional or longitudinal studies have identified components of the built environment associated with physical inactivity, dietary intake, violence, obesity and increased risk factors for certain diseases and mental health [5, 6]. For example, lack of sidewalks, distance to school or public open spaces, and density and availability of healthy food sources are correlated with poorer physical health behaviours and outcomes [7, 8]. Worse mental health outcomes have been documented to be associated with exposure to violence or crime in selected city neighbourhood [9]. In Nairobi, crime and violence are much higher among the poor slum neighbourhoods than in non-slum city environs. Although adaption of the built environment to overcome these factors may have the potential to improve health outcomes, robust interventions are required to reduce the impacts of some of these known risk factors.

In Kenya, health is increasingly included as an important goal of national development and is well documented in the national development blue print—Kenya vision 2030 as a means of achieving sustainable development and increasing the productivity of the population. As a result, Kenya's health sector reforms are based on a holistic view of the health sector and targets the linkages between different institutional actors in the health sector and addresses linkages across different functional areas of reform action. Nairobi city relies on the national health strategies and national health reforms to achieve its health development targets and goals. Kenya's national health sector comprises the public system, with major players including the Ministry of Health (MOH) and parastatal organizations, and the private sector, which includes private for-profit, non-governmental organisations (NGO), and faith-based organisation (FBO) health facilities. Health services are provided through a network of over 4700 health facilities countrywide, with the public sector system accounting for about 51 % of these facilities. The public health system consists of the following levels of health facilities: national referral hospitals, provincial general hospitals, district hospitals, health centres and dispensaries. National referral hospitals are at the apex of the health care system, providing sophisticated and smart health diagnostic services, including therapeutic and rehabilitative services. The two national referral hospitals are Kenyatta National Hospital located in Nairobi and Moi Referral and Teaching Hospital in Eldoret. The equivalent private referral hospitals are Nairobi Hospital and Aga Khan Hospital both located in Nairobi city. Provincial hospitals act as referral hospitals to their district hospitals. They also provide very specialized care including availability of smart health diagnostic services. The provincial level acts as an intermediary between the national central level and the districts hospitals.

26.2.2 Energy Sources and Health

Clean energy sources play a key role in ensuring smart health cities. Kenya has a liberalized energy sector and has made significant progress in the recent past in formulation of renewable energy policies. Most importantly, Kenya's and Nairobi's electricity power mix sources are among the most sustainable and clean in the world, with 80 % of electricity coming from renewable sources [10]. However, a substantial proportion of national renewable energy resources are yet to be exploited. Of the potential renewable sources, Kenya has harnessed only about 30 % of its hydropower sources, approximately 4 % of the potential geothermal resources and much smaller proportions of proven wind and solar power potentials. Furthermore, a large potential exists for the development of biomass-based energy such as biogas and biodiesel and power generation form bagasse that remains from the sugar production processes. As an importer of petroleum fuels, Kenya spends a

substantial amount of foreign reserves to import oil. Oil imports consumed 55 % of the country's foreign exchange earnings from exports in 2014 [10]. On the other hand, there is a high dependence on wood biomass energy, leading to an imbalance in its supply and demand. This has exerted considerable pressure on the remaining forest and vegetation stocks, thereby accelerating the processes of land degradation. Moreover, despite the abundance of potential and a strong growth in demand for electricity, the country faces constraints in satisfying electricity demand. At the national level, only 18 % of the households have access to grid electricity. The access is much lower in rural areas where only 4 % of the households have grid electricity.

Harmful emissions of particulate pollution levels from automobiles are slowly increasing due to the large increases in the number of cars on Nairobi streets, coupled with a lack of effective transport and land use planning and traffic congestion. Fine particulate matter ($PM_{2.5}$), generated by fuel combustion from motor vehicles, is linked to a wide range of health effects, including more than 800,000 deaths in cities around the world [11]. There are many sources of air pollution in Nairobi, including open air burning of refuse and biomass, industrial operations and domestic cooking fires, but motor vehicles play a leading role in the emissions problem and this is made worse by a high prevalence of old, poorly maintained vehicles alongside availability of low-quality fuels. According to a 2004 KNBS survey, the mixture of vehicles in Nairobi was 29 % passenger cars, 35 % light-duty trucks, 7 % heavy-duty trucks, 7 % minibuses (Matatus) and 22 % others, but by 2006, the number of trucks had increased by 60 % reflecting increased activities in the agricultural and industrial sectors [12]. Most trucks and buses rely on high sulphur diesel fuel (≤ 5000 ppm S) which leads to high particulate emissions which makes it reasonable to assume that if nothing is done, urban air quality will continue to worsen in Nairobi.

26.2.3 Remarkable Progress in Health Care Transforms Nairobi Towards a Smart City

The Kenya Expanded Programme of Immunization (KEPI) under the Ministry of Health is aimed at ensuring that all children are fully immunized by their first birthday. In Kenya, children should receive one dose of tuberculosis vaccine (BCG); three doses of the vaccine against diphtheria, pertussis, tetanus, hepatitis B and Haemophilus influenza b (DPT-HepB-Hib, or pentavalent); three doses of polio vaccine (OPV); and one dose of measles vaccine. However, only 68 % of children aged 12–23 months have received all these immunizations, compared with the KEPI target of 80 % (KDHS 2014). In Nairobi, this figure is 60 as per the 2014 Kenya Demographic and Health Survey (KDHS) findings. About 89 % of women

in Nairobi are able to deliver in a health facility, with an almost equivalent proportion having assisted delivery with a skilled service provider; this is in contrast to about 62 % nationally. In Nairobi, access to antenatal care is almost 98 % compared to 96 % in other parts of the country (national level). Acute respiratory infection (ARI), malaria and dehydration caused by severe diarrhoea remain major causes of child morbidity and mortality in Kenya. The prevalence of these three diseases that affect the well-being of children's lives in Nairobi is 15.6 % for diarrhoea, 5.9 % ARI and 19 % fever. The prevalence of fever is 24 % nationally. The proportion of children with fever for whom advice or treatment was sought in Nairobi is 67 % versus 72 % nationally. The proportion of those who sought advice or treatment for diarrhoea is 57.4 % for Nairobi and 57.6 nationally. Safe disposal of children's stools is a good marker of good household hygiene. In Nairobi, 75 % of households practise safe disposal of children's stools compared to 83 % nationally. These results indicate remarkably that living in Nairobi provides the opportunities of having close proximity to better health care facilities, but this does not translate into access or good utilization of the city-based health facilities for some of the services, and this is more so among the poor residents of the city.

Malnutrition is an underlying factor in about 70 % of the illnesses that cause death among children under five. The KDHS 2014 found that about a third of all children less than five years in Kenya are stunted or too short for their age. Specifically, 26 % were stunted, 8 % were severely stunted and 11 % were underweight. In Nairobi 17 % are stunted and 4 % are underweight, which is an indication of better nutritional outcomes for the capital as compared to the national average.

26.2.4   Significant Decline in Infant and Child Mortality Rates

Kenya's infant mortality rate (IMR) was estimated in 2014 at 39 deaths per 1000 live births in the five years preceding the survey, while under-five mortality rate was estimated at 52 deaths per 1000 live births. This represents a remarkable decline from the figures observed in 2008/9 KDHS: infant mortality rate was 52 per 1000 and under-five mortality rate was 74 per 1000. Considering the trends in the last 15 years, the infant mortality has significantly decreased from 77 per 1000 in 2003 to 39 per 1000 in 2014, while the under-five mortality has also declined from 115 per 1000 to 52 per 1000. The declines in mortality are also evident in many other regions of the country, albeit with varying levels of the rate of decline. In Nairobi, infant mortality rate was estimated in 2014 at 55 per 1000 live births and under-five mortality estimated as 72 per 1000. This represents a decline in the IMR from 60 per 1000 last estimated in 2008/9, and an increase in the U5MR from 64 per 1000

that was observed in 2008/9. Nairobi has a significant poor and slum-resident population whose access to some of the key health interventions and facilities remains limited and many other health outcomes are worse for this slum population than other regions of Kenya as a whole. Results from a 2014 cross-sectional slum survey conducted in selected slums in Nairobi estimated the U5MR at 80 per 1000 [13]. Overall, excluding people living in Nairobi slums, other city populations tend to have a better life expectancy which is estimated at 61 years. In Kenya, increasing life expectancy and decreasing childhood mortality rates in the last 15 years have been associated with several interventions. Substantial increases in immunization coverage at national and regional levels have been documented, alongside increased health facility deliveries and access to antenatal and postnatal care and use of iron supplements during pregnancy (KDHS 2008/9). In addition, there has been a remarkable improvement in household access to improved sources of drinking water and improved sanitation [14]. Finally, there were improvements in key malaria indicators, including ownership and use of treated mosquito nets, preventive treatment of malaria during pregnancy, and treatment of childhood fever [15]. There is no doubt that the observed health improvements are contributing to the Nairobi health city smartness. The counts of quality health facilities and services available in Nairobi are unmatched with other regions of the country despite the limitations as who is able to access or afford such facilities. With a growing middle class and increasing interventions geared towards the reduction in income and health inequalities in the capital, there is no doubt that the effects of urbanization on smart health outcomes will begin to work for all.

26.2.5 The Role of Health Development Plans in Building a Smart City

To improve the overall livelihood of citizens, Kenya aspires to provide an efficient integrated and high-quality affordable health care system and this is laid out in the health sector strategic plan which has, as its vision, "having a globally competitive, healthy and productive nation". The plan has, as its goal, "accelerating attainment of health impact goals" as defined in the Health Policy. The mission of this strategic plan is "to deliberately build progressive, responsive and sustainable technologically driven, evidence-based and client-centred health system for accelerated attainment of highest standard of health to all Kenyans". In this set-up, priority is given to preventive care at community and household level, through a decentralized national health care system. With devolution of funds and decision-making to county level, the Ministry headquarters now concentrates on policy and research issues, while counties such as Nairobi are involved in the day-to-day delivery of health services. Improved access to health care for all is being achieved through: (i) provision of a robust health infrastructure network countrywide; (ii) improving the quality of health service delivery to the highest standards; (iii) promotion of partnerships with the private sector; (iv) providing access to those excluded from

health care for financial or other reasons. At the centre of this is Nairobi County that works as a model and leader in health services provisions. This county is home to the leading and technologically advanced medical schools, and national referral (Kenyatta National Hospital) and private referral hospitals (Nairobi hospital, MP Shah Hospital, Agha Khan Hospitals, etc.). With the support of the private sector, Nairobi is increasingly becoming the regional provider of choice for highly specialized health care, thus opening Kenya to "health tourism".

In Kenya, the medical human resource staffing distribution remains skewed overall, with some areas of the country facing significant gaps while others have optimum/surplus numbers. Nairobi has a significantly higher number of medical personnel compared to many other counties and cities in Kenya. A staffing norm has been defined for each level or health service, to outline the minimum health workers, by cadre, needed to assure provision of the Kenya Essential Package for Health plan. It should be emphasized that this only defines the minimum that the sector will work towards ensuring equitable distribution of human resources for health. At the Nairobi County level, there are several ongoing initiatives aimed at improving the supply and quality of health services such as construction and rehabilitation of health infrastructure, e.g. the Pumwani Women hospital to increase its hospital bed space, and strengthening the community outreach and health promotion approaches; better remuneration of the health staff; recruitment of skilled health personnel; and promotion of generic drugs. This also includes improvements in the performance in the prevention and management of chronic diseases. Nairobi city is also part of a network of cities that have signed on to the HIV/AIDS fast-track cities initiative that aims to end the AIDS epidemic as a public health threat by 2030. This includes embracing a series of fast-track targets for 2020, including ensuring that 90 % of people living with HIV in Nairobi know their status, 90 % of people who know their HIV-positive status receive treatment and 90 % of people on treatment should have suppressed viral loads. For now, Nairobi has a stable HIV prevalence with the level estimated at 6 %, although this prevalence remains slightly higher among women, and special interest groups such as sex workers and men who sleep with men. Comprehensive knowledge about AIDS ranges from 67 % among women to 74 % among men for Nairobi County.

On the disease prevention strategies, more emphasis is being placed on hygiene and promotion of healthy eating habits. Also other public–private partnerships in the construction and operation of health infrastructures and pooling of resources and risks are being encouraged, and this is expected to culminate in the creation of a "Nairobi Medical city". Good governance is key for the building a good foundation and establishment of a smart Nairobi health city. Governance and good leadership are expected to influence improvement of the efficiency and effectiveness of public spending on health and strengthening of the medical monitoring and information management systems.

26.2.6 Smart City and Universal Access to Health Care

Increasing demand for health care along with inadequate funding for existing needs support the need for continued increases in financing for health. According to the most recent national health accounts (2013/14), the country was spending approximately 5.4 % of its GDP on health (equivalent to 42.2 US$ per capita), with government health expenditure equivalent to only 4.6 of general government expenditures. The government health expenditures have been between 4 and 7 % of total government expenditures, which is under half of the Abuja declaration target of 15 % and the economic recovery strategy (ERS) target of 12 % of total government allocations. Nearly 63.3 % of total health expenditure is funded publicly, including external (donor) support and health insurance, the latter being responsible for 11 % of total health expenditure. The remaining 36.7 % is funded privately, with out-of-pocket payments at the point of service being predominant. Private health insurance is limited. According to the latest 2014 KDHS survey, 63 % of all men in Nairobi don't have any form of health insurance compared to 78 % of men nationally. Among Nairobi women, 72 % don't have any form of health insurance, compared to 82 % of women nationally [15]. The accessibility of health care and insurance is restricted to the few who can afford them, and is largely inaccessible for the poor residents of Nairobi where less than 4 % of the slum residents have any form of health insurance or social benefits that can support various kinds of medical emergencies. Nairobi and Kenya as a whole will be able to sustain and improve on the achievements made towards the attainment of the Millennium Development Goals if the Kenya health sector embraces e-Health. E-Health improves the use of information and communications technologies to support the delivery of services and management of health systems. The devolved government structures pose some new challenges in ensuring equity in health such as what is being witnessed in Nairobi, and technology provides an opportunity to bridge these gaps. Technology can be used to support affordable and timely health insurance schemes, community health savings programmes, private insurance mobile applications including reimbursement issues and venture capital and investment opportunities. Training of health workforce through e-Learning, e-Solutions-supported supervision, job aids access on mobile technology, automation of registration and licensing application and renewal for personnel are some of the many opportunities that technology will enhance and that will lower the cost of delivering quality health. Already, Nairobi city is at the centre of leading on some of these most innovative e-health initiatives and solutions.

In Nairobi, a sizeable number of beneficiaries from the vulnerable and most poor communities are covered by social protection mechanisms especially orphans, disabled and vulnerable children from the poor neighbourhoods and slum areas. Disbursements are electronically facilitated and performance is monitored routinely and electronically to ensure proper implementation and achievement of better outcomes to the rightful beneficiaries. This social protection mechanism was pioneered in Nairobi city and has now been extended to other parts of the country.

26.2.7 Increased Improvement on Traditional Environmental Diseases and Other Mortality Causes

Selected features of the physical environment are vital to keep urban areas free from certain disease outbreaks. These include access to safe drinking water, drainage systems, sanitation, garbage collection, air pollution, noise pollution, etc. From a health perspective, these features are key as they control the pathways of pathogens and vectors associated with infectious and parasitic diseases. Over centuries, we have documented that for many urban areas, improvements in the conditions of water, garbage removal and sanitation led to significant reductions in mortality and morbidity from many infectious diseases [16]. Unlike many other parts of Kenya, Nairobi is less affected by malaria transmissions. Numerous studies have shown that while several Nairobi outpatients report fever with a suspicion of malaria, repeated laboratory checks shows that less than 1 % turn out to be positive for malaria. It is common practice therefore not to treat any suspected fevers among children in Nairobi with anti-malaria drugs. Even among pregnant, women only less than 7 % receive intermittent preventive treatment for malaria, compared to nearly 30 % of all pregnant women nationally (KDHS 2014). The absence of active malaria transmission in Nairobi is a key attraction to many international visitors as well as investors (Table 26.1).

Unintentional injuries are a common occurrence in many urban areas. In Kenya, fatalities as a result of road traffic accidents increased by nearly sixfold between 1962 and 1992 [18]. A study carried out in two slums of Nairobi revealed that injuries contributed about 18 % of the burden of disease measured as life years lost due to premature death (YLL), with injuries ranking second to HIV/AIDS as a cause of death among individuals aged 5 years and above [19]. According to the latest KDHS, the prevalence of unintentional injuries in Nairobi is close to 20 % for both men and women. Nationally, this prevalence is close to 33 % for men and 20 % for women. Other studies conducted in Nairobi slums have shown that violence-related deaths are more common than road traffic accidents, and intentional injuries that account for 51 % are as common as unintentional ones (49 %) [20]. Recent data have shown that the prevalence of physical violence remains high nationally and in Nairobi County. Close to 54 % of women in Nairobi report having experienced a form of physical violence versus 34 % among men.

Similarly, maternal mortality ratio is estimated at 360 deaths per 100,000 live births in Kenya [20]. In Nairobi, as in most other developing country cities, the vast majority of maternal deaths take place during child birth and the immediate 24 h following delivery. Most maternal deaths are attributable to just a few direct causes: haemorrhage, hypertension, sepsis and unsafe abortion. Virtually all of these conditions can be prevented or managed by basic healthcare services, including quality antenatal care, safe and clean delivery practices, and access to emergency referral facilities when needed. Similarly, neonatal mortality is closely related to the skills of health professionals who provide care during and after delivery: a clean environment, effective resuscitation if required, keeping the baby warm, and taking

Table 26.1 Selected indicators for health in Nairobi and Kenya as a whole

Variables	Men		Women	
	Nairobi	All	Nairobi	All
Proportion of women who have had a cervical cancer examination			23.6	13.8
Proportion of men/women involved in physical activity that increases their heart rate for at least 10 min	14.8	17.0	4.6	11.6
Unintentional injury (%)	19.2	33.4	20	19.7
Experienced physical violence since age 15 (%)	33.5	44.0	53.9	44.8
Percentage of pregnant women who received 1 or more doses of SP/Fansidar, i.e. (Intermittent preventive treatment for malaria) %			6.3	29.5
Percentage with a comprehensive knowledge about AIDS	73.8	65.9	66.7	56.3

Source [17]

proper care of the umbilical cord are some of the other key essential practices. Young mothers living in slums are identified as particularly vulnerable to maternal mortality risks due to a lack of basic health services and inability to pay related obstetric costs. Some findings have shown substantial limitations in access to antenatal care in urban slums as compared to the overall population in urban Nairobi.

Despite its high performance in access to health care, the city of Nairobi is severely haunted by its weak city foundation characterized by poor urban infrastructure in selected areas, and limitations in the provision of basic services. There are several areas such as slums and low-income residential areas which are unplanned with high-level population densities (more than 60,000 inhabitants per square km), built in flood-prone areas combined with multiple deprivation of basic infrastructure. Among the poor neighbourhoods, access to quality clean water is limited, despite significant investments in the expansion of the water infrastructure to keep pace with population growth of the city, and the more recent reduction in water losses from illegal connections. In many of the poor residential settlements, the sewerage systems are also non-existent, leaving a significant proportion of the population exposed to water-borne diseases. This has prompted the Kenyan water sector to consider significant reforms including considering the establishment of commercially orientated water and sewerage companies with asset-owning water services boards. Most utilities have established informal settlement departments to manage service delivery in low-income areas, but these units often have limited resources. In Nairobi, the construction of communal sanitation blocks with an improved management structure and with a possibility of connecting these blocks to the sewerage network is ongoing. This model is also being extended to include household or compound latrines, through collaborations with Nairobi City Water and Sewerage Company (NCWSC) that is undertaking a mapping of demand and facilitating the latrine upgrading and connection process.

It is possible to reduce the risk of diarrhoeal diseases among un-served and underserved populations by moving them from community water sources (improved or unimproved) to piped water on premises, even when the piped supply is not necessarily providing microbiologically safe or continuous service. Improved operator training and certification has also been shown to lead to significant improvements in the operation of a piped water system, including an increase in measurable free chlorine residual, and significant health benefits [21]. Combined sanitation with effective hand washing with soap or other agents, quality household water treatment combined with safe storage, can provide significant protection against diarrhoea and create a safe environment that enhances health of the city population.

26.2.8 Modern Environment Diseases Substitute to Traditional Environmental Diseases

Cities such as Nairobi are themselves a major contributor to the emerging challenges of environmental change in urban areas. Cities consume an enormous share of the national energy and emit large amounts of carbon dioxide annually. At the same time, they are heavily vulnerable to climate change and are increasingly exposed to climate-induced risks (including floods from rising sea levels and higher precipitation, destruction from stronger storms, and periods of extreme heat and cold, disease outbreaks). The phenomenon of urbanization itself is also increasingly being altered by environmentally induced migrations especially rural to urban migration. The impact of all these environmental changes is manifested in hikes in several diseases prevalence in urban areas. These modern environmental diseases appear to impede declines in morbidity and mortality rates in urban areas. Primary causes include changing urban lifestyles attenuated by increases in use of motorized means of transport that offer less physical exercises, environmental water pollution from populated areas and industry, urban air pollution from automobiles, etc. Kenya, just like many other countries, is undergoing an epidemiological transition characterized by an increase in non-communicable diseases, obesity, and other conditions associated with urbanization and modern, less active lifestyles. Due to lack of public transport, Nairobi is haunted by motorized traffic dominated by old buses; floods are repeatedly reported in major low lands of the city such as slums including clogging major roads and pathways during the rainy seasons. These environmental mini-disasters have had adverse effects on the prevalence of communicable and non-communicable diseases. Non-communicable diseases are estimated to account for 27 % of all deaths in Kenya. The corresponding figure for Nairobi is in the range for 30–40 %. As a result, cardiovascular diseases have become a serious public health problem and are now the second leading cause of death after diarrhoea, and pneumonia in health facilities in Nairobi. Cardiovascular diseases have been long neglected, given the magnitude of communicable diseases,

but increasingly the country and Nairobi city are stepping up the interventions to address some of the emerging disease challenges through health promotion and increased awareness. Nationally and in Nairobi County, about 25 and 37 % of women aged 15–49 have performed a breast self-examination, and 14 and 21 % have had a doctor or health provider perform a breast examination, respectively. Nationally, about two-thirds (65 %) of men have heard of prostate cancer, but only 3 % have been examined by a doctor or a health care provider for prostate cancer. In Nairobi County, 66 % of men know about prostate cancer, but only 4 % have been examined by a health care worker.

Strong associations between biofuel exposure and increased incidences of chronic bronchitis in women and acute respiratory infections in children have been documented in the country. In Kenya, there is a comprehensive choice of fuels used for cooking ranging from electricity, biogas, charcoal, wood, etc. Nationally, 75 % of households use solid fuels, mostly wood (56 %) and charcoal (17 %). In Nairobi, the main sources of cooking fuel are LPG, paraffin and charcoal, and these account for close to 75 % of cooking fuels in the county.

The fight against childhood diseases and other emerging adult diseases should go beyond the traditional environment of diseases which is the household, to the so-called modern environment of diseases—outdoor pollution, climate change, etc. It must be at the city foundation level as well as incorporating the strategies at the infrastructure development and designs stages. At the infrastructure development, this will go with the promotion of public transport in order to reduce emission of CO_2 and other outdoor pollutions. Streets that promote walkability and cycling as elements of an active lifestyle contribute to healthy living, as well as reduction in vehicle emissions. Many important quality-of-life benefits also arise when streets promote non-motorized transport. Increased outdoor activity and reduced air pollution translate into better public health in reducing heart diseases associated with obesity, high blood pressure and diabetes which are now common diseases among the middle class and the richest families in cities.

26.3 Investing in Education Creates Smart, Innovative and Productive People and Promotes Sustainable Smart City Economy

The right to education has been universally recognized since the 1948 Universal Declaration of Human Rights and is enshrined in various international conventions including the Convention on the Rights of a Child (CRC) (Articles 28 and 29), national constitutions and development plans [22]. The right to education as defined by these instruments calls for: universal access to free and compulsory primary education and universal availability/accessibility of secondary education, through the progressive introduction of free education; and equal access to higher education on the basis of capacity and by the progressive introduction of free education.

Education is not only a fundamental human right, but is very essential for the exercising and achieving many other human rights.

Quality education plays a crucial role in creating smart cities and smart people. A good education in any city is the key to achieve prosperity, people empowerment and a stronger economy. For each year of school completed, a person's earnings and employability level will increase by nearly 10 % [23]. Other evidence has shown that women with higher levels of education have healthier children, thereby improving the overall human development index of a nation.

Over the last decade, the world has witnessed incredible increases in school enrolment confirming the central role that education plays in developing nations and cities. Smart cities invest in building the educational needs for developing the human resources' quality of its people, in addition to attracting the best human resources to work in its city. A skilled and educated workforce is increasingly vital to a city's innovative abilities and economic sustainability. Even when city officials do not play a direct role in governing the school systems within their jurisdictions, there are numerous ways in which they can exercise leadership to support establishment of quality education, or develop and expand alternatives for their populations to develop and acquire various skills.

Kenya has had numerous shifts in the education system, mostly affected by changes in political dispensations and influenced by policies implemented by various political regimes to boost educational attainment. By the time Kenya obtained its independence in 1963, only a few thousands of Kenyans of African descent had any form of education. Since then many governments have made efforts to revamp the educational attendance and attainment of the citizens, and this was later reinforced by the global Millennium Development Goals that encouraged government to work towards achieving some targets for education. In this regard, focus on increasing primary school enrolment became key on the agenda with policies such as the free compulsory basic education and capitation grant alongside others. These educational reforms yielded several positive gains as the country currently has more than 75 % completion rate in primary education and about 60 % for secondary school. Gross enrolment increased to 94 % in primary school and 77 % for secondary schools by 2011 [24].

Cities with healthy, skilled, educated populations, low levels of crime and corruption, higher discretionary income, regulatory stability and predictable commercial environments are beacons for talent, business and investment. Such cities offer their citizens greater promise and opportunities than cities without these characteristics [25]. The full enjoyment and maximum utilization of a city's physical infrastructure (e.g. ICT, transport, energy) in turn depends on the city's ability to improve its business climate, invest in people's education skills development and health, and promote good governance [26]. In turn, the ability to access health and education depends on the availability of health and education facilities, as well as transport infrastructure; utility services to a large extent determine housing quality; and information technology affects the ability to participate in society—all components cumulatively contribute to improved access, economic opportunities and social inclusion [27].

Table 26.2 Human development index trends in Kenya 1990–2014

HDI rank	Country	Human development index (HDI) Value							Average annual HDI growth (%)			
		1990	2000	2010	2011	2012	2013	2014	1990–2000	2000–2010	2010–2014	1990–2014
145	Kenya	0.473	0.447	0.529	0.535	0.539	0.544	0.548	−0.58	1.70	0.92	0.62

Source [28]

The Human Development Index (HDI) as a measure of average achievement in key dimensions of human development (health, education, standard of living) is a good indicator of the level of development in knowledge and smart people. Ranked 145th globally, Kenya has a HDI of 0.548 which is an improvement from the 0.447 level recorded in 2000. This represents a shift from negative annual HDI growth recorded at −0.58 between 1990 and 2000 to a growth of 0.92 between 2010 and 2014 (Table 26.2).

The education sub-index has consistently been the highest sub-component of the HDI in Kenya since the 1990s, with good performance credited to an increase in the education indicators such as increased public expenditure on education as a percentage of the GDP, increased gross enrolment ratio, pupil-to-teacher ratio, percentage of trained teachers, among other indicators. The public expenditure on education as a percentage of GDP was 6.7 % between the period 2002 and 2005, and declined slightly to 6.6 % between 2005 and 2014 [28, 29]. Given that the country's GDP at market prices (current US$) increased from 13.1 Billion US$ in 2002 to 60.9 Billion US$ in 2014 [30], the public expenditure on education in Kenya has more than quadrupled between 2002 and 2014. Youth literacy has in turn increased from 80.3 % recorded between 2000 and 2005 to 82.4 % between 2005 and 2013 [28, 29].

In Kenya, the County Development Index (CDI) is a variation of the HDI computed as a national average using nine indicators, and four component indices of poverty, infrastructure, health and education. CDI was developed by the Commission on Revenue Allocation to determine the level of marginalization of different counties and in turn determines the proportional distribution of national resources by the central government. Nairobi's calculated CDI is 0.7663 [31], which is both higher than the national CDI of 0.5204 and higher than all the other counties. Although the education sub-index for Nairobi is lowest among the measured items (0.5790), it is higher than the national level of 0.3935 [31] and the second best among Kenya's 47 counties (Fig. 26.1).

The attainment of a smart city, and in turn an empowered human capital (smart people) that can generate diverse opportunities for smart growth, etc., depends on many variables, key among them is the investment in the availability of quality education facilities. In a socially segregated city like Nairobi, access to education facilities and their related benefits depends on among other factors the socio-economic setting of a household and their spatial location which affects or determines access. For example, whereas public primary and secondary schools are somehow fairly distributed throughout the city (particularly in traditional formal
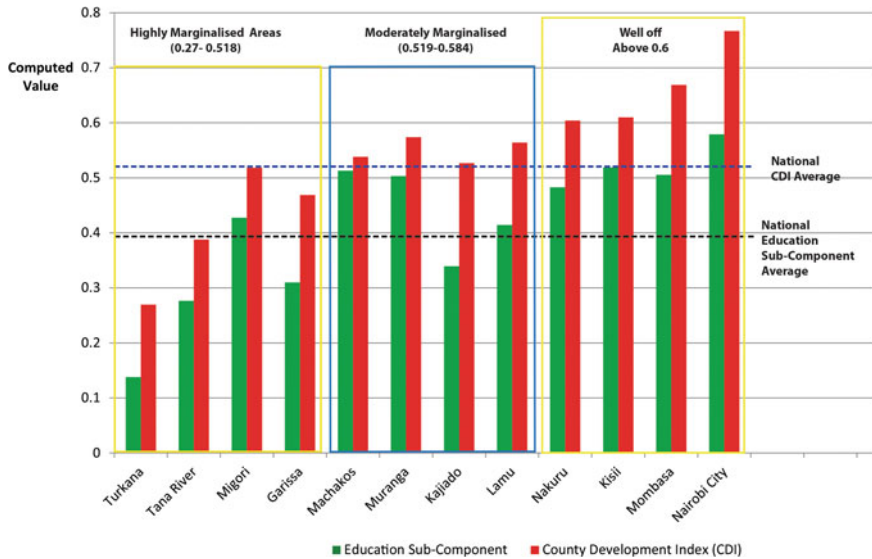
Fig. 26.1 CDI for select counties in Kenya. *Data source* [31] (Kenya has 47 counties designed to decentralize power from the central government since 2013. The county is the highest political unit after the central government and is headed by a governor)

growth areas), the level of services, accessibility, capacity to handle varying populations and thus quality of education vary among settlements. In the unplanned and informal settlements for which development was not anticipated after 1963 when the city started to experience uncontrolled growth, very few public schools existed and those that existed were less equipped to cater for the education needs of the large number of kids willing to attend school. Privately owned schools exist to cover the shortfalls in education needs from the public schools in many parts across the Nairobi city. Private schools tend to be more equipped and organized, with regular attendance of classes by teachers, but this comes at a slightly higher cost than the publicly available schools especially following the introduction of free primary education in 2003. The free primary education schools report more teacher absenteeism, and the performance of kids from such schools is very poor compared to other private schools. Figure 26.2 shows the distribution of primary and secondary schools in Nairobi against the population density.

The spatial distribution of schools against population illustrates three key points

1. There are more private schools than public schools in Nairobi, although public schools are known to have more student-to-teacher ratios compared to private school.
2. Although public schools are spatially distributed throughout the city, their numbers are not commensurate with the population density in various parts of the city.
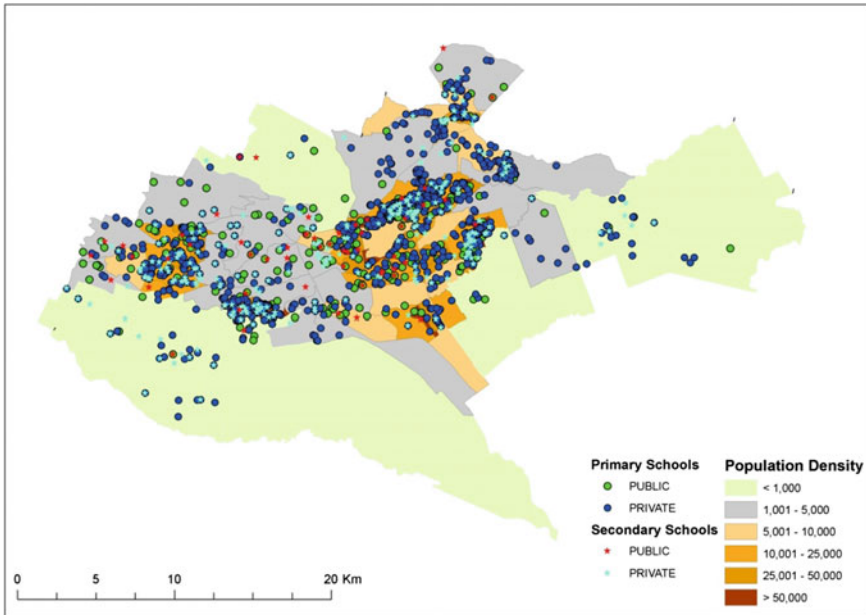
Fig. 26.2 Distribution of primary and secondary schools in Nairobi. *Source* Authors 2016. *Data sources* [32, 33]

3. Although private schools are more than public schools in all parts of the city, the private school densities (number of private schools per square kilometre) are highest in the poor- and low-income neighbourhoods, which also exhibit the highest population densities. For example, private primary school density in the Mathare North poor- to low-income ward is 101.4 (population density 119,053.1) compared to a private school density of 0.3 in Karen which is a middle- to high-income area (Population density 466.8) (Table 26.3).

The kind of private schools also differ significantly between the poor-, low- and middle-income neighbourhoods to those in the middle- to high-income areas with the latter having well-equipped facilities. The availability of fewer secondary schools (both private and public) in the poor- and low-income areas also negatively affects the primary to secondary school transition since most parents cannot afford to take their children to far off schools for which they will not only need to cater for the high fees but also pay more for the bus transport for their children. This has resulted in differential levels of school completion, which vary based on both closeness of primary and secondary schools as well as on the family socio-economic status. A good example of this differential is between Korogocho ward and Kileleshwa ward in Nairobi city. Whereas Korogocho ward has a total of 37 primary schools, it only has two privately run secondary schools as compared with Kileleshwa's 6 secondary schools. This low level of secondary school availability, coupled with the low economic status in the Korogocho ward, has resulted in having a very low rate of transition from primary to

Table 26.3 Schools density versus population density for select wards in Nairobi

Ward name and settlement type	Total population	Area (Km²)	Population density	Total No. of schools	No. of private schools	No. of public schools	Private school density	Public school density
Mathare North (P-LI)	55,158	0.463	119,053	48	47	1	101.4	2.2
Korogocho (P-LI)	41,946	0.892	47,017	37	33	4	37	4.5
Serangombe (P)	54,347	1.035	52,485	36	34	2	32.8	1.9
Umoja II (LI-MI)	53,666	1.657	32,378	12	9	3	5.4	1.8
Kilimani (MI)	43,122	16.0506	26,867	36	26	10	1.6	0.6
Kileleshwa (MI-HI)	27,202	9.0337	3011	8	6	2	0.7	0.2
Kitisuru (UMI-HI)	31,242	21.291	1467	13	7	6	0.3	0.3
Karen (UMI-HI)	33,303	71.342	467	24	21	3	0.3	0.04

Source Author calculations based on data from [32, 33]

P-LI poor to low income; *P* poor; *L-MI* low to middle income; *MI* middle income; *MI-HI* middle to high income; *UMI-HI* upper-middle income to high income

secondary education as indicated by the 23 % of residents with secondary plus education against 59.9 % of residents with only primary school education. In contrast, 71 % of Kileleshwa residents have a secondary or higher education level and only 22.2 % have primary school education [34]. Although out migration of the more educated residents from the ward may be a cause for the low levels of secondary or higher education attainment in Korogocho, a few number of secondary schools and the low-income status among the parents of this ward contribute significantly to the low primary to secondary transition. In Kileleshwa, parents are not only able to take advantage of higher number of secondary schools within the ward, but are also able to pay for education in the many institutions surrounding the ward and even outside the city.

Similar to many other cities in the developing world, the poor quality of education or form of marginalization seen in some pockets of Nairobi city affects a significant proportion of the urban poor and this directly affects the right to education from being realized. The findings of the National Assessment System for Monitoring Learning Achievement report [35] for Kenya point out a number of significant relationships between school level factors and learning achievement indicating that the quality of education needs greater improvement. For example, children from smaller class sizes which are usually found in private schools performed better, as well as pupils who had their own textbook or shared with only one other pupil. Inequalities were also observed in the availability of both qualified teachers and textbooks between cities and wards, and in pupil–teacher ratios. Wards covered by informal settlements or those near informal settlements exhibit the largest shortage of teachers and the highest pupil–teacher ratios. Within Nairobi, key factors that contribute to the slow improvement in access to quality education include a weak Education Management Information System (EMIS) combined with frequent natural and man-made disasters disrupting children's schooling, rising cost of living, low political commitment to ensure equity in resource allocation, and a backlog of cumulative historical inequalities. One of the specific capacity gaps identified in the city level is the lack of guidelines on costing of pre-primary classes, which leads to inequalities in the costs incurred.

Policymakers interested in fighting crime often focus on enforcement and punishment; yet, recent research suggests that other policy mechanisms can also be effective. This review focuses on growing international evidence that suggests that policies designed to increase educational attainment and improve school quality can significantly reduce crime rates [36]. Studies have emphasized the role of education as a human capital investment that increases future legitimate work opportunities, which discourages participation in crime. If human capital raises the marginal returns from work more than crime, then human capital investment and schooling should reduce crime. Thus, policies that increase schooling (or the efficiency of schooling) should reduce most types of street crime among adults; however, certain types of white collar crime (e.g. embezzlement, fraud) may increase with education if they sufficiently reward skills learnt in school [37].

In summary, a more educated city resident increases the productivity gain of a city compared to a resident with no education. This phenomenon has resulted in

policy initiatives at increasing education in developing countries where productivity is generally low. The next generations will be technologically driven, which requires city and national governments to invest massively to build the core and required ICT skills (supply side) that matches the demands of the emerging Nairobi smart city. Infrastructure developments, provision of learning materials and supply of well-qualified teachers are important for enhancing the quality of education. It is also important to note that education attainment can lead to reduction in violent crime which is a big threat to peace, stability and progress which reduces the smartness of a city.

26.4 The Demographic Dividend—An Opportunity for Smart Economic Growth

A demographic dividend is "the potential economic growth that can result from shifts in a population's age structure, mainly when the share of the working-age population (15–64) is larger than the non-working-age share of the population (14 and younger, and 65 and older)". In other words, it is "a boost in economic productivity that occurs when there are growing numbers of people in the work-force relative to the number of dependents". A country with both increasing numbers of young people and declining fertility has the potential to reap a demo-graphic dividend. Family planning is critical in attaining the Kenya vision 2030 goal of improved quality of life, and sets the stage for the demographic dividend for Kenya and Nairobi County. Family planning has a large effect on fertility, through lowering it to fewer children per woman, thereby balancing Kenya's age structure, and increasing the working-age population to close to 70 % of the total population. If this is paralleled with investments in education, this would generate a skilled workforce, raise incomes and improve economic development for the country and cities. In addition, if investments are made in domestic industries and technology, labour and financial markets are improved, and public institutions are strengthened, then GDP per capita will be more than 12 times higher by 2050, and this would ensure that nearly 90 % of the working-age population will be employed. This situation will be defined as reaping the demographic dividend. As described above, this will require sustained investments in contraceptive prevalence to increase it 70 %, fertility will need to decline to 2.1 children per woman to ensure a reduced dependency ratio, and average years of completed education will need to rise from 6 to 11 years among adults. With nearly 90 % of the working-age population employed, GDP per capita will increase from the current $900 to $11,300. According to the most recent KDHS survey, fertility continued to decrease from 4.9 births per woman in 2003 to 4.6 in 2008–09 and further to 3.9 in 2014, representing a one-child decline over the past 10 years. This is accompanied by a marked increase in the national contraceptive prevalence rate (CPR) from 46 % in 2008–09 to 58 % in 2014, which is 12 % points away from the ideal 70 % required for

moving towards a demographic dividend. As of 2014, Nairobi County had a contraceptive prevalence rate of 63 % which is closer to the ideal target.

With a median age of 24, Nairobi's population is predominantly young (See age pyramid) and there are a sizeable young people aged 20–30 years old, corresponding with a decrease in the dependency ratio. This represents a potential for cut spending on dependents and can spur economic growth marking a possibility of a demographic dividend for the capital city. In Nairobi, the period of the demographic dividend is also marked by an increase in age of first marriage meaning that young people are staying longer at school and being equipped with knowledge and skills before transitioning to parenthood. Young people also enjoy better health and increased access to family planning allowing them to delay their reproduction and/or to have fewer children. Unemployment rates in Nairobi range from 24 to 40 %, and youth unemployment is slightly higher making them more dependent on their parents and other family support networks. Majority of young people in Nairobi are employed in the informal sector, with unemployment being higher in poor urban neighbourhoods such as slums. This worsens the dependency ratio leading to increased urban poverty among families with no workers, married couple families with one breadwinner and families with more children. Also, women face lower wages and fewer job opportunities due to discrimination and are more likely to be unemployed and income poor in Nairobi (Fig. 26.3).
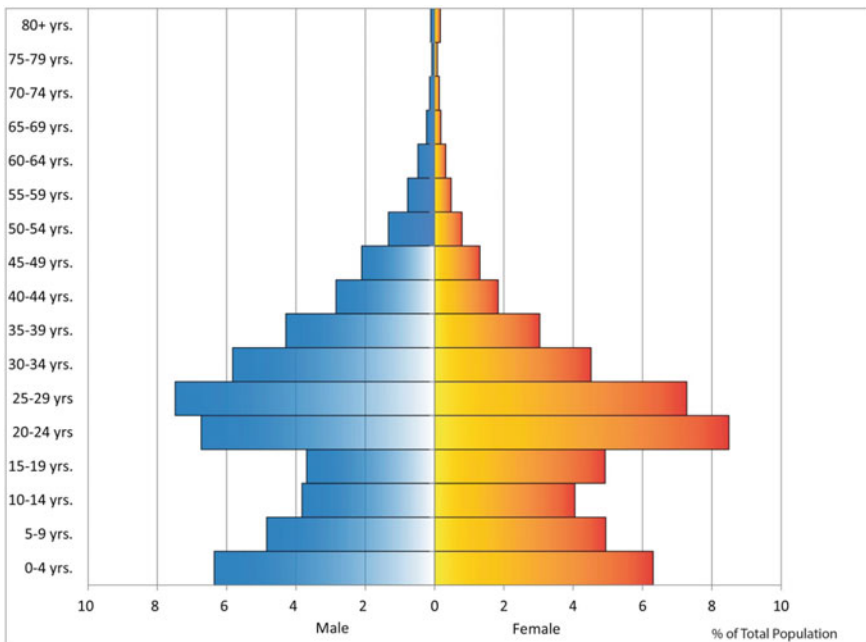
Fig. 26.3 Population distribution by age in Nairobi. *Source* Computations based on data from [32]

Population size and other demographic factors such as age and gender have been related to urban security. Cities with large population create anonymity and ready markets for stolen goods, while young male residents have higher propensity of engaging in crime and female are easy target of violent crime.

26.5   Peace and Security Boosts Smart Economic Development

Cities and urban areas generally have from time immemorial been viewed as the epitome of an advancing civilization; however, crime and insecurity is becoming a major threat to the peace and good ideals associated with urban areas. In the context of smart philosophy, crime and insecurity not only threatens peace and peaceful coexistence in the city, but also has serious implications on social and economic development due to the instability it generates. Crime ranks as one of the major inhibitors to investment on the Africa continent, and those countries with higher rates of violent crime tend to make less progress in reducing poverty and expanding development [38]. As more people choose to live in town and cites, the quality of the urban environment becomes increasingly important. These concerns bring out clearly the need to articulate security matters in cities in helping them achieve competitiveness, which is more critical for most African cities whose citizens are keen in making sustainable progress by improving the livability conditions and attraction of investors [39]. Nairobi city has been facing challenges of insecurity attributed to key components of the smart economy in smart city conceptual framework such as (a) urban planning which has exacerbated segregation which to a certain extent contributes to periodic ethnic tension during general elections period, (b) basic infrastructure which has contributed to dilapidated environment of hopelessness of broken windows principle of crime and (c) poor institutional governance which has slowed functions and capacities of institutions to spearhead smart development.

The security environment in Nairobi today faces many forms of crimes such as organized crimes, cybercrimes, terrorist threats; drug trafficking, money laundering, homicides, rape, defilement, robberies; and crimes involving officers. Escalating crime and insecurity in the city of Nairobi are hindering social and economic development in the city and severely eroding the city's reputation internationally [40].

The predicament of the growing insecurity in Nairobi is essentially a development crisis which threatens its smartness but which can be worked on in ensuring that the City attains the desired smartness.

Despite all these fundamental challenges in the security sector, the opportunities for attaining smart development in Nairobi are emerging given the modern technologies of surveillance and security provision for example the rapid expansion and accessibility of mobile communications technology in Africa which is creating new

opportunities for combating crime and strengthening police accountability. Twitter, SMS and event-mapping technologies are being used to connect communities with police and security forces as never before [38]. In addressing peaceful inter-communal coexistence in slums, the District Peace Committees (DPCs) have been formed. These committees have established Conflict Early Warning (CEWARN) system as well as a Conflict Early Response Unit (CEWARU) to help in detection and response to inter-communal conflict in Nairobi slums [41]. Mobile phones play an important role in detection and prevention of violence. Nairobi therefore, as one of the major ICT hubs in Africa, has great potential for tapping into its potential in relation to other efforts of planning for the city, existing legal and institutional and more important goodwill of the City County Government of Nairobi to embrace positive change in ensuring attainment of inclusivity and competitiveness which are key ingredients of smart economies in smart cities.

26.5.1 Nairobi's Crime and Insecurity Patterns Affect Economic Development Variedly

Since its independence in 1963, Kenya was considered to be among the most stable and peaceful democracies in the continent, and a prosperous economy [42]. This state of affairs has changed and more so in Nairobi as shown by various reports indicating urban security is one of the major concerns among urban dwellers and investors within Nairobi [43]. In Nairobi, bank raids, carjacking, muggings and armed robberies had become routine for almost a decade that led to the United Nations to downgrade Nairobi as a hardship post for its staff from a B-station to a C-station in January 2001 and later upgraded to B-station status in 2010. Apart from boasting the busiest airport in the East and Central Africa region and being home to several diplomatic missions, Nairobi is a host to the headquarters of United Nations Environment Program (UNEP) and the UN Center for Human Settlement (UN—Habitat).

One of the big challenges for documentation of Kenya's crime status is the reliability of the crime statistics. In a context of widespread corruption, political manipulation, weak police oversight and a variety of organizational inefficiencies, crime recording practices invariably remain inaccurate [44]. This is further compounded by the limited reporting of crimes by victims. Nevertheless, police reports are still seen as the most authoritative sources of crime data and hence are widely used for policy formulation and designing crime response mechanisms.

Nairobi contributes more than 10 % of crime in Kenya despite covering only 0.1 % of the total surface of Kenya and hosting up to 8 % of the country's total population based on 2009 census [45]. The annual rate of city population growth correlates positively with homicide rate. Nairobi crime statistics in 2012 was 9259 out of 77,852, 8929 out of 71,832 in 2013 and finally 7288 out of 69,376 in 2014. From the chart below, the highest contribution in the 3-year period was in 2013 at

12.4 % in the year 2013 which dropped marginally to 10.5 % in year 2014. This may not necessarily imply that the crime is reducing, but can be related to underreporting of crime or displacement of crime to other areas due to installation of security devices such as CCTVs in Nairobi. The findings support World Bank (2010) reports which noted that crime and violence in Kenya are concentrated in Nairobi and other large urban centres.

Causes of crime are complex, but it is widely accepted that environmental factors can play a part as argued by those agitating for crime prevention through environmental design (CPTED), which is related to how city foundation and design determines some socio-economic features of a place. Different crime typologies have different causes with impacts attributable to gender and age dimensions. In Nairobi, for instance, women cited drug and alcohol abuse, refusal to have sex, and engagement in extramarital affairs as the main causes of domestic violence. A group of adult men in one of the Nairobi communities considered violence against women a legitimate cultural way of disciplining married women [43]. Unemployment and idleness can be a cause of concern with regard to looking for alternative and illegal ways of eking out a living and pointed out engaging in crime as one of the possible ways of engaging their bubbling energies [46]. In Nairobi, the youth unemployment rate is high and accounts for 46 % of the total unemployed population. As a result, youths tend to spend long periods of idleness in their communities and are easily lured into criminal activities [47]. In a context of deep inequality, high patterns of crime and violence, and widespread impunity, normal patterns of competition with peers and neighbours can also degenerate into violence. Other demographic and social factors relevant to explain the current levels of crime and violence include changes in family and household structures, and gender norms, which along with the abuse of alcohol and drugs undermine social cohesion and are associated with growing violence [43]. Nairobi's informal settlement areas are balkanized largely along tribal lines and specific ethnic groups are dominant in specific areas within the slums, and this at times is a challenge to peaceful coexistence. Inequalities and economic marginalization, often viewed in ethno-geographic terms, were also very much at play in the 2007 post-election violence in places like the slum areas of Nairobi.

Drivers of insecurity and crime in Nairobi are complex based on the crime typologies discussed ranging from theft to terrorism, and the causes may be attributed to lack of economic opportunities for the youths, political rivalry, religious intolerance, corruption and primitive cultural practices. The causes therefore call for accommodative and open approaches to reducing of crime, if at all the city is to reach the desired status of smartness which will be able to unlock the potential of the city to create more employment opportunities and to practice tolerance among and within Nairobi city residents.

The Kenya police services have gone ahead to list some of the crime hot spots in Nairobi which they consider as a threat to security as shown in Fig. 26.4. The areas listed as hot spots are populous and are common areas of residence, industrial and commercial activities. From the police analysis of these areas, it is clear that they attract all manner of crime including violent crime and peddling of crime. This is

consistent with the victim of crime survey undertaken in Nairobi under the auspices of UN Habitat safer city Nairobi, which found that key crime in Nairobi that require attention is violent crime, given that 37 % of all Nairobi residents had been a victim of robbery, 18 % had been a victim of assault and that 29 and 30 % of all homes and commercial enterprises had fallen victims. The most unique findings in the 2002 survey were that most burglary happens on Friday and Saturday showing that people being at home are not a deterrent [48]. Some areas such as Kibera Soweto and Kamukunji's Mlango-Kubwa among others are busy almost twenty four (24) hours but are still crime hot spots which negates the security principle of "*more eyes translates to more security*". The hot spots are what crime experts describe as in a status of *broken window*, and they are unkempt and in desolate state and give an impression of lack of care and concern which touches both on the physical state and governance of urban spaces. Since some of the spots are shared public spaces, their zoning cannot directly be linked with their observed insecurity.

Another emerging challenge contributing to insecurity in Nairobi is terrorism and gangs formation especially in informal settlements and during electioneering years. According to Kenya Police 2014 annual report, suspected Al-Shabaab militias posed security threats with incidents of grenade attacks, improvised explosive devices (IEDs) and shootings witnessed particularly at major urban centres and public roads, i.e. Nairobi, Mombasa, Garissa, Mandera and Wajir [49]. In Nairobi, the Westgate Mall terror attack on September 21, 2013, is the most recent serious terror incidence where the Somali terror group Al-Shabaab, an affiliate of al Qaeda, claimed responsibility for the bloody four-day siege at the upscale mall in Nairobi [50].

Nairobi has seen the emergence of several youth gangs, such as the *Taliban, Kamjesh, Mungiki and Siafu*. These gangs are organized along ethnic and political lines and operate in and control specific areas in the city's informal settlements and slums. Their activities appear to range from extorting money from residents in the so-called protection rackets to muggings, robbery and other violent crime to providing de facto rule of law. The gangs are more feared than the police in low-income settlements, and their threats are taken seriously by the residents [46].

Kenya's post-election period in 2007 and 2008 also brought in a unique negative character which is a threat to making the city attractive to investors. According to the popular Justice Waki[1] report, brutal accounts of sexual violence during the post-election period in 2007 are highlighted including a note that more than 900 women were treated for rape and other brutal acts in Nairobi. The report also highlights that 75 % of women were raped in their homes in front of their family

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[1]The Waki Report was commissioned by the Commission of Inquiry into Post-Election Violence (CIPEV) to investigate the facts and circumstances surrounding the violence during the post-national elections period in the end of 2007.
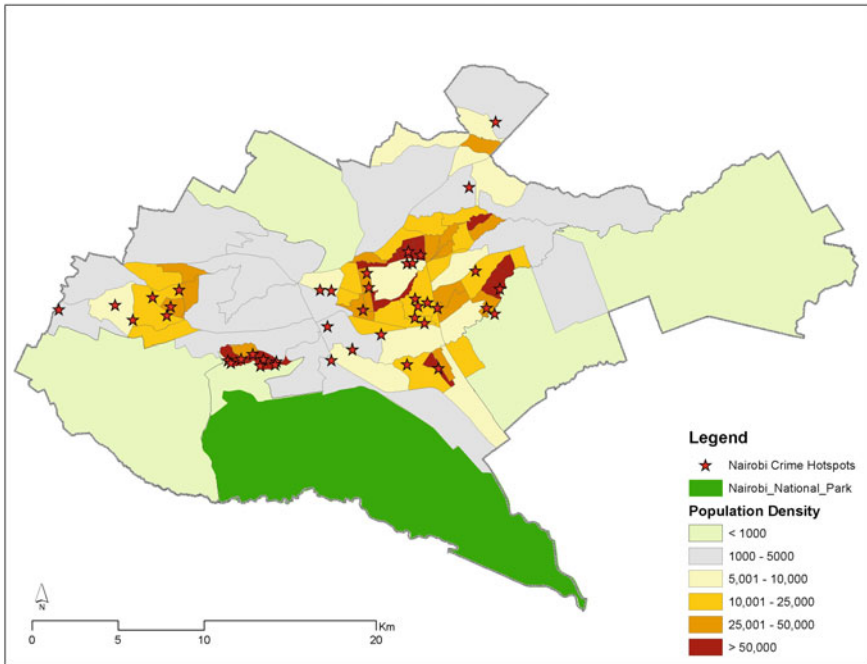
Fig. 26.4 Nairobi crime hot spots. *Source* Author representation of data from [49]

and that many of the youths involved in the 2007 post-election violence in Kenya were unemployed. The post-election violence (PEV) witnessed in 2007 and 2008 eroded trust among neighbours especially in most of Nairobi slums which has serious implications as noted by Pouligny (2006)

> When violence permeates daily life, people often experience trauma, and they begin to change their habits. They may limit their mobility or their investment in business enterprises for fear of victimization. They also may stop practicing different forms of solidarity if they do not feel safe doing so [51].

The crime and insecurity status of Nairobi as supported by the statistics and various reports cannot be seen as unique to Nairobi alone, cities such as Johannesburg report high serious crime figures, but the government and other players have come in handy to invest heavily in the security sector including CCTV installations in a bid to contain crime and attract investors which has worked well to a certain extent. Since security is an ingredient of good governance and sustainable development, this should motivate and encourage Kenyan Government, Nairobi County Government and other key players to focus on how crime can be prevented or reduced as part of the goals to the attainment of smart economy and smart city status.

26.5.2   Crime and Insecurity Inhibits Nairobi's Smart Economic Development

Inadequate security threatens peace and impacts the economy negatively as it impedes economic growth and investment [52]. Residents and investors shun away from investing their quality time and resources in cities that are crime-ridden and insecure. Studies and reports have pointed at the following as implications of insecurity which in this section is argued to be a threat to smartness [53];

(a) **Short working Hours:** Security risk affects performance of firms through various channels. Some firms lose sales or face low turnover due to reduced demand/market scope which is partly attributed to limited hours of doing business.

(b) **Reduced market penetration:** Firms also lose sales due to inability to distribute the products. It is this feeling that has translated into user-initiated transformations that are now manifesting as physical security.

(c) **Higher Operation Overheads:** The competitiveness of firms is also lost due to either high prices of products in an effort to cover the costs of providing individual security or the disincentive to invest in technology that would see the products attain a competitive quality.

(d) **Disincentive to Investors:** Security risk also affects firm investment decision. For example, firms may refuse to undertake heavy and new investments especially if they are irreversible. Firms may also take the option to wait pushing investment to the unknown future.

(e) **Increased Cost of Capital:** Insecurity also increases the cost of capital by raising the risk premium tagged on financial capital. Old firms find access to financial capital now dearer with shorter repayment schedules because of the insecurity. New entrants into the market may also be discouraged. Thus, to private firms, insecurity means no business growth, and for economy, no employment creation and poverty reduction.

(f) **High Insurance Premium:** Lately, the cost of insuring businesses has escalated because of the high risks associated with insecurity in some areas. The scope has been complicated further with security firms themselves working with felons to carry out criminal activities.

In assessing its performance in relation to insecurity, Nairobi City County noted that during this period, the sector experienced decreased performance owing to a number of factors. This included insecurity mainly associated with terror attacks, adverse travel advisories and continued spread of Ebola in West African countries. As a consequence, the tourism earnings decreased by 7.3 % from Ksh 94.0 billion in 2013 to Ksh 87.1 Billion in 2014 (US$94.0 million and US$87.1 million, respectively, at 2016 exchange rate of I US$ for Kshs. 100). This was attributed to a decrease of 11.1 % in the number of international visitor arrivals over the same period mainly due to adverse negative travel advisories by key source markets [54].

26.5.3 Smart Systems Are Contributing to Improved Security and Enhanced Economic Productivity

The police are the most visible manifestation of government authority responsible for public security in any country. While being under enormous pressure by both state and non-state actors to counter the increasing wave of crime and the new threats to national security, including those emanating from terrorism, the police have the highest responsibility in addressing crime in any country. Kenya has witnessed numerous reforms geared towards improvement of security. This is driven by the national government since security is not a devolved function. The reforms are geared towards ensuring that the police operate within the law but remain more responsive to the security challenges the country is facing. Police reforms across the world have been seen as a consistent with goals of modern policing initiatives [55].

Various efforts have been put by the national and county governments and indeed various stakeholders including residents in an attempt to reduce insecurity and criminal activities in the city of Nairobi. Some of the notable efforts include:

1. **Community Policing**
   Community policing focuses on communities working with police in deterring crime. This has worked well in some areas, but due to suspicion between police and citizens it is yet to pick up well in urban areas such as Nairobi. Some element of it is now operated as ten homes initiative "*nyumba kumi*" whose benefits are yet to be realized in Nairobi. This is an attempt at bringing in the people-centred and people-driven approaches in dealing with security and promoting peaceful coexistence in neighbourhoods and between police and civilians which is key in the achievement of smart city foundation and smart institutions, where citizens are not mere observers in matters and decisions affecting them.

2. **Installation of Closed-Circuit Televisions (CCTVs)**
   This has gained a lot of interest, and the Government of Kenya in partnering with the Nairobi City County Government has installed CCTVs along many highways and roads in the city. Individuals in residential and commercial enterprises have also installed CCTVs to deter crime. CCTV has helped in the reduction in crime at certain levels, e.g. domestic violence and in commercial areas, but the crime has not reduced in public spaces, e.g. on major highways or city streets. Their locations are also questionable since the government and county government have only located them along the highway, and apart from traffic-oriented crime most crimes happen far from highways. This adoption of ICT techniques in fighting crime is gaining popularity, and issues of twitter and tracking system are becoming useful tools for preventing and containing crime in cities such as Nairobi.

3. **Purchasing of Equipment and vehicles for Police**

   This is geared towards equipping security officers with modern equipment to enable address insecurity. More vehicles also increases police visibility, and this may be useful in tackling crime in Nairobi city.

4. **Screening of People and vehicles**

   This is an emerging feature of Nairobi security necessitated by the terrorist threats and attacks experienced in Nairobi. Observations show that it is becoming more of a routine exercise and it needs to be taken more seriously to deter terrorists from attacking innocent citizens and Nairobi residents generally.

5. **Training and hiring of more security officers**

   Security officers are trained on intelligence gathering and new and modern ways of dealing with insecurity to help them tackle insecurity in Nairobi and in Kenya. More number of security officers are hired to help Kenya attain the recommended UN ratio of 1 police for 450 people in a population (1:450).

6. **Hiring of Private Guards**

   This is common with institutions, private firms, high and middle income to provide security to their investments.

7. **Social Equality**

   Social equity is essential for peace; therefore, special efforts are needed to correct the existing inequality in education, access to services and living conditions [56]. Currently there are efforts by the County Government of Nairobi and central government to improve the living conditions of the poor living in slums through upgrading the electricity and water supply programmes.

26.6   Conclusion

Understanding the determinants of high unemployment and urban poverty and its impact on the well-being of family's social structures, food security, crime rates, etc. is essential in order to address the needs and inequities caused by urbanization in Nairobi. In Nairobi, a number of factors have been associated with urban poverty, crimes, unemployment and underemployment. Routinely there is a mismatch between the skills of the unemployed and the skill requirements of potential employers, resulting in a significant proportion of trained youth remaining unemployed for long periods, which easily tempts them to join crime rings as an alternative. This mismatch is more marked for school leavers and fresh graduates which partially explains the higher unemployment rate among younger people and new entrants into the job market in Kenya. As per the 2009 labour survey, there is also a gender bias in employment with 45 % of females aged 20–24 being unemployed. Despite the impressive double digit economic growth of 10 % per annum projected by the Kenya vision 2030, there is need for a large-scale job creation programme that will drive reductions in poverty and ensure that the benefits of the demographic dividend are well spread and shared equitably.

To bring about sustainable peace and security in the Nairobi slums must be based on sound analyses of the relevant group dynamics and the options for enlightened intervention. Above all, such interventions need a high level of dedication and preparedness to go beyond mere firefighting activities. Peace building is a socio-cultural engagement that requires patience, skill and material resources [41].

For urban areas in Kenya, the National Urban Development Policy (NUDP) was designed with the intention to guide the spatial allocation of resources and to serve as a framework for the governance and management of urban areas. As a critical guide for policymakers aligned with a devolved system of governance under the constitution, the policy focuses on: (i) supporting an urban system that equitably serves the whole country and addresses the historically neglected regions of the country; (ii) reversing the marginalization of sub-national governments through devolution, decentralization and reforming local governance and finance systems; (iii) introducing integrated land and environmental management practices that serve the demands of inclusive and sustainable urban development; (iv) addressing infrastructure and housing backlogs, and improving service delivery; (v) improving living conditions in informal settlements and opportunities for the residents; (vi) improving urban safety; and (vii) protecting the rights of vulnerable and marginalized groups.

Various studies show that Africa's young people will be the driving force behind economic prosperity in future decades, but only if policies and programmes are in place to enhance their opportunities. Nairobi County is a leading centre for testing new technologies, innovations and for acting as a learning centre for other counties to emulate. On the health front, there are numerous opportunities that the county can invest in and ensure a good health population for the city. There are numerous policy regimes, legislative and legal frameworks, and programmatic interventions that have been adopted by the county in the last four years aimed at the realization of better health outcomes for its citizens. Some of the health challenges identified fall on both sides of the duty bearers and health rights holders to ensure a progress realization of the right to good health for all. For example, individuals need to play their role in maintaining a good health and ensure that the risk factors leading to causes of certain illnesses are avoided, while the local authorities continue to invest in the protective measures such as provision of functional and well-resourced hospitals for the population.

The ability of the youth to adopt emerging technologies and transfer experiences from other parts of the world must be key drivers of Nairobi's smartness in the long term. It is also important to encourage young people's participation in public life, and in policies, programmes, and services that keep them away from crimes such as the national youth service programme. However, youthful population could also present a significant risk and threat to social cohesion and political stability if Nairobi fails to create sufficient economic and employment opportunities to support decent living conditions for them. Empowering young people starts by ensuring that the youth have solid foundational skills. By addressing these urgent education

issues, governments could ensure that youth have the basic skills to build on through further education or on-the-job experience.

Overall, Nairobi has made significant strides in improving the health, education and safety of its citizens, but for the urban poor some of these benefits remain a distant dream. Informing the city residents of both their own rights and ways in which they can control or improve their own health, education and safety status is vital to improving the overall city welling outcomes and the institutional governance of the cities. For example, improving city health care services requires the coordination of government priorities and community needs and ensures that this is well rooted in a communal vision that supports better outcomes for urban environment and quality of life for all city residents. There should also be regular periodic surveys to track down the progress recovery efforts in the slums that were adversely affected by post-election violence in order to identify emerging challenges.

Overcoming the city's crime challenges requires proper institutional and legislative framework addressing the city by-laws leading to reforms at devolved level supported by the national framework which espouses committed sense of making Nairobi competitive and attractive to live and do business. In relation to smart technology, the Government of Kenya is implementing the National Cyber security Strategy and National Surveillance, Communication and Control System to enhance security, which has great potential for addressing some security threats affecting Nairobi's smart city status.

Devolution has taken centre stage in all the local government structures of Kenya with even greater responsibilities to deliver in the health, education and security sectors. Improving the city's governance and ability to deliver in all these sectors depends on directly allocating the right amounts of resources that match the national- and local-level responsibilities. So far, the degree to which financial resources match the devolution of responsibility has been a mismatch hence affecting the overall service delivery in these sectors.

With good investment in social development sector such as education, Nairobi will not only fast track innovation diffusion, but will also able to catalyse the city's investment in assessment of threats and risks vulnerability thus deterring crime and general insecurity. This will at the same time help the city achieve desirable health status through interaction between health and security sectors which is pertinent in identifying vulnerabilities in preparedness and response required in attaining city smartness. Finally, improving Nairobi's smart city outcomes requires not just improvements in selected sectors (such as health, education, security, water, sanitation, transportation, infrastructure, etc.), but a coordinated improvement in the entire service system. This highlights the need for inter-sectoral planning especially among urban planners and specialist practitioners. Building healthy and secure smart cities means building economically sound, environmentally safe smart cities where residents are able to access all services easily, in a setting where social networks are strong and citizens express free political will in a peaceful environment.

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Chapter 27
Towards Smart Economic Development in Nairobi: Evaluating Smart City Economy Impacts and Opportunities and Challenges for Smart Growth

Dennis Mwaniki, Michael Kinyanjui and Romanus Opiyo

Abstract Kenya intends to transition into a middle-income economy by 2030. According to the 2008 Kenya Vision 2030 strategy, this goal would be achieved by growing the country's gross domestic product (GDP) at an average rate of 10 % per annum between 2012 and 2030. Eight years after enactment of the vision 2030 strategy as the country's long-term growth blueprint, the country's economy is still dragging behind, with an average GDP growth rate that is about half the target rate. Recent reviews by the World Bank indicate that for Kenya to achieve middle-income country status by the end of the planning period, her gross national income per capita needs to triple from the $1290 recorded in 2014 to $4125 by 2030, and her GDP needs to grow at a rate of about 7 % until 2030. In a country where the productive sectors of the economy (manufacturing) are overshadowed by both agriculture and low-technology small-scale enterprises and informal activities, this goal seems far-fetched. Recent investments in infrastructure development, and particularly on information communication technologies (ICTs), have, however, opened a new growth trend, which when properly explored could trigger rapid economic growth and help the country achieve the 2030 goal. Rapid adoption of ICTs in various economic sectors, particularly the growth of e-commerce, e-finance and e-governance, coupled with friendly policies and a rapidly emerging middle class are already causing an economic revolution, particularly in Nairobi—the country's capital city and commercial hub. This chapter explores Nairobi's economic growth trajectory within the framework of Kenya's long- and short-term economic goals. It identifies that an ICT-driven smart economic growth revolution has started in the city, in both the formal and informal sectors, and establishes that there are massive opportunities for sustained growth. These opportunities, which emanate from increasing investment in ICT infrastructure development, ICT

D. Mwaniki (✉) · M. Kinyanjui
Global Observatory Linking Research to Action, Nairobi, Kenya
e-mail: dmwaniki@gora4people.org

R. Opiyo
Social Scientist and Urban Planner and Researcher-Statistician, Nairobi, Kenya
e-mail: romanop2000@gmail.com

education, an innovative population and suitable government policies, will greatly help shape the country's economic growth in the next decade. The chapter also identifies that challenges such as cyber security, a thin manufacturing sector, slow adoption of e-commerce, a hugely informal economy and little research on innovative technologies and their adoption are limiting the city's smart transition.

27.1 Introduction

Over the past three to four decades, Kenya has experienced shifts in her economy. The first change has been from a hugely agricultural to a more diverse economy incorporating components such as services, information communication technologies (ICTs) and trade, and the second change has been a shift from almost exclusive face-to-face transactions to more electronic forms of trade. Whereas the former shift has been triggered by a general reduction in agricultural productivity caused by low-technology adoption and external shocks (such as unpredictable weather conditions, poor farming practices, inaccessible markets and competition from imports), the latter trend has mostly been due to growing investment in information and communication technologies (ICTs) and a general shift in urban trade dynamics. However, despite its declining productivity, the agricultural sector still plays a major role in the country's economy, not only contributing the highest share of the national gross domestic product (GDP) but also employing the largest share of the national labour force. ICT on the other hand is a fast-growing economic sub-sector, emerging only in the last two decades and growing to contribute about 1.2 % of the national GDP by 2014 [1], this not including its added value to other economic sub-sectors. For example, ICT is today greatly contributing to increased outputs from the manufacturing and agricultural sectors by linking buyers to sellers and creating information management and dissemination platforms for enhanced efficiency in the sectors. When this added value is measured, ICT contribution to the national GDP will be much higher.

The huge leap in ICT, as an economic contributor and an enabler of economic development in other economic sectors, has been boosted by a growing investment in ICT infrastructure at the national level. This chapter discusses both the classical and emerging economic trends in Nairobi. It highlights the overall economic growth direction over the last decade and shows how Nairobi's economy has unfolded against an increasing population. It undertakes a cross-cutting analysis of the incorporation of ICTs in various sectors of the economy and highlights the emerging economic options that have been shaping the city's economy over the last decade. In particular, it highlights the aspect of e-commerce and shifting municipal revenue collection systems, as influenced by a growing adoption of ICTs by the Nairobi city government. It further underscores the inherent opportunities for

further smart growth (both policy and investment) and also identifies the challenges that are constricting the city's smart growth. Whereas attempts are made to present all arguments at the city level, some discussions are based on national data, with application at the city level. This is majorly because most (economic) data in Kenya are presented at the national level.

27.2   Overview of Kenya's Economy

Kenya's economy has been on a steady upward growth. In 2014, the country's GDP recorded a growth of 5.3 % from only 0.6 % recorded in 2000. The GDP at market prices grew from US$12.71 billion in 2000 to US$60.94 in 2014 [2, 3], placing the country 8th in Africa and 74th in the world in nominal GDP ratings [4] (Fig. 27.1).

Kenya's economic blueprint, the Kenya Vision 2030 strategy document [5], envisions Kenya as a middle-income country by 2030. The achievement of this goal requires Kenya to more than triple her gross national income per capita, from $1290 recorded in 2014 [6] to $4125 which is the benchmark for upper middle-income countries [2]. This goal will require the country attain a GDP growth of about 7 % until 2030 [6]. This is not an easy target, especially given that the economy grew by more than 7 % in only four of the past 40 years and that the GDP growth rates have been below the targets set in the Kenya Vision 2030s Medium-Term Plan which envisaged growth of 6.1 and 7.2 % in 2013 and 2014, respectively [6].

The prevailing challenges towards the achievement of middle-income status are not just limited to the slow rate of GDP growth, but also the mix of the economic sub-sectors. Kenya's economy heavily relies on agriculture, which in 2014 accounted for 27.3 % of the national GDP share. This was more than a quarter of the country's GDP and almost three times the 10 % contribution of manufacturing to GDP (Fig. 27.2).
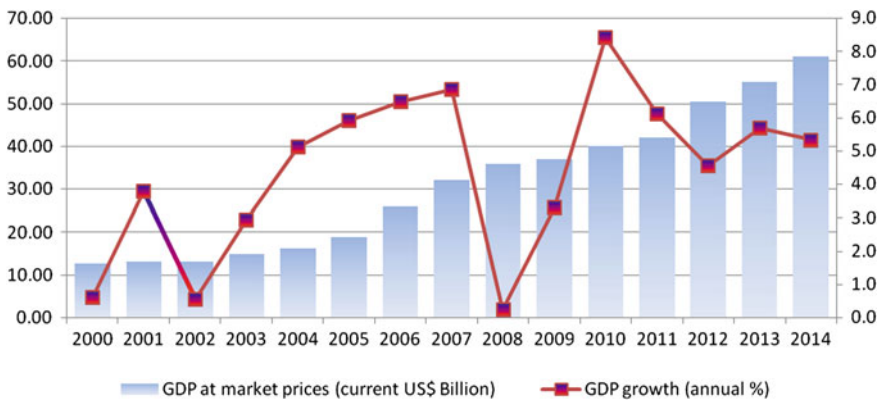
Fig. 27.1 GDP at market prices and economic growth rates 2000–2014, Kenya. *Data Source* [2]
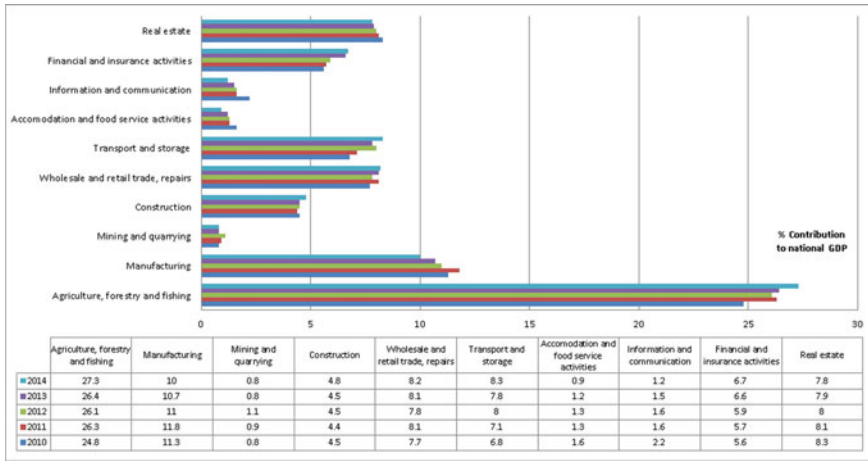
Fig. 27.2 Contribution of select sectors to Kenya's GDP, 2010–2014. *Data Source* [1]. *Excluded sectors include* Electricity supply, water supply, sewerage, waste management, professional, scientific and technical activities, administrative and support service activities, public administration and defence, education, human health and social work activities, arts, entertainment and recreation, activities of households as employers

Figure 27.2 portrays a growing agricultural sub-sector against a declining manufacturing sub-sector. Whereas agricultural development is good for the attainment of food security in the country and for the economic development of the 74.4 % Kenya's population living in non-urban areas [7], its long-term potential for economic contribution is threatened by many factors such as a changing climate, fluctuations in global commodity prices, poor farming practices, deteriorating soil conditions and lack of adoption of modern framing technologies. On the other hand, the declining contribution of the manufacturing sector to the economy is posing a huge challenge for the long-term growth of the entire economy, and the attainment of the goals sets out in the Kenya Vision 2030 strategy.

Previous research has identified that human capital development, urbanization, exploitation of natural resources and growth of the manufacturing sector (especially for export) are critical structural determinants of the sustainable long-term economic growth [6]. Growth of the manufacturing sector is a common denominator in the achievement of continuous growth and one which developing countries such as Kenya cannot ignore in their bid to transition into middle-income economies. This is clearly outlined in a World Bank report [6], which identifies that:

– Urbanization is an important characteristic of *successful* low- and middle-income economies. It influences economic growth through greater technological progress occurring in urban areas, mainly through manufacturing production and some services, which in turn raises labour productivity. The economies of agglomeration in product market, practical knowledge and technology found in

urban areas further create the necessary conditions for the rapid economic growth.

– In a fast-urbanizing, non-resource rich low- or middle-income country, it is typically the manufacturing sector that generates integral migration to urban areas. Increasing employment in manufacturing creates "production cities" that generate demand for urban goods and services.

– Expansion of a country's manufacturing sector (particularly focused on manufacturing for global markets) has historically been proven to contribute to long-term and sustained economic growth.

– The manufacturing sector is perceived to be one of the key drivers of technology development, "know-how", and, consequently, productivity growth.

Upon identification of the role of increased productivity and value addition in promoting rapid and long-term economic growth, the Kenya Vision 2030 identified industrial development as one of the three development pillars necessary for the achievement of the country's economic goals. The industrial sector comprises manufacturing, mining and quarrying and construction sub-sectors of which the manufacturing sub-sector accounts for about 70 % of industrial sector value added. Mining and quarrying, and construction sub-sectors account for about 4 and 26 % of industrial sector value added, respectively [8]. Based on these facts, the vision 2030 strategy envisaged increasing the manufacturing sector contribution to GDP by at least 10 % annually [5]. This goal has, however, largely remained a dream on paper, and little has been achieved over the last eight years since the strategy and its short-term plans (medium-term plans) were put into place. In addition to the stagnating share of manufacturing to the national GDP, the annual growth rate of the manufacturing sector has largely remained below 5 %, which is far below the 10 % growth target as shown in Fig. 27.3.

The slow growth of the manufacturing sector has been associated with, among other factors, its high reliance on agricultural goods value addition, its low adoption of technology and a dominance by micro and small enterprises (MSEs), most of which are informal in nature. While reliance on agricultural goods value addition
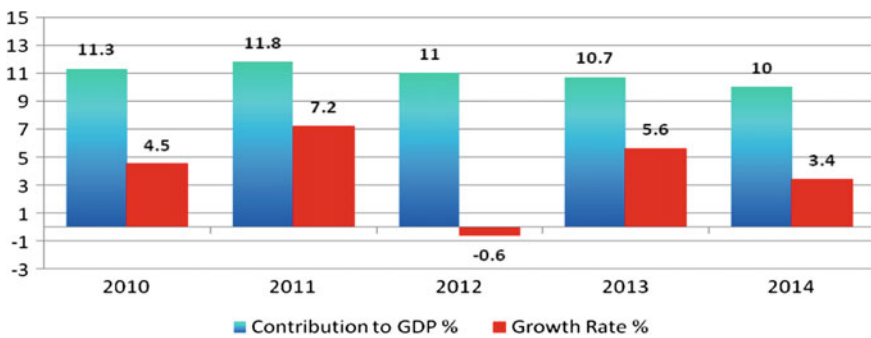
Fig. 27.3 Annual growth rate and share of GDP from manufacturing sector. *Data Source* [1]

limits the sector's level of technology adoption and ability to evolve into developing new products, the dominance by MSEs limits the ability both to adopt new technologies (due to unaffordability of emerging technologies by small and informal enterprises) and also to scale up innovations. These in turn create barriers for product expansion beyond the local, national or regional boundaries, inhibit ICT adoption and in turn slow transition of MSEs to medium and large enterprises and ultimately create bottlenecks for smart economic growth.

27.2.1 Kenya's Manufacturing Sector Is Hugely Composed of Small-Scale Enterprises

Micro and small enterprises account for more growth at the lower levels than the large industries due to the large number of poor people they employ. This in turn plays an important role in economic development and poverty reduction, particularly in poorer counties. This realization has greatly shifted government policies in developing countries towards supportive strategies, the most prominent ones being policies and a variety of programmes oriented towards the supporting growth and formalization of MSEs through incentives such as technical assistance, technology transfer and training and collective bargain agreements [9, 10].

The Sessional Paper No. 2 of 2005 [11] defines micro and small Enterprises (also referred to as small and medium enterprises—SMEs) as all enterprises—both farming and non-farming—employing less than 50 persons. The National MSE Baseline Survey conducted in 1999 identified that there were a total of 1,289,012 MSEs in Kenya at that time, employing about 2.4 million people, and that about 15.8 % (204,280) of the enterprises were found in the two cities of Nairobi and Mombasa [12]. The survey further identified that about 70 % of the total MSEs in the country were one-person units. Other data suggest that a significant amount of enterprises that employ more than 25 people are found primarily in Nairobi and Mombasa [10].

Subsequent studies have identified that Kenya, like many Sub-Saharan Africa countries, exemplifies a distinct characteristic in the manufacturing sector, in which there are much more MSEs than the number of medium and large enterprises. This is despite the fact that the medium and large enterprises employ more people and produce more economic output than the MSEs [8]. Recent findings show that large and medium establishments constitute just about 33 % of total manufacturing establishments in Kenya, but create 71 % of (the manufacturing) sector employment, and that the large and medium establishments account for 86 % of sector GDP compared to MSEs, which account for 67 % of establishments and contribute only 11 % to sector GDP [8]. These statistics exclude the many informal sector MSEs, which account for most of the employment in the informal sector. Further, most of the MSEs (both formal and informal) are identified as being in the less

productive sectors of wholesale and retail trade, as well as in hotels and restaurants, and only less than 10 % of total MSE employment is in the manufacturing sector.

Inspite of this, Kenya's MSE manufacturing sector portrays massive opportunities for growth, particularly through adoption of ICTs to access global markets, for improved communication and access to information, and improved transactions among others, all of which contribute to production efficiency, product diversity and increased profitability [13]. The MSEs are also crucial players in the country's economy, and the two fastest ways to hasten their transition to middle and large enterprises are technology transfer in both the actual productive processes, and also in the product distribution chain (market access, etc.), and formulation and implementation of policy directives to promote their growth and the growth of the manufacturing sector as a whole. The strategy to achieving growth in the sector should focus on both creating new technology-oriented, high-production MSEs and also on fostering growth in the existing enterprises to enhance employment opportunities, technological progress and in turn their transition to medium-sized enterprises [14]. Since the missing middle enterprises in the country are indicative of inherent challenges for upscaling from MSEs to medium-sized enterprises (such as difficulties in accessing finance, low entrepreneurial skills, lack of competitiveness in international markets [15]), emerging policies should consider addressing these challenges. The Micro and Small Enterprises Act of 2012 has made several provisions to this end, which if implemented can hugely shift the country's manufacturing sector towards improved productivity.

27.2.2 Labour Market and Employment

Kenya's labour allocation comprises public and private formal sectors, the informal sector, the self-employed and unpaid family workers [8]. The numbers of jobs have been increasing steadily across all sectors, with more growth recorded in the informal sector. Between 2008 and 2014, the Kenyan economy generated a total of 4.3 million jobs (including self-employed and unpaid family workers), jobs of which 88 % (3.8 million) were in the informal sector and only about 11 % (464.6 thousand) were in the formal sector [16], (Table 27.1). Throughout the period, the informal sector accounted for an average of 82 % of the total national employment, indicating a highly informal economy.

As shown in Table 27.1, Nairobi accounts for an average of 25 and 24.6 % of the national formal and informal employment, respectively, making it the largest concentration of the country's labour force. In absolute numbers, Nairobi's informal sector created almost ten times more jobs than the formal sector between 2011 and 2012 (164,600 vs. 17,000) and cumulatively employed almost 5 times more people than the formal sector in 2012. Despite these differentials, Nairobi still has the highest number of formal employees compared to other national sub-regions (counties). Although there are few data to help disaggregate employment per sector within the city, national statistics are indicative of the employment distribution

Table 27.1 Employment per sector in Kenya, 2008–2013

Indicator	2008	2009	2010	2011	2012	2013	2014
Labour force (million)	5.9	16.4	16.9	17.4	17.6	17.8	–
Formal private sector employment ('000)	1309.0	1347.0	1396.4	1440.8	1493.6	1599.8	1669.4
Formal public sector employment ('000)	596.6	612.0	619.8	643.3	662.1	683.3	700.8
Total formal employment ('000)	1905.6	1959.0	2016.2	2084.1	2155.8	2283.1	2370.2
Self-employed and unpaid family workers ('000)	67.4	67.5	69.8	73.8	76.9	83.8	103.0
Informal sector ('000)	8039.5	8676.6	9371.1	9958.3	10,548.4	11,150.1	11,843.5
Total employment Kenya	10,012.5	10,703.1	11,457.1	12,116.2	12,781.1	13,517.0	14,316.7
Formal sector as % of total employment	19.0	18.3	17.6	17.2	16.9	16.9	16.6
% self-employed	0.7	0.6	0.6	0.6	0.6	0.6	0.7
% informal sector	80.3	81.1	81.8	82.2	82.5	82.5	82.7
Total formal employment in Nairobi city	479.6	495.8	510.3	525.7	542.7	–	–
Total informal employment in Nairobi city	1968.8	2131.8	2303.5	2459.8	2624.4	–	–
% of total formal employment in Nairobi	25.2	25.3	25.3	25.2	25.2	–	–
% of total informal employment in Nairobi	24.5	24.6	24.6	24.7	24.9	–	–

Source [8, 16]

trends. Existing data illustrate a trend in which manufacturing employs a majority of people in the private formal sector and comes second after trade and services in the informal sector. This emphasizes the earlier observation that Kenya's economy outside agriculture is more service based and that a lot of manufacturing activities are found in micro and small enterprises in the informal sector.

Nairobi city has a highly youthful population, where 15–34 year olds constitute 49 % of the total population, as well as a very high proportion of the working age population (those aged between 15 and 64 years old) who form 68 % of the total population. This is both a result of natural population increase and a high rate of immigration of people seeking work [17]. Compared to other counties in Kenya, Nairobi city has the highest proportion of population working for pay, estimated at 47.1 % of the city labour force compared to 11.3 % of the population without work [17]. However, whereas the share of the population working for pay in Nairobi is higher than the national and urban average of 23.7 and 38.1 %, respectively, the proportion of population without work is higher in Nairobi (11.3 %) than both the national (7.7 %) and urban average (10.2 %). The level of employment varies significantly across various education attainment levels, spatial location within the city, gender of the household head and age of the labour force entrant. For example, a higher proportion of the population with the secondary education and above engage in work for pay activities (49.1 %) compared to those with no significant education (33.7 %). Equally, there are more people working for pay in male-headed households (48.4 %) compared to female-headed households (41.81 %) [17]. Attainment of a high level of education is, however, not a guarantee for job market incorporation as the labour market favours both older people and men, and disadvantages the youth and women. Although there are no sufficient data to analyse unemployment at the city level, national data are indicative of huge variations in unemployment rates between men, women and the youth. In 2013, the national unemployment rate in Kenya was 9.2 %, of which male unemployment rate was 8.1 % and women unemployment rate was 10.5 % [18]. While youth aged 15–24 years made up over 35 % of the working age population in 2012, they accounted for less than 19 % of total employment in the country. As such, the youth employment rate, at 32.8 %, was less than half the adult employment rate [19].

With these low levels of employment among the country's ICT savvy population, who have the potential to promote and totally shift the country's economy towards a smart trajectory, there is significant lost potential for smart economic growth in Nairobi and Kenya at large. As more young people become unable to get jobs in the formal sector, they either shift to the vibrant informal sector or become economically inactive and start to engage in unpaid family labour. Inasmuch as the informal sector has in the past motivated creativity and contributed hugely to Kenya's innovation ecosystem (particularly in ICT and business-related aspects), the rate of inactivity among the country's well-trained youth is becoming an issue of major concern for its future economic development. In 2012, the inactivity rate for people aged 15–24 in Kenya reached 60.5 %—an increase of 5 % since 2000 [19]. The problem is particularly acute among young women whose rate of inactivity is 8 % points higher than that of young men [19].

While a smart city economy is innovative, adjustable to prevailing conditions and changes in the larger economic networks, re-invents itself to cope with internal and external shocks, and is self-adjusting to maximize on prevailing opportunities, the basic opportunities need to be assured, especially among the most creative, well-educated and most active sections of the population. Nairobi's transition to a smart economy will thus require major shifts in the city's labour market composition and employment trends—to create a friendly environment for the section of the population that will trigger rapid and sustained smart economic growth. To create the necessary conditions for the attainment of smart economic growth, the city needs to incorporate manufacturing as a core component of its productive sector and also to promote the principles of inclusive economic growth. Further, as the government continues to create an enabling framework for smart growth through investment in ICT infrastructure and friendly policies, there is need for increased partnerships for the development of high-value output sectors and integration of the formal and informal sectors.

27.2.3   ICT as a Major GDP Contributor

The ICT sub-sector is a relatively new economic area in Kenya, emerging only over the last three decades and growing rapidly to take up a significant portion of the country's GDP growth. Over the last two decades alone, ICT has grown from an insignificant economic sector, often jumbled together with other "major" economic sectors, to become an independent GDP contributor and one of the fastest growing economic sub-sectors. Until 2013, ICT was measured as part of the transport and communication sub-sector, and thus, it was difficult to understand its growth and contribution to the economy outside the number of people it employed. When ICT was first measured as an independent economic sub-sector in 2014, it employed 99,100 people in both the private and public formal sectors and contributed 1.2 % to the country's GDP [1]. The sector has grown at an average rate of more than 13 % between 2010 and 2014, with acute fluctuations in some years [1]. The most significant growth has been recorded in the telecommunications sub-sector, which has grown against a declining publishing and broadcasting sub-sector (Fig. 27.4). Given the fact that recorded values are from ICT-based activities such as mobile money transactions, calling rate tariffs, postage charges, printing services and related activities, leaving many aspects such as contribution to productivity and commodity markets, the sub-sector is estimated to contribute much more to the country's GDP than is typically measured.

As Kenya's capital city, most growth in ICT-related services has been head-quartered in Nairobi, starting from the introduction of the first computer and widespread use of the Internet to the incredible growth of mobile phone services. Government investment in ICT infrastructure has also been aligned with the city's importance as the seat of government, from where the services disperse to other parts of the country. A good example is the recent construction of the undersea fibre
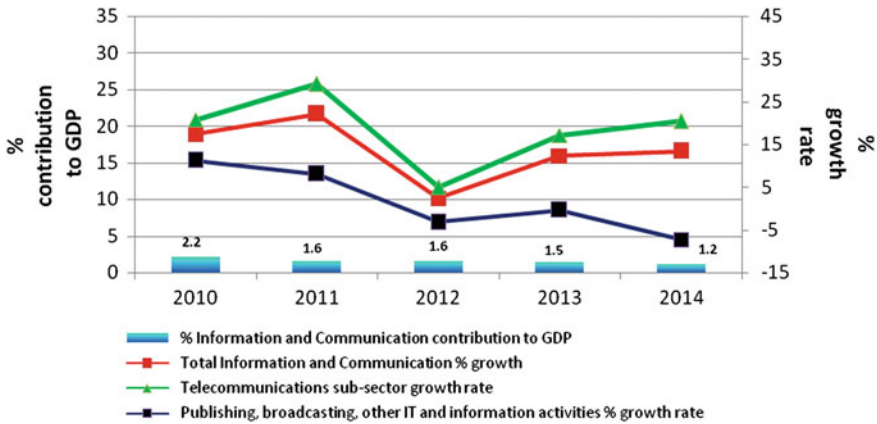
Fig. 27.4 ICT sector growth rate and contribution to Kenya's GDP, 2010–2014. *Data Source* [1]

optic cable, which moved from the port of entry in Mombasa to Nairobi, before further distribution to other parts of the country through the National Optic Fibre Backbone Infrastructure (NOFBI) I and II projects. In effect, most ICT-related economic activities are headquartered in Nairobi city, ranging from innovation incubators to e-commerce enterprises to regional headquarters for various multinational corporations which rely on the Internet for their day-to-day operations.

27.3   Revenue Sources for Nairobi City

Nairobi city, like other urban and rural counties in Kenya, relies on internal and external sources of revenue to finance its service delivery. Internal county revenue streams include rates, single business permits, parking fees, building permits, and billboards and advertisements, while external sources include transfers from the national government. Transfers from the national government have evolved over time to cover equitable share and conditional grants such as free maternal health care, compensation for user fees foregone, leasing of medical equipment and road maintenance levies. Before promulgation of the current constitution of Kenya in 2010, Local Authority Transfer Fund (LATF) and the Roads Maintenance Levy Fund (RMLF) formed national government direct transfers to local authorities.

27.3.1   Central Government Transfers

The Local Authorities Transfer Fund (LATF) was introduced in 1998 as part of the Local Authorities Reform Programmes in Kenya with the specific aim to improve

Financial year	Allocation (Kshs)
2005/06	889,446,590
2006/07	1,383,563,693
2007/08	1,531,798,825
2008/09	1,729,445,664
2009/10	1,956,739,527

Source [22]

and extend service delivery to communities, improve financial management and resolve local authority (LA) debts. The LATF was structured in block transfers of 5 % of the national income tax revenue to LAs [20]. The goal of the LATF was to enable Local Authorities to improve and extend service delivery to citizens, improve financial management and resolve outstanding local authority's debts. To qualify for LATF funding, LAs were required to submit budget estimates outlining how funds would supplement local revenue and for what they would be used. The direct block grant that was not earmarked for any specific local expenditure was based on an objective formula that included the overall population size of the LA (weighted at 60 %), the urban population of the LA (weighted at 31 %) and a basic minimum guaranteed lump sum allocation of Ksh. 1.5 million, roughly equal to 9 % [21]. LATF has not been factored in the new governance ordered by Kenyan constitution of 2010.

Over the years, LATF allocations for Nairobi city experienced an upward growth and increased from Ksh. 889 million to Ksh. 1.9 billion between the 2005/2006 and the 2009/2010 financial years [22] (Table 27.2).

Kenya's new constitution in 2010 established county governments, which are a decentralized system of governance. In this system of governance, each of the 47 counties would receive a share of the national budget based on a pre-defined and regularly updated revenue sharing formula. One of the key considerations for revenue sharing as defined by the commission on revenue allocation is county population size. Given that Nairobi city, whose boundaries are also the same for Nairobi County, has the highest population among all counties in Kenya, it receives the highest share of national government county allocations. During the 2013/2014 financial year, Nairobi's county allocation was Ksh. 11.3 billion, which increased to Ksh. 12.7 billion and further to Ksh. 13.4 billion in the 2014/2015 and 2015/2016 financial years, respectively.

27.3.2 Internal Revenue Collection

Nairobi funds a larger share of its yearly budget from internal revenue collection sources, some of which include parking fees, land rates and a diversity of permit fees. Between 2005 and 2010 for example, while Nairobi's LATF allocations were comparatively larger than those for other LAs in Kenya [23], the city's dependence

on the fund was the least, as it relied more on its local revenue collection [23, 24]. During the 2008/2009 financial year, the city's local revenue contribution to its budget was Ksh. 6.7 billion against central government allocations of Ksh. 2.8 billion. In the 2009/2010 financial year, a similar trend was reported, with internal revenue contributing Ksh. 5.7 billion against the central government's Ksh. 2.8 billion [23]. According to the 2015/2016 budget estimates, Nairobi's total expenditure is Ksh. 30.8 billion, of which Ksh. 19.8 billion is recurrent expenditure and Sh11 billion (36 %) is development expenditures [25]. The central government allocation of Ksh. 13.4 billion accounts for only about 43.5 % of this budget, meaning that the larger share of the budget is to be generated from internal revenue collection.

Over the years, despite the wide options for revenue collection, Nairobi has faced major budgetary deficits, mostly associated with corruption and lack of competencies in collecting and collating revenue [26]. In extension, the level of service delivery has remained a major challenge in the city [23], with key sectors such as basic infrastructure development remaining largely ignored. Although the challenge is related to budgetary issues, the distribution of revenue between investment and recurrent expenditure such as salaries has also remained a major setback for the city's development. The 2015/2016 budgetary allocations for which recurrent expenditure accounts for 64 % of the city's budget against 36 % for development expenditure are a good indicator of the high level of under-investment in service delivery in the city.

In the recent years, an increasing need to raise the city revenue collection to meet its development goals has motivated uptake of ICTs, both to improve efficiency in the system and improve fiscal transparency, while also reducing the city's operational costs [26].

27.4 Smart City Economy Impact in Nairobi

A smart city economy uses ICTs in all cycles, is innovative enough to create opportunities where the options seem thin, is adjustable to prevailing conditions and changes in the larger economic networks, re-invents itself to cope with internal and external shocks, is self-adjusting to maximize on prevailing opportunities and creates equitable opportunity for all to prosper. While it is difficult to quantify all aspects of a smart economy in Nairobi, mainly due to lack of industry-specific data and the value added from adoption of ICTs in the various cycles, it is no doubt that Nairobi has among the most dynamic and ICT savvy economies in Africa. Various innovations contributing to national and regional economic growth, such as mobile money, have their roots in Nairobi. Equally, the city is among the first places in Africa where incubation hubs were built and also where many locally grown innovations spread to the rest of the country.

Nairobi ranks highest among African cities in the adoption of ICTs for growth. In 2014 and 2015, it was named the most intelligent city in Africa by the Intelligent

Community Forum, which views "intelligent communities" as those that have taken "conscious steps" to create an economy that can prosper in the broadband economy" [27]. In 2015 and 2016, Nairobi was further ranked top 20 (rank 15 and 11, respectively) in the City Momentum Index (CMI), which tracks the speed of change of a city's economic base (as in*fluenced by the emerging forces of urbanization, globalization and technology*) and its commercial real estate market, delves into the underlying drivers that are the hallmark of highly dynamic cities. The index puts forth the idea that the true foundation of highly dynamic cities emerges from such factors as speed of innovation through adoption of technology, and creation of cutting-edge businesses, along with new building construction, property price movement and investment in real estate from cross-border investors and corporations [28, 29]. Nairobi's high rank was as a result of its impressive demographic and economic momentum, investment in long-term city foundation including infrastructure, its growth as an important air transport hub and its push to become the centre of technology in Africa through growth in tech incubators and venture capital funds [29].

In this section, we highlight some sectors where the smart economy revolution has created growth opportunities for Nairobi-based enterprises and households, and in turn impacted positively on the city's overall economic growth. While we make every effort to cover as many case examples on the adoption of smart economy approaches, the discussions focus majorly on individual innovations and/or enterprises, with deductions made on the contribution of the enterprise growth to the larger city economy. In particular, the discussion in this section touches on several manifestations of a smart economy, but focuses more on the sharing economy as influenced by e-commerce, and contribution of ICTs to improved economic output through enhanced revenue collection cycles, increased efficiency and profitability in the manufacturing and logistics sectors, as well as the opportunities created by smart economy for financial inclusion and environmental sustainability.

27.4.1 E-Commerce at the Centre of Nairobi's Smart Economy

Electronic commerce, commonly known as e-commerce, is the process of buying and selling products or services over electronic systems, such as the Internet and other computer networks [30]. Some common applications of e-commerce include tracking industry trends and competitive intelligence, general business research and customer service and sales [30]. This kind of trade is highly reliant on availability, uptake and reliability of Internet services and also on the availability of secure payment channels, whether through e-banking or mobile money platforms. Over the past decade, Nairobi has experienced an e-commerce revolution. Subsequent growth in Internet usage, high mobile phone penetration and developments in online-based payment platforms (mobile money and e-banking payment) have

greatly contributed to the growth of Nairobi's e-commerce. Today, many businesses in Nairobi have integrated ICT into their architecture, not only to enhance efficiency in their operations, sales and customer support, but also to create a new customer base and create new avenues for distribution and marketing. New online shops are cropping up every day in the city, selling a wide variety of items ranging from clothing and household items to larger items, such as cars.

In Nairobi, e-commerce manifests in three unique forms—individual company website advertising and sales, listing in a market place or advertising in social media. The most common option in Nairobi over the past decade has been the individual company website, where sellers develop a website and display their products and add contact numbers or guidelines on online purchases and delivery logistics. The challenge of this option is that the level of sales is limited due to low traffic to the website. Advertising on social media faces the same challenge, so most sellers combine these two options. The third option, selling through an online marketplace of an e-commerce company (such as Amazon for example), is proving to be the most beneficial venture for sellers. In this option, the seller can either offer drop shipping, where they keep the product and have it shipped when an order is placed, or offer consignment, where they allow the e-commerce company to keep the products in their warehouse for free and deliver to customers directly when an order is placed. While larger companies have an option to adopt the three options, small and medium-sized companies have mostly been using the first two options. The third option offers retailers more traffic and thus more value than an independent website [31]. The seller, however, runs the risk of losing brand identity and often pays a sizeable fee to the e-commerce company.

27.4.1.1 Online Marketplaces Define Nairobi's E-Commerce

The establishment of online businesses such as Jumia-Kenya, OLX, among other small online businesses which are advertised and operated through common social media platforms has emerged and is projected to grow rapidly in Nairobi, especially with the increasing Internet uptake. Jumia and Kaymu are the two most prominent virtual markets in Kenya today, both operating from Nairobi. The Jumia Online Market Place (launched in 2014) allows retailers to sell their products to its large customer base. This can either be done by advertising directly on the Jumia website or opening a shop-in-shop on the market place website where only the company products are listed on a particular web page. Jumia offers storage of products in their warehousing for free and only gets commission on the actual sales. This saves sellers many upfront and sunken costs, such as rent, wages, salaries, government and city council charges, which can open massive growth opportunities for small companies, while also availing products at low prices to the buyers. The delivery service by Jumia further opens products to a wide market from all over the country. The market place further offers the selling company/individual a mean to track customer preferences, which helps make decisions on stocks and/or production. Various local and international brands in Kenya use the Jumia platform as a launch

pad for their products, and others offer the online trading company exclusive distributorship for their merchandise, greatly reducing counterfeiting [31]. Opening of online shops in Jumia by hundreds of micro and small enterprises (MSEs) has also expanded their sales, increased their profits and opened up their innovation landscape from user reviews.

Other online market places such as Kaymu and OLX create a space where the buyer and seller can interact and agree on product prices and mode of delivery. These two marketplaces give users the option of dealing with second-hand and custom items. This enables people to dispose of items that they no longer need and also offers buyers a chance to procure goods that would be difficult or expensive to procure in a typical commercial environment. Buyers also get a chance to sample and buy various items at reasonable prices. These platforms, which do not charge for usage but rather rely on advertising to their huge customer base, have become very popular in Nairobi as sellers are able to access a very large customer base for free.

The sail has, however, not been all smooth for these online businesses as they have had to restructure their operational procedures to gain confidence from the customers and also to expand their customer base. One such innovation has been the introduction of cash payments to complement the platforms' preferred cashless payment platforms. For most Nairobians, paying for goods ordered online from a local company whose authenticity is not known was unheard of until the entrance of Jumia into the market. Upon realizing this customer behaviour, Jumia (as well as other companies such as OLX, Kaymu) had to include a buy-online-pay-offline system through which goods or services would be ordered from the company website and paid for on delivery. The company further integrated an option to make payments through mobile money, hugely improving customer confidence. As a result, and with rapid marketing and publicity campaigns accompanied by positive consumer reviews, Jumia reported a 900 % growth in orders in its first year of operation [32]. All the emerging online marketplaces have also developed mobile phone applications, which offer users the convenience of browsing through products and making orders, while at the same time avoiding relatively high Internet (data) costs.

Subsequent partnerships between the online marketplaces and manufacturers, retailers and shipping companies such as G4S have further improved consumer confidence and further increased their sales. For example, Jumia has partnered with various manufacturers, retailers as well as delivery companies for a complete shopping experience where shoppers buy products online and have them delivered to their preferred location. Equally, OLX, whose initial role was to create a platform where sellers and buyers could interact and trade freely, has partnered with the shipping company G4S to create a trusted brand in the middle for enhanced safety and shopping experience. This "*middleman*" service, for which a small fee is paid by the buyer or seller as per their negotiations, was particularly necessitated by high numbers of fraud cases reported as a result of direct dealings between sellers and buyers [33]. In addition to boosting customer experience in e-commerce, the partnerships between online marketplaces and shipping companies have been

beneficial to the local shipping industry, which recorded a 30 % upsurge of ship-ments in the last half of 2015 [34, 35]. As e-commerce grows and new partnerships are formed, more jobs are being created and revenues for the shipping companies are increasing, significantly contributing to the local economy. Further, partnerships between the e-commerce companies and establishments such as Posta Kenya have brought new life to the postal service network, which was rapidly dying as a result of fast dropping demand for physical letters that have been replaced by emails, phone calls and text messages.

Outside the online marketplaces, many retailers have individual websites and social media pages through which they advertise their products. Social media platforms such as Facebook host thousands of pages through which sellers—both companies and individuals in the formal and informal sectors—advertise and sell their products to their peers. The level of sales is hugely dependent on the traffic to the sites, but the two platforms have so far offered a unique starting point for small-scale traders who cannot manage high-quantity sales associated with existing and emerging online marketplaces.

Looking into the future, the fast adoption of the online marketplace as a trading platform, growth in social media marketing, well-established mobile money plat-forms, hybrid systems of buy-online/pay-offline, among others, will continue to shape the evolution of e-commerce in Nairobi in the coming years. Although the actual contribution of these emerging dynamics to the city economy is not properly quantified, they will form a huge part of smart economic growth in the city. As the growth occurs much time and commitment on the part of the government to make policies that allow the growth to be accentuated is needed.

27.4.1.2 The Sharing Economy Is Helping Individuals Generate Incomes

California-based accommodation platform Airbnb, through which people can monetize extra space in their homes by sharing with visiting guests at a fee, is in Nairobi and is generating incomes for individual households as well as accom-modation enterprises. In 2015, about 56 % of properties listed in the online mar-ketplace (788 out of 1400) were located in Nairobi [36]. Through this platform, home owners have a chance to grow their household economy by earning cash from their unused rooms/spaces. In 2016, the price listing in available spaces in Nairobi averages US$52 per night, with prices ranging widely depending on the size of the space and the location [37].

Mobile-based taxi sharing platforms such as Uber and Easy Taxi have also gained popularity in Nairobi, particularly for their innovation in providing cheap and reliable taxi services. Although the service providers have faced several chal-lenges in penetrating the Nairobi market, such as resistance from traditional taxi operators, they are fast becoming the preferred taxi ride service in the capital and have created employment opportunities for the city residents. They have, however,

also had to innovate and switch to cash payment options, which is the largely preferred mode of payment in the city.

27.4.2 ICT Adoption Is Increasing Nairobi's Revenue Collection

Nairobi City County has embraced ICT and e-governance to improve revenue collection and management. Through the support of the World Bank under the Kenya Transparency and Communications Infrastructure Project (KTCIP), Nairobi is among three counties being supported to develop master plans for the use of ICT to increase accountability in the management of resources, through the reduction in revenue leakage, and the optimization of collection and management systems [38]. The ICT applications are meant to integrate the counties to the national government's Integrated Financial Management Information System (IFMIS)[1] and to enable them to increase service delivery to citizens, as well as generating analysis reports that can help drive policy.

ICT initiatives with positive results have been developed in Nairobi city to help enhance revenue collection. Insufficient collection of parking fees and revenue leakages has led to the introduction of e-payment to reduce revenue losses. Through e-Jiji pay, which uses Google Android applications or a designated web address (URL), motorists in Nairobi are able to pay for their parking fees through banks or mobile money accounts. Through e-payment, revenue collection in the parking sector has grown by 30 %, and administrative costs have been minimized. The e-jiji pay cashless payment system is also used by Nairobi Water Company to electronically collect water charges by Nairobi residents [39, 40]. Other services currently offered electronically include the following: application and renewal for a single business permit, payment of land rates and rent for city houses and construction fees. In 2016, an estimated 69,000 businesses out of the 112,000 registered on the portal used the e-system to renew their single business permits [41].

The automation of revenue collection has largely transformed the city's operations to being more efficient, effective, economical and accountable. Currently, over 31 % of all incoming payments are made electronically, which has also accounted for steady revenue growth at an average of 6.3 %. The introduction of electronic payments led to increase in revenue collection by Ksh. 1.3 billion in the 2014/2015 financial year [42].

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[1]IFMIS is an automated system that enhances efficiency in planning, budgeting, procurement, expenditure management and reporting in the National and County Governments in Kenya. Its central purpose is to oversee the implementation of a unified financial management system and its adoption across all Government departments.

27.4.3   ICT Adoption Is Increasing Profitability in Micro and Small Enterprises

The overall goal of adoption of ICTs and technology transfer in the manufacturing sector is improved enterprise productivity, enhanced value addition and expanded product markets. For Nairobi's many MSEs, the most important driver of ICT adoption is enhanced access to product markets and increased profits. A 2012 study of 400 formal small manufacturing and service enterprises carried out in major towns in Kenya (Nairobi, Mombasa, Kisumu and Nakuru) found that the majority of entrepreneurs viewed ICT adoption as an avenue of venturing into new markets but not as a tool for developing new products and services [43]. This is highly related to short-term productivity increase by improving efficiencies in the supply chain and expanding the marketing network, as opposed to the long-term goal of broadening variety and enhancing the production cycle through mechanization/automation.

Increased sales through expanded markets, as opposed to the actual enhancement in value addition, equally apply in the incorporation of ICTs in the informal MSEs. The Kamukunji Jua Kali[2] cluster, a huge cluster of (the oldest) informal manufacturing activities located in the outskirts of the Nairobi central business district, is an example of how ICTs are being used in improving profitability within informal MSEs. Through their association, the Kamukunji Jua Kali Association, the MSEs developed a website (sites.google.com/site/kamukunji jua kali) as a way of linking product buyers and sellers. The website, in addition to providing general information about the cluster, also gives consumers a detailed catalogue of available products, the names and contacts of the sellers and their store numbers (Fig. 27.5). This has greatly improved consumer information access, since one can contact the product sellers from numbers provided on the website and compare the price of products before physically visiting the cluster to make a purchase. It has also expanded the market base for manufactured products, increased profitability and created opportunities for sellers located in the less accessible parts of the cluster to market and sell their products.

Through the website, the public can now access previously unavailable information and interact with Kenya's oldest Jua Kali cluster. Equally, students interested in various internship opportunities, such as industrial design and innovation, can also get information on available opportunities and apply online.

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[2]Jua kali is a Swahili word for hot sun and is used to refer to informal manufacturing and other kinds of informal activities in the country.

Fig. 27.5 Kamukunji Jua Kali cluster association website. *Source* [44]

27.4.4 Smart Economy Is Improving Efficiency and Increasing Profits in the Logistics Industry

Most logistics firms in Nairobi have adopted ICT applications such as the radio frequency identification (RFID) and global positioning systems (GPS) for enhanced efficiency and profitability. With the economic integration of the East African Community, the logistic industries based in Nairobi play a great role in facilitating the exports and imports throughout the region. As a result, use of ICTs in fleet management—car tracking, maintenance, driver management, speed management, fuel management, is gaining ground in the region. However, with about 120 registered logistics firms, ICTs in logistic management are yet to be fully embraced by logistic businesses in Nairobi as only less than 50 % of firms have incorporated ICTs in their operations [45]. This is despite findings from a survey conducted in Nairobi which identified a positive correlation between ICT adoption in logistics firms in the city and improved performance and profitability [45]. Companies using ICT in logistic management such as cargo tracking increase customer confidence and reduce cost on the security bonds imposed on logistic firms. This further contributes to increased profitability and product safety.

27.4.5 ICTs, Energy Use and the Environment

ICT-driven urbanization will greatly contribute to a reduction in GHG emission in Nairobi, particularly through the reduced travel as more people become able to work from home as a factor of growing virtual offices and expanded ICT-based income generation opportunities. Equally, as the city adopts high value—smart transport—approaches that favour mass movement, efficiency in the transport sector and speed as opposed to personal comfort (such as through private cars), the amount of GHGs generated and the associated costs of energy will marginally drop. The associated benefits will greatly boost the city's economic position and improve efficiency in the transport system, which is currently estimated to cost the city approximately US$500,000 per day in lost productivity and excess fuel consumption [46, 47]. E-commerce and online banking are also reducing travel needs and saving energy. Further, creation of ICT integrated mixed neighbourhoods, which create convenience at the local level and link to other parts of the city and world, will further promote healthy living, which is one of the components of a smart city.

Current trends in energy trade are already incorporating ICTs in the supply of green energy. After the Kenyan government relaxed value-added tax on photovoltaic products, private companies have adopted mobile money payment platforms to facilitate growth of green energy with tremendous positive impact in helping Nairobians living in the informal settlements to use sustainable sources of energy. Private companies such as M-Kopa[3] Solar, M-Power and SolarCity that sell household-scale energy technologies are circumventing the need for transmission infrastructure and energy governance, while meeting energy needs of households and reducing use of unsafe energy. M-Kopa Solar for example offers customers a pay-as-you-go service for green energy, for which they receive a solar panel, control unit, light bulbs, mobile phone charger, rechargeable torch and a radio for a pre-defined deposit and standard daily fee which is paid on a daily basis via mobile money [48]. This platform has given poor families in Nairobi, which previously relied on unsafe energy sources such as kerosene for lighting, to reduce indoor pollution, while accessing cheap and reliable energy. It has also increased income opportunities for households who can charge multiple phones for a fee.

27.4.6 E-Banking and Mobile Money Are Enhancing Inclusive Growth

Internet banking (e-banking) allows anyone with Internet access to connect to their bank and perform transactions without having to physically visit the bank. Almost

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[3]The word 'kopa' is Swahili for *borrow*.

all banks and banking corporations in Kenya have adopted e-banking as a main-stream part of their operations, complete with secure networks and dedicated customer care. This shift in the market has been encouraging their clients, who prefer to use online platforms to perform transactions as opposed to visiting the banking halls.

This approach has boosted e-commerce tremendously, in the sense that a client can order particular commodities from an online store, such as Jumia, and pay for them online anytime of the day. This enhances 24-h shopping, while saving time and boosting security among the shoppers and sellers, who do not need to handle cash for every single transaction. E-banking is not limited to paying for goods. Most banks in Kenya have also partnered with utility service providers, such as the Nairobi City Water and Sewerage Company (NCWSC) and the Kenya Power Company for online payment of utility bills. By completing a simple one-time registration for each bill, a user can pay their bills as a one-time payment or create a recurring bill payment from their online portal [30]. Equally, one can transfer money to other accounts within the same platform, thereby greatly reducing the amount of time spent queuing in banking halls to perform a single transaction.

Mobile money is another secure payment platform through which mobile sub-scribers across the various service providers register their mobile phone lines as virtual banks through which they can send or receive money and pay for various services. Like Internet banking, this platform is greatly contributing to the growth of e-commerce in Nairobi, since customers can order goods online and pay for them directly from their phones.

In addition to promoting e-commerce, growing innovations in mobile money have greatly contributed to financial inclusion among the most marginalized sec-tions of Nairobi's population, especially the urban poor living in the slums and informal settlements. The partnership between banks and mobile phone operators has resulted in affordable and easy to operate banking systems. For example, Kenya's largest mobile operator, Safaricom, partnered with the Commercial Bank of Africa (CBA) in 2012 to create a virtual banking platform, M-Shwari, where users can save and withdraw money, get interests on their savings (interests range between 2 and 5 % depending on savings) and even get loans through their mobile phones. Users have an option to run a fixed deposit account or current account and can save as little as Ksh. 1 in their accounts and access instant loans of as little as Ksh. 100 (depending on credit record and usage of various Safaricom services—voice, data and M-PESA), payable within 30 days and for which a 7.5 % facili-tation fee is charged [49]. By 2015 (3 years since launch), the M-Shwari product has served over 12 million customers and had disbursed Ksh. 64.65 billion in loans [50]. Other similar platforms include M-Kesho (through partnership between Safaricom and Equity Bank) and KCB-M-Pesa (through partnership between Safaricom and the Kenya Commercial Bank—KCB).

The second largest mobile phone operator in the country, Airtel, has a part-nership with a local bank and introduced a Visa card, in itself a manifestation of the smart growth. The Airtel Money debit card, which is a mirror of a users' Airtel money account (the service provider's mobile banking platform), uses the secure

Pin and Chip technology and allows customers to shop or make secure payments at any Visa-accepted merchant worldwide and withdraw cash from any Visa ATMs worldwide [51]. This greatly improves user convenience, not just locally, but also internationally. The Visa card service is an extension of the other mobile money platforms and is thus expanding user experience and options for international e-commerce. Another mobile service provider, Orange, also has a Visa debit card service, which it offers in partnership with Equity bank. It operates in a similar manner to the Airtel Visa card.

The mobile phone operators are also forming partnerships with various companies for cashless payments on delivery of goods and share dividends. One such partnership was formed in November 2015 between Safaricom and the Kenya Co-operative Creameries (KCC) to deploy a KES 55.7 million cashless payment to over 200 sales and distribution agents. KCC will be able to place and process orders, access live delivery reports, create invoices and make payments. The application will also generate regular reports to ensure accountability and enhance record keeping and address the risks associated with cash handling with an eye towards business efficiency [52].

E-banking has thus not only created an easy platform for payment for goods ordered online, but is also promoting smooth business flow and has opened up more time for Nairobi citizens to engage in economically productive activities by reducing time spent in banking halls. One can, for example, pay for their debtors while comfortably performing other work-related tasks in the office or at home, provided they have an Internet or data connection. The advance in mobile money platforms, as well as partnerships between banks and mobile money operators, has also enabled the city residents to both pay for services from their mobile phones, to transfer money to their dependents and also to access both deposit and withdrawal services from their banks without having to visit the bank or Automated Teller Machines (ATMs). All of these elements have enhanced efficiency in business activities and also enhanced security of transactions associated with cash dealings. For example, a buyer can easily stop a payment if a seller/supplier fails to meet their end of the bargain, or they can use their transaction details (both for banking and mobile money transfer) as evidence in resolution of legal disputes emanating from transactions.

The importance of e-banking in reducing cash transaction-related insecurity and fraud cases has recently been strengthened through a regulatory circular (policy directive) by the Central Bank of Kenya, which created a ceiling for cash withdrawals at USD10,000. According to the circular, any transaction above this ceiling should be effected through an electronic funds transfer (EFT), either at the bank or through online banking (or through older methods, such as cheques or money orders). This move is geared towards promoting more electronic forms of payment, which the Central Bank of Kenya believes will curb widespread cash related insecurity and also reduce the levels of corruption associated with case dealings.

Outside of facilitating e-commerce, e-banking is also reducing operational costs within banks by reducing the number of employees required to service customers at

the banking halls. Other services possible through e-banking include checking bank balances, applying for loans, paying for loans and credit card bills, reporting loss of cards or unauthorized transactions, among others.

As more people use e-commerce and talk about it, consumer confidence in the service will continue to be enhanced and result in more adoption of the services. Ultimately, it will become the major form of trade in the city. As the service grows, the physical trade boundaries will be broken down, and transactions will be possible within and outside the city borders, greatly expanding the economic growth opportunities and improving incomes for Nairobians.

27.5 Emerging Opportunities for Nairobi's Smart Economic Growth

27.5.1 Growth in E-Governance Is Boosting Growth of Nairobi's Smart Economy

E-governance, the use of information technologies to improve efficiency and effectiveness in service by the government, as well as to promote good governance, has been picking up in Kenya over the last decade. The Kenyan government has installed an e-government strategy designed to promote efficiency in the delivery of government information and services to the citizens, promote productivity among public servants, encourage participation of citizens in government and empower all Kenyans regarding development priorities outlined in various economic development strategies. This would be achieved through improved collaboration between government agencies and reduction in the duplication of efforts, improved competitiveness through provision of timely information and delivery of government services, reduced transaction costs through availing of services electronically and provision of citizen participation forums in government activities [30]. The end goals for this are stimulating the economy through easing the cost of doing business.

Today, e-governance is contributing greatly to Kenya's economic growth, particularly through improved ease of doing business especially on aspects associated with applying for business permits. The government of Kenya has in the last decade launched various e-governance avenues ranging from creation of websites for all government ministries to creation of dedicated portals for both accessing various government services, as well as accessing data crucial for decision-making. Some examples include the following:

– eCitizen, eVisa and eBusiness portals—these are one-stop centres for accessing various government services. The eCitizen platform (www.ecitizen.go.ke) enables anyone to undertake activities such as business name search and registration, application for work permits, civil registration, searching for title deed, land rent clearance and payments, among others. The eBusiness portal (www.

ebusiness.go.ke) enables individuals owning businesses to access Government-to-business (G2B) services online and enables businesses to access services such as business licences, as well as permits and registrations offered by different government departments conveniently. The eVisa portal (www.evisa.go.ke) enables visitors to apply for a single-entry visa, a transit or courtesy visa to Kenya and pay securely using online platforms such as Visa and Mastercard (Fig. 27.7).

- The National Electronic Single Window System—launched in 2014 and implemented by the Kenya Trade Network Agency (KENTRADE) a state Agency under the National Treasury—is aimed at facilitating trade within the East African region [53]. This is being achieved by creation of a single system through which all permits and licenses can be obtained. This window, together with a national e-payment system, is enabling East African traders to swiftly complete all official procedures that would have taken months to complete previously and has been claimed to reduce the shipping costs within the region by up to 50 % [54].

- Automation of tax systems is easing business operations—unlike previously when Nairobians had to spend long hours queuing to pay their taxes, tax returns can today be done through the Kenya Revenue Authority Website (www.kra.go.ke). This saves considerable time, which can be shifted to productive economic development.

- Access to information through an open data portal is a key for business market research. The launch of the open data portal in 2011 (www.opendata.go.ke) presented new and varied opportunities for market research, which is invaluable in both the establishment and growth of various forms of businesses. Through the platform, any company intending to set up shop in Nairobi can easily and readily get information on such things such as population, educational attainment, Internet access and coverage, mobile phone penetration and transport systems and make informed decisions on the best place to locate without having to set foot in the country/location. The data in the platform also help citizens know-how government resources are being efficiently used and give a good basis for demanding accountability by the citizens.

- E-tendering system, through which tenders are floated online and qualified parties are encouraged to apply, is promoting transparency and expanding opportunities for economic growth in Nairobi.

As a result of the various e-governance approaches, necessitated by a growing adoption of ICT systems in various government processes, Kenya's rank slightly improved in the World Bank ease of doing business index from 129 in 2013 to 108 in 2015 [55, 56]. The biggest beneficiary of these emerging patterns has been Nairobi's economy, in which the city and central governments as well as the private sector and individual players are enjoying the improved business environment.

27.5.2 Decreasing Communication Costs and Increasing Adoption of ICTs Is Enhancing Smart Growth, but More Needs to Be Done

The technological innovations emerging from the ICT industry, such as those that improve access to and functionality of mobile phone and Internet services, have the potential to catalyse Kenya's economic growth and improve its efficiency [57]. The increasing investment in the enhancement of ICT service delivery in Kenya through the improved Internet connectivity (increasing bandwidth), increasing the number of Internet and mobile service providers and the reduction in costs due to economies of scale has opened up new and varied opportunities for growth throughout the country and particularly in Nairobi where ICT services are becoming deeply entrenched into the economic systems.

The cost of Internet access in commercial areas, such as cyber cafés, in Nairobi has gone down from Ksh. 15 per minute in 1998 [58] to Ksh. 0.5 in 2016, signifying a 3000 % decrease in under two decades. Similarly, call rates have significantly gone down over the years. A 2012 study indicates that Kenya had the lowest price for mobile services in Africa with the cost of the low-user mobile basket being just US$1.90 for a basket of 30 calls and 100 SMS per month. This was as a result of regulatory interventions by the communications authority to set a mobile termination rate, which is the lowest in Africa at 1.44 shillings (1.68 US cents) per minute [59]. In general, calling rates in Kenya have reduced from between Ksh. 8.50 and 32.27 in 2004 to an average of between Ksh. 2.2 and 2.6 per minute in 2016, and short message service (SMS) charges have declined from an average of Ksh. 10 in 2000 to Ksh. 1 in 2016 [58, 60–62].

With about 99 % of Internet access in Kenya estimated to be through a mobile phone device, mobile data have become the new battleground for customer base control among the country's major mobile service providers. The three mobile operators in the country have very competitive mobile data options, which are mostly issued as daily, weekly, monthly and unlimited plans, all with varying data limits and pricing. A user also has an option to choose a bundled plan, in which they pay distinctly for data, SMS and voice package, among the various networks. Table 27.3 compares mobile data charges among the three major mobile service providers in Kenya.

The fact that Nairobians can browse the Internet for as low as Ksh. 5 per day (and access social media platforms free for the entire day/night) is enhancing the growth possibilities towards a smart economy. With a rapidly growing mobile penetration, and as the number of people buying smartphones continues to surge amidst a sharp decrease in their prices, Internet access through mobile phones will greatly contribute to the future of Nairobi's smart economy. For now, the challenge remains on how to translate the 89 % of the population who use the Internet for social networking [65] into active online economy players. The shift in the Internet user trends towards e-commerce will, however, require further reduction in Internet

Table 27.3 Cost of mobile data in Kenya

Mobile data charges					
Mobile service providers	Ksh. 5	Ksh. 10	Ksh. 50	Ksh. 100	Ksh. 1000
Safaricom	– 5 MB + 5 SMS daily bundles – 5-MB weekly bundles	– 15 MB + 15 SMS daily bundles – 10-MB weekly bundles	– 150 MB + 150 SMS daily bundle – 65-MB weekly bundle	– 130-MB weekly bundle – 100-MB monthly bundle	–
Airtel	– 6 Mb – 8 MB + 5 SMS— (club 5 bundles)	– 15 MB	– 50-MB internet bundles – Unlimited daily internet	– 125-MB internet bundles – Unlimited daily internet	– 5-GB internet bundles – Unlimited monthly bundle
Orange	–	–	– 50-MB internet bundles – 50-MB monthly bundles – Unlimited daily internet	– 100-MB internet bundles – 100-MB monthly bundles	– Unlimited monthly Internet at Ksh. 990
Cyber café	–	– 20-mins unlimited surfing	– 100-mins unlimited surfing	– 200-mins unlimited surfing	– 2000-mins unlimited surfing

Source [51, 63, 64]

Whereas cyber cafés allow for better speeds (though not always) and give alternatives to perform more tasks at once than is practical in a phone (e.g. the number of pages one can comfortably browse simultaneously or availability of printing), they have major limitations, such as the fact that one needs to be physically in a specific space to access the service and that they are only open for a specific amount of time, hence limiting 24 h usage, unlike the mobile phones

costs, which according to various online market places are still very high and limiting to would-be e-commerce clients.

27.5.3 A Fast-Growing Middle Class Is Supporting Nairobi's Smart Economic Growth

Kenya has a youthful, well-trained and active population, which is engaging in multiple income generation activities, while promoting a fast growth of the middle class. According to the African Development Bank, the middle class is comprised of people who spend between US$2 and 20 per day [66]. In 2010, Kenya's middle class was estimated to be larger than the Sub-Saharan Africa average, as informed by 28 % of Kenyans spending US$2–4 per day and 17 % spending US$4–20 a day. This compares favourably to the rest of Sub-Saharan Africa, where 14 % spend US $2–4 a day and 10 % spend US$4–20 per day [66]. With most of the population in this class projected to be living in Nairobi, their purchasing power and their adoption of ICTs into their day-to-day activities are unquestionably the major driving force behind the fast-emerging e-economy.

Kenya's middle class is very resilient to global economic downturns. Their agility and ability to cushion themselves from external financial shocks were recently proven during the 2008–2009 global financial crises. Most of the population in this class remained steady financially and were not pushed back into poverty [67]. Though there has been increased pressure among this class from growing inflation in the country, the class has remained relatively steady. The consistency in this class' purchasing power has already largely contributed to the growth of a thriving shopping mall lifestyle in Nairobi, Internet-related trade, a burgeoning housing market, a booming automobile industry, improved banking performance and growing domestic tourism [39, 68]. Equally, this class has facilitated the ballooning of the property market—both commercial and residential properties—which was estimated to have grown by 25 % between January and December 2011 [68].

27.5.4 ICT Education Guarantees Nairobi's Sustainable Smart Economic Growth

Enjoyment of the long-term benefits of smart economy relies on a population's ability to continuously utilize emerging ICT technologies to enhance their economic productivity, which is itself reliant on both formal and informal trainings. For Nairobi to enjoy sustainable advancement towards smart economic development and achieve maximum benefits from its large demographic dividend, ICT education is crucial for all levels of its population. Long-term smart growth, where

many smart technologies will be at the centre of economic development, will be felt in the medium-to-long term, as more establishments adopt ICT in their operations, larger populations get inculcated into the e-culture and the ICT infrastructure expands to more parts of the city.

While the government and the private sector have been investing heavily in the ICT infrastructure in Kenya, there has been a comparatively lower level of investment in the human resources required to design, develop and operate these infrastructure and their associated e-applications [69]. With the increasing sophistication of ICTs and their applications, high-end skill sets are increasingly required and the lack of a properly educated and trained workforce tailored to ICT presents a challenge to the country's smart economic growth.

Computer education was first introduced in Kenya's public secondary schools in 1996, through two major educational resolutions: (a) an agreement between the Ministry of Education and UNESCO in 1996 on the funding of the project and training secondary schools to teach computer skills and (b) publishing of policy and curriculum guidelines in 1997 approving the teaching of computer education in secondary schools and making it an examinable subject in 1998 [70]. Over the next two decades, a lot of progress has been made, both in terms of policy and physical infrastructure development, resulting in a highly computer-literate population. Major challenges, including lack of adequate resources, limited ICT infrastructure, electricity supply, have, however, prevailed over the years and continue to challenge universal ICT education to date.

The second major stride in ICT education started to emerge in the mid-2000s, when the government of Kenya through its 2004 e-government strategy [71] started to emphasize the need for transformation of government services from manual- to digital-based operations. The strategy created the platform for formulation of other policies which have guided ICT education to date. Such policies include the Sessional Paper No. 1 of 2005—"Policy Framework For Education, Training and Research"; the National ICT policy in 2006 and the National ICT Strategy for Education and Training in 2006. Through the provisions of these policies, various interventions have been made, ranging from the development of partnerships on school computer projects to creation of school (secondary and university)-specific ICT policies [70, 72].

The progress in achieving ICT education has, however, been slow, mainly due to challenges such as lack of electricity, lack of adequately trained computer teachers in secondary schools and lack of funding for the attainment of computers in schools. As a result, many schools still lack computer equipment, and where it exists is inadequate, with student–computer ratios as high as 150:1 [72]. Internet access in the schools is also limited, creating a challenge in sharing of e-learning content. In 2007 for example, only about 10 % of secondary schools with computers were able to share teaching resources via a local area network [72]. Similar challenges exist in the country's institutions of higher learning, which are supposed to be the epitome of ICT adoption in the education system.

Until the late 2000s, when universities started creating partnerships with private sector entities and multi-national companies on ICT-related development, access to

ICT facilities such as computers and Internet had been largely limited. This was largely in line with a World Bank Institute survey, which identified ICT infrastructure in African universities as being "*too little, too expensive and poorly managed*" and comparing the average bandwidth capacity to a broadband residential connection available in Europe, and for which the cost was 50 times more than their educational counterparts in the rest of the world [73]. In line with the ongoing ICT revolution, and taking advantage of the decreasing bandwidth, several universities in Nairobi are creating wi-fi hotspots throughout campus through which students can access Internet. Adoption of ICT systems in training, and particularly on productive sectors such as manufacturing, however, remains limited due to the high investment costs associated with modern technologies. This forces most students to learn to use various high-end, job-related ICT systems and machinery at the job market, creating a huge disconnect between training and the job market [74]. This trend is slowly changing with the integration of ICT into the training and curriculum update from various policy directives. ICT infrastructure in primary school in the country has largely been negligible and mostly restricted to certain well-established schools in Nairobi, at least until after 2013, when a newly elected government started working on its campaign promise to issue laptops to every primary school entrant.

Despite the slow pace of transition towards ICT education in Kenya in the mainstream education sector, there are positive indicators of a tech-oriented population, which creates numerous opportunities for smart growth. Many ICT training colleges have emerged all over Nairobi and other towns throughout Kenya in the past two decades, offering numerous courses in computer and related education. Similarly, mid-level colleges are also offering numerous courses on ICT, such as training of ICT technicians.

27.5.5   Increasing Investment in ICT Is Expanding Smart Economy Alternatives

Achieving smart economy alternatives will require significant financial and human resources. In 2011, the Government of Kenya spent 0.3 % of overall spending, US $860 million on IT. Most of the government ICT spending is on hardware at 65 % compared to global benchmark of 18 %. However, IT spending on staff is significantly lower at only 18 % as opposed to 38 % for global benchmark.

The massive investment in ICT infrastructure development in Kenya through the Internet submarine cable projects (SEACOM, TEAMS, EASSY and LION cables), the National Optic Fibre Backbone Initiative (NOFBI) network, licensing of mobile phone operators, reduction in various ICT-related tariffs (e.g. removal of taxes on services and reduction in call termination rates) as well as promotion of ICT education in the country is creating the proper baseline for Kenya to achieve smart

economic growth by 2030, as provided for in the country's long-term plan, the Kenya Vision 2030.

The undersea cables have increased the bandwidth in the country from a mere 28 Megabits per second (Mbps) in 2004 to 193.58 Gigabytes per second (GBps) in 2015 [75, 76], and thereby greatly enhancing connectivity. This has resulted in Kenya being identified as a market leader in Africa in Internet connectivity, with the highest bandwidth per capita [77]. The increase in bandwidth, which has also been reflected in decreasing cost for Internet and data services, has increased Internet usage and opened new opportunities for economic growth. In addition, growing ICT education, both in schools and the many emerging innovation centres in Nairobi, has not only attracted many tech companies, such as Google, Cisco, Intel, IBM, Huawei, RTI, Motorola, Nokia and Pfizer, but has also strategically placed Nairobi as Africa's ICT savannah. Mozilla's Global Community Manager, William Quiviger, has been quoted making a case as to why Nairobi deserves to be crowned Africa's ICT Innovation hub [78], and Google executive chairman Eric Schmidt predicted that Nairobi could become the African tech leader [78]. The founding of hubs and expansion of businesses by Google and other tech giants such as Cisco Systems, Intel, Nokia and Microsoft, as well as setting up of the IBM laboratory for the Africa region in Nairobi (in partnership with the Kenyan government), is a show of good faith in the city's promising tech potential [79]. This also implies both the huge strides made in ICT development and also portrays the unlimited opportunities for smart economic growth in the city.

To further the opportunities for ICT-based growth, the government of Kenya has put in place several measures to guarantee the country's long-term smart growth. Some of the efforts have included a creation of a friendly policy environment, such as reductions in mobile connection charges by the Communication Authority of Kenya, creation of the ICT master plan (2006), prioritization of ICT invention and development through the Kenya Vision 2030 strategy, and establishment of policies and programmes on ICT education at various learning levels among other interventions. The establishment of Konza Technology City, established through the Kenya Vision 2030 strategy, is perhaps the largest leap for Kenya to achieve a smart economy, after the sub-marine fibre optic cable project. The Konza Technology City, whose development began in 2008, is expected to become Kenya's first fully fledged technology city, tapping on the growing global business processing outsourcing and information technology-enabled services (BPO/ITES) sectors in Kenya, as a means to enhance smart economic growth (Box 27.1). Ongoing Investments in other infrastructure services, such as roads, railways, airport expansion, energy production and distribution, are also opening massive opportunities for smart growth in Nairobi.

Box 27.1: Konza, Kenya's First Fully Fledged Smart City
Konza, 60 km south of Nairobi on 5000 acres of land, is expected to grow into a community of over 200,000 people supporting the development of BPO/ITES, life sciences, telecom and education industries. Konza

Technology City is a twenty-first century city that will foster the growth of the technology industry in Kenya. As a Kenya Vision 2030 flagship project, it will create a competitive and prosperous nation, helping Kenya attain middle-income status by 2030. Konza is connected to Nairobi, Jomo Kenyatta International Airport and Mombasa, the primary port of entry to East Africa and Kenya's second largest city by a class A highway.
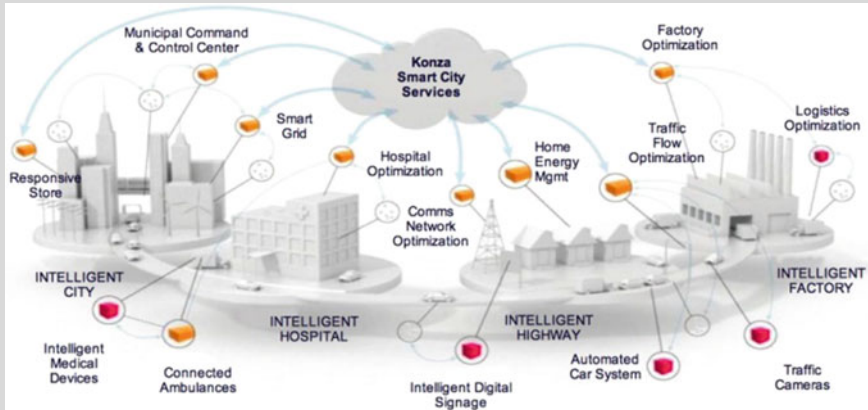
As a smart city, Konza will gather data from smart devices and sensors embedded in the urban environment, such as roadways, buildings and other assets. Collected data will be shared via a smart communications system and be analysed by software that delivers valuable information and digitally enhanced services to Konza's population. For example, roadway sensors will be able to monitor pedestrian and automobile traffic, and adjust traffic light timing according to optimize traffic flows.

By leveraging the smart city framework, Konza will be able to optimize its city services, creating a sustainable city that responds directly to the needs of its residents, workers and visitors.

The implementation of a smart city framework at Konza has begun with detailed planning relating to ICT infrastructure. As Konza continues to develop its technology network, it will draw from a range of international best practices, including the Intelligent Community Forum, Smart Cities Council and International Standards Organization's methodologies for the sustainable development of communities. Konza will learn from global cities that have successfully incorporated smart city frameworks, including Santander, Spain; Barcelona, Spain; Singapore; Amsterdam, The Netherlands and Rio de Janeiro, Brazil.

Source: [79].

27.5.6 *Innovation Ecosystem and Growing Partnerships on ICT Will Enhance Long-Term Economic Growth and Financial Inclusion*

Kenya, and Nairobi in particular, is a breeding ground for massive ICT innovations, many of which are aimed at improving efficiency in her commercial and productive sectors. From the development of ICT innovation hubs to development of partnerships between training institutions and employers to establishment of regional headquarters for tech-oriented multi-national companies, Nairobi's position as Africa's silicon savannah is clearly evident. The opportunities for smart growth with these kinds of development are equally enormous.

Whereas most productive processes in Nairobi are taking up ICT to improve efficiency in their performance (manufacturing, service), two unique areas have emerged through which ICT is not just a means to improving efficiency, but for which ICT is itself a very valuable good. The two areas—mobile money and information sharing and management platforms—have offered unlimited opportunities for innovation, which positively impact all sectors of the economy, both the formal and informal ones. While mobile money is the screaming giant in the room, information sharing and management platforms are rapidly becoming a major player in the city and are greatly contributing to improved economic productivity. These systems are for example helping drivers use less congested routes, thus reducing the amount of time spent in traffic, are helping sellers reach buyers and vice versa, are giving consumers an avenue to compare products, are aiding in market research and, as a result, are contributing to informed business decision-making.

One such application is the ma3route (short form for matatu/minibuses route), which is a mobile/web/short message service crowd sourcing platform that integrates big data on transport and provides users with information on traffic, public transport routes and accident occurrences, and gives driving reports. The 2012 start-up, which integrates various social media platforms, especially Twitter, allows users to not only get traffic updates, but to also get directions and report careless driving and traffic accidents. Ma3route is one of the most relied upon traffic update applications among road users in Nairobi. There are over 300,000 daily users engaged on its website, social media accounts and mobile app. Additionally, there are about 20,000 people in Nairobi who receive SMS notifications two or more times a day, depending on their preference [80]. As of 2016, the ma3route mobile application has been downloaded over 10,000 times.

Equally impactful in the manufacturing sector, most players have adopted automated processes and ICT-driven precision technologies. This does not only apply to the large, formal manufacturing companies, but also to the huge informal manufacturing and service sectors.

27.5.7 Suitable Government and City Policies and Institutional Framework Is Promoting Smart Growth

As discussed throughout this chapter, various government policies have accompanied various interventions towards smart alternatives over the last decade. The key ones include the Kenya Vision 2030, the national ICT policy, the Kenya national ICT master plan, the Kenya National Cybersecurity Framework and the National ICT Strategy for Education and Training.

27.6 Emerging Challenges to Nairobi's Smart Growth

27.6.1 The Challenge of Cyber Security Is Slowing Nairobi's Smart Economic Growth

As Kenya's e-economy has grown and become more diverse, so have the cases of fraud and insecurity. Cyber crime is estimated to cost the country upwards of Ksh. 3 billion ($36 million) or 0.05 % of its GDP [59], a fact that has kept many consumers away from using online payment platforms. In cases where online marketplaces play a minimal direct role in transactions, such as the case of OLX and Kaymu where buyers interact directly with sellers using the marketplace as just a trading platform, fraudulent cases have been reported. Over the past few years, social media has been filled with complaints of fraud and insecurity cases associated with OLX transactions, often resulting in loss of property [33]. To curb this trend and improve on consumer confidence, OLX has partnered with the shipping company G4S, which receives and inspects products before shipping at relatively fair prices. The market platform has also partnered with KK security, a local-based company, to provide private investigator services, making the platform more secure for buyers and sellers [81].

Whereas adoption of modern technologies epitomizes Nairobi's (and Kenya's) manufacturing sector, the Internet is the future of Kenya's trade industry, which today accounts for most of the city's income and labour force in formal and informal sectors. A recent study commissioned by the Centre for International Governance Innovation (CIGI) and research firm Ipsos established that most Kenyans (95 % of respondents) view the Internet as part of their economic future and livelihood. The same study also established that although 39 % of respondents did not have a problem with sharing their private information with companies online, 96 % were unlikely to take up online banking services since they feared cyber criminals [82]. This conflict paints a clear picture of the need to improve on the country's cyber security.

The government of Kenya has over the past few years been working towards improving the cybersecurity situation in the country. The National Cyber Security

Framework, which is composed of a strategy, digital certificates and a portal where Kenyans can report incidents of fraud, has been seen as a step in the right direction. The ICT authority, whose mandate is to coordinate the ICT sector, establishes, develops and maintains secure ICT infrastructure and systems, and, to market Kenya as a local and international ICT hub, is piloting a digital certificates programme in partnership with the Kenya Revenue Authority to curb the rising cases of cyber security [83]. This effort, combined with changes in the debit/credit card technologies to incorporate chip and pin technologies, which are more secure, is helping to reduce the cases of fraud. As the activities of the National Cyber Security Framework pickup, Nairobians are opting for a hybrid of their traditional methods and new systems in a buy-online/pay-offline approach (based on cash-on delivery) or payments through mobile money services, which are identified as being more secure.

27.6.2 A Huge Informal Sector Based on Offline Trade Limits Rapid Smart Growth

As discussed in Sect. 27.2, Nairobi's economy is still largely informal, which creates challenges for growth in ICT-enabled economies. Since most of the informal activities rely on small commodities, often sold on the city streets or in informal markets and jua kali clusters, the uptake and shift of these businesses towards ICTs are largely limited and might remain so in the near future if urgent action is not taken by various trader associations. Contrary to individual "informal" ventures and the case of Kamukunji Jua Kali Association which has adopted ICTs to market their products, the practice has not been picked up by many other informal business clusters in the city. Upon identification of the potential in marketing locally produced products online, middlemen have cashed in on several ventures.

A good example is Nairobi's largest and most famous handcraft market, Maasai Market, which gives the country a unique identity and brand through unique clothe and jewellery, home/office equipment, art, etc. The market wares, which are sold in various parts of the city, are famous all over the world, and most tourists visit one of the market spots to partake in true Kenyan art. Hosting thousands of traders, the most obvious thing would be for the traders to have an association and a collective online marketing platform to target the international clientele, who often praise the originality and quality of the art. Instead, in the absence of such an initiative, private entrepreneurs have taken up the task of forming various websites and social media pages to market the "Maasai market" brand, while acting as middlemen for the craft. A simple Google search of "Maasai Market" gives results on individually registered businesses selling the Maasai handcraft or various shopping malls in Nairobi where the markets are held on various days of the week. For example, the online business "The Maasai Market" (www.themaasaimarket.com) is a family business operating in the USA since 1998, and which imports handcraft from

Nairobi and sells it in the USA (acts as middlemen for the products). Several other social media pages exist, which are run by individuals who are most likely middlemen.

Generally, although the high levels of informal activities generate income for the participants, it generates little revenue for the city government. This is a limiting factor for smart economic development. Ongoing efforts to integrate the informal sector into the formal economy through the Micro and Small Enterprises Act, and the creation of the Micro and Small Enterprises Authority, present a unique opportunity for inclusion of the small and informal enterprises into the formal economy. This not only creates a stream for growth and development of relevant infrastructure for the sector, but also opens the sector for technology transfer.

27.6.3   Limited Research on New Economic Growth Areas Restricting Smart Growth Opportunities

As new avenues for smart growth emerge all over the world, Kenya is still reliant on traditional forms of economic activities, such as agriculture and service delivery. There is a need for diversified research on emerging economic trends, such as business process outsourcing (BPO), cheap technology manufacturing and creation of relevant mechanisms for transfer of practices being used in other fast-emerging economies, which are using similar models. Whereas some of the practices are being borrowed and transferred to the country, such as through the proposed Konza Techno City, action by the private sector and small-scale players for outsourcing of local customer relations and production processes should be explored.

27.6.4   Other Challenges

– High levels of unemployment—the attainment of a smart economy requires a sustainable and consistent revenue generation culture, which promotes adoption and use of ICTs in both productive and other commercial activities. The high levels of unemployment in Nairobi, particularly among the youth, are pushing both the educated and less educated young people into informal activities, restricting their creative ability. In 2009, about 84 % of employed youth aged 15–24 years were in the informal sector, which provides a rough estimate of individuals engaged in vulnerable jobs [84]. Some deliberate government initiatives such as the 2006 youth enterprise development fund and the 2009 "*kazi kwa vijana*" (jobs for the youth) initiatives have been rolled out with an intention to improve access to finance for business start-ups and offer them on-the-job training. Although these initiatives have created some successful enterprises, they have been faced with massive mismanagement of funds, which

has often limited their reach and impact. With the majority of youth employment in the country happening in the informal sector, more research needs to be undertaken on approaches for promoting youth involvement in economic development. On the other hand, however, some of the most innovative ICT-based activities are emanating from these informal sector entrants, who see technology as a way to income sustainability.

– Complex business climate—Kenya has a disruptive political cycle, with a mediocre, but improving, business climate. Political uncertainty, especially around elections, and the associated volatility are arguably the main handbrake on sustained private sector investment and growth. Without long periods of stability and peaceful transitions of government, private sector performance will continue to underperform against its long-term potential [57]. The widespread perception on corruption, political interference and patronage in business further hinders the growth of businesses, particularly the emerging ones which are majorly driven by local investors, especially young, entrepreneurial citizens. In 2014, Kenya was 145th in Transparency International's Corruption Perception Index [85], with Nairobi at the centre of public funds embezzlement.

– Macro-economic volatility—this has been identified as a major challenge to doing business in Kenya and is influenced by a high cost of capital, unstable exchange and inflation rates, complicated land tenure systems (including fraud) and ownership restrictions, local political vested interests in various businesses, anticompetitive behaviour by dominant firms, etc., which greatly affect business operations and planning. The macro-economy has, however, been generally stabilizing in the recent years despite the depreciating shilling and rising inflation [57]. These have generally raised the cost of doing business in the country and lowered the level of foreign direct investment (FDI).

– Slow pace of infrastructure development—basic infrastructure services such as reliable and affordable electricity and efficient transport systems still remain a major challenge to Nairobi's achievement of optimum productive capacity. As a regional trade and transport hub, Nairobi's transport and logistics systems, including customs, goods clearance and weighbridge processes, are a great bottleneck to the country's growth. Adoption of ICTs in various sectors such as customs and goods clearance is, however, improving the state of affairs in the various sectors.

– Mismatch between training and the emerging ICT-based economy, which is identified as increasing the cost of production in firms, who have to retrain their new employees. This is, however, fast changing through growing partnerships between production firms and training institutions.

– High levels of poverty and inequality result in unequal access to opportunities and in turn biases wealth creation to a smaller section of the population, limiting Nairobi's potential for sustainable and smart economic growth. With an income Gini coefficient of 0.59 [86] and a consumption coefficient of 0.341 [17], Nairobi is no doubt an unequal city. Whereas only 21.8 % of Nairobi's population was estimated to live below the poverty line in 2009 (against a national and urban average of 45.2 and 33.5 %, respectively) [87], about 50 % of the

city's population is estimated to be living in informal settlements [88], which are deprived of several basic infrastructure. The economic, social and spatial segregation of the city population is closely associated with the city's level of insecurity.

27.7 Conclusion

Increasing investments in ICT and other physical infrastructure, alongside policy changes to promote ICT adoption, are already creating a friendly foundation for smart growth in Nairobi. In order to fully enjoy the benefits of the city's fast evolving ICT landscape and its growing human capital, Nairobi needs to work more on catalysing adoption of ICT by both the manufacturing and informal sectors. Uptake of innovative ICTs by the manufacturing sector would greatly contribute to a huge increase in the country's growth rate, which would not only create the right environment for transition towards the goal of Kenya Vision 2030 to become a middle-income country, but also create the right prerequisites for the sustained smart growth. High technology-based production and technology transfer to the many MSEs involved in manufacturing activities will further help this transition and also aid in shifting the production and trade cycles from the largely informal nature to more regularized trends. Ongoing efforts on the integration of the formal and informal economic sectors are likely to boost this process.

Whereas cybersecurity will remain a challenge as more people take up electronic-based economic activities, a growth in both policy and digital security oriented local companies will no doubt lead to enhanced cybersecurity, creating more opportunities for growth in e-economy. The ongoing investment in the Konza Techno City has opened numerous opportunities for a shift towards ICT-driven smart growth, such as through creation of opportunities for business process outsourcing.

The rate of adoption of ICT by the city of Nairobi has already brought forth massive positive changes in the revenue collection structures, eased the process of business permit attainment, improved traffic management and opened new doors for innovation and growth among the city residents. At the citizen level, massive innovations in the various incubation hubs are already diversifying economic productivity options and creating a fast-growing clique of middle class population. This class will further drive Nairobi's long-term smart growth. The largely youth full and well-educated population in the city, and continued enjoyment of a demographic dividend over the next few decades, will further help sustain the smart growth.

Sustained smart economic growth will, however, require directed political and policy intervention, especially on the reduction of the country's political and economic volatility. This will help create the right climate for investment (both local and foreign investments), grow individual incomes and promote equality, and also

generate revenue for the government to invest in core infrastructure necessary for sustained growth.

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Part XI
Nigeria-Lagos

Chapter 28
Smart City Foundation for Smart Economy

Femi Olokesusi, Femi Ola Aiyegbajeje, Gora Mboup
and Dennis Mwaniki

Abstract A smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centric approach based on three core components and seven dimensions, all of which integrate ICT into their architecture. The three core components are *Smart City Foundation and Smart Institutions and Laws,* which in turn are the pillars of the seven dimensions of a smart city: infrastructure development, environmental sustainability, social development, social inclusion, disasters exposure, resilience, peace and security. The three components together with the seven dimensions make a smart economy. A smart city foundation is composed of three elements: urban planning and design, land policies and basic infrastructure. For a city foundation to be smart, it must be inclusive at the onset of the urban planning and promote mixed neighbourhoods where social clustering is prevented.

Keywords Lagos · Smart city · Smart economy · Smart city foundation · ICT · Urban planning · Streets · Public spaces · Secure tenure · Basic infrastructure · Flooding · Adaptation · Mitigation · Policies · Programmes

F. Olokesusi (✉) · F.O. Aiyegbajeje · G. Mboup · D. Mwaniki
University of Parakou, Parakou, Benin
e-mail: femioloke@yahoo.com

F.O. Aiyegbajeje
e-mail: femidavid2002@yahoo.com

G. Mboup
e-mail: gmboup@gora4people.org

D. Mwaniki
e-mail: dmwaniki@gora4people.org

G. Mboup · D. Mwaniki
University of Ibadan, Ibadan, Nigeria

G. Mboup · D. Mwaniki
Global Observatory Linking Research to Action, Nairobi, Kenya

28.1 Introduction

Lagos, the former capital of Nigeria and the largest city in sub-Saharan Africa, is located on the southwest coast of Nigeria and has a history dating as far back as the fifteenth century when it grew as a trade centre and seaport. It was captured by British forces in 1851, annexed as a British colony in 1861 and became the capital (regional administrative centre) of the colony and protectorate of Nigeria in 1914, a status it maintained until 1991 when the country's capital was formally moved to Abuja [1, 2].

The city of Lagos is among the few African cities with a population of over 10 million and hence considered as a megacity. In 2014, the population of the urban agglomeration of Lagos was estimated at 12 million. A large population gives Lagos an economic comparative advantage associated to high population density and massive youthful active population. The urban agglomeration of Lagos is part of the Lagos State that encompasses an area of 3577 km^2 of which 787 km^2 are lagoons and creeks [3]. It has a population of 17.5 million [3]. Metropolitan Lagos covers 37 % of the land area of Lagos State [4]. While the population density of the state is about 4193 persons per km^2, the density in the built-up areas of Metropolitan Lagos, made up of Lagos Island, the original city, and the Mainland, is over 20,000 persons per km^2 [3].

Despite the movement of the federal capital to Abuja in 1991, Lagos has remained as the country's dominant economic, social, and financial centre as well as the hub of national and international communications. It is a thriving industrial and commercial centre with seaports, local and international airports, and industries concentrated in the Apapa, Ikeja and Ilupeju industrial estates. Lagos state contributes more than 30 % of Nigeria's GDP, accounts for about 90 % of the national foreign trade flows, 70 % of all industrial investments, consumes more than 60 % of the national electricity supply and generates 70 % of its revenue internally [5]. Lagos is one of Africa's five biggest consumer markets, has higher standard of living than anywhere else in Nigeria and is home to almost half of Nigeria's skilled workers [4, 6]. In addition, Lagos is a major educational centre, providing a well-educated and highly skilled labour pool. The employment opportunities continue to attract both domestic and international migrants [4].

Despite its potential to be a sustainable, inclusive and prosperous city, Lagos smartness has over the decades continued to suffer from a weak city foundation, emanating from years of urban planning negligence and under investment in basic infrastructure development. Many settlements in the city lack a sewerage system and rainwater drainage facilities, and adequate waste management sites are missing, which are key components of smart basic infrastructure along with connection to water and energy. Flooding during rainy seasons as well as uncollected garbage is frequent phenomena in all parts of the city, but particularly in the poor settlements. Frequent energy shortages also affect the city's economy.

This chapter discusses the city foundation of Lagos and how it is shaping the city's prospects for smart economic growth.

28.2   The Concept of Smart City Foundation

A smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centric approach based on three core components—*Smart City Foundation, Information and Communications Technology (ICT) and Smart Institutions and Laws.* These three core components are the pillars of the seven dimensions of a smart city: infrastructure development, environmental sustainability, social development, social inclusion, disasters exposure, resilience, and peace and security. The collective of these components and dimensions constitute a Smart City Economy (Fig. 28.1).

A smart city foundation is composed of three elements: urban planning and design, land policies and basic infrastructure, all of which integrate ICT into their developmental and operational architecture. For a city foundation to be smart, it must be inclusive at the onset of the urban planning and promote mixed neighbourhoods where social clustering is discouraged. Having all the poor living together creates slums and fuels instability and insecurity. Inclusive urban planning eases access to basic services (water, sanitation, housing, education and health) and to decent employment for all. A key element of smart urban planning is a smart
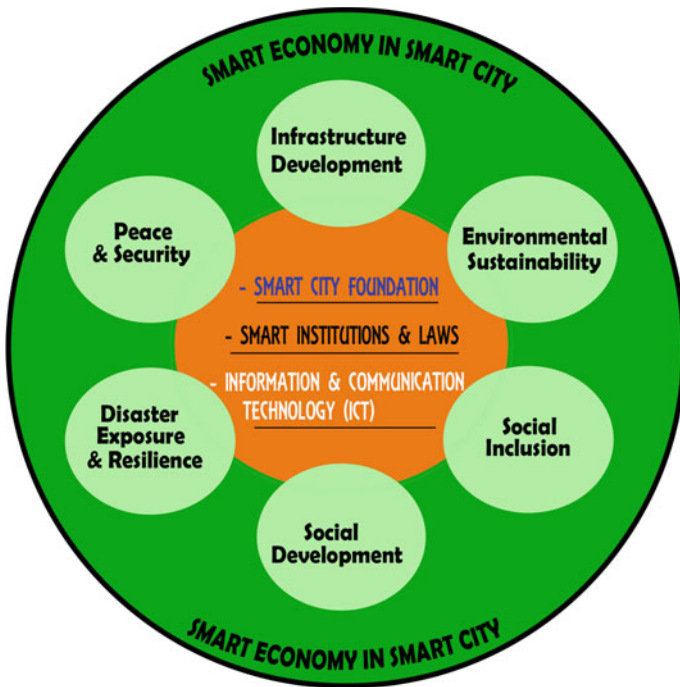
Fig. 28.1 Conceptual framework—smart economy in smart cities in the African context. *Source* [7]
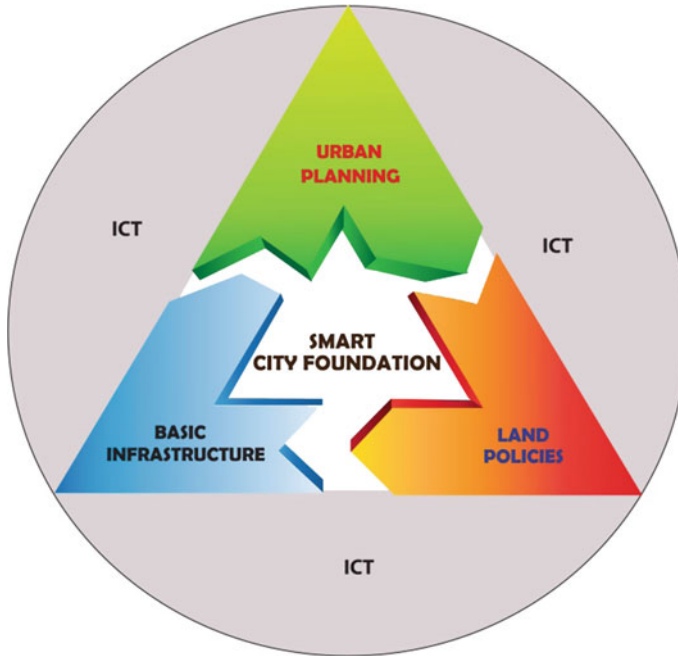
Fig. 28.2 Smart city foundation. *Source* [8]

street network that reduces travel time and encourages walking and social inter-actions. Smart urban planning enhances infrastructure development, environmental sustainability, economic and social development; makes cities resilient and pre-pared to overcome natural disasters; and promotes mixed neighbourhoods where services are walking distances from people's residences. ICT plays a crucial role in promoting a smart city foundation, by enabling inclusiveness in planning, policy and infrastructure provision processes such as through public participation; as well as creating enormous non-physically limiting opportunities to all city residents. Basic infrastructure constitutes access to urban basic services such as water, sani-tation, housing and energy (Fig. 28.2).

Infrastructure development complements the basic infrastructure services under smart city foundation and extends to actual investment and advancement of services such as transport, ICT, industrial energy, education, health, etc. **Environment Sustainability** is comprised of elements of energy, transport, building and pollution. **Social inclusion** includes aspects of participation in deci-sion making as well as according all city residents equal opportunities for growth and prosperity. **Social development** encompasses elements of education, health, public space, social inclusion and social capital. **Disaster Exposure** incorporates elements of mitigation and adaptation to various disasters such as flooding, droughts, storms and earthquakes. **City Resilience** is composed of elements of city foundation, environment, social capital and social development. **Peace and**

security deals with all forms of violence and conflicts, including domestic violence, violence in public places, crime, armed conflicts, terrorism, etc. An insecure city limits opportunities for investment and economic growth and cannot be a smart city.

28.3 Two Centuries of the Planning of the City of Lagos

Lagos, originally known as *Eko*, has a history dating as far back as the fifteenth century when it emerged as a pepper farm, fishing post and later grew as a trading centre and sea port [9]. Lagos started around the Island and Mainland areas and served as a major slave trade centre between 1404 and 1889. It was captured by British forces in 1851, annexed as a British colony in 1861 and became the capital (regional administrative centre) of the colony and protectorate of Nigeria in 1914, a status it maintained until 1991 when the country's capital was formally moved to Abuja [1, 2]. Lagos has been administered under a variety of territorial schemes. When it was ceded to the British in 1861, it was administered as a city-state with its own separate administration. In 1866, it was included in the West African Settlements under a Governor-in-Chief resident in Sierra Leone, but retained a separate legislative council and a local administration. Various changes followed, through its status as a separate colony, to its merger with Western Nigeria in 1951. When Lagos state was carved out as one of the then 12 states in the federation, Lagos assumed new role as a regional administrative centre [10].

Owing to the historical investment by the colonialists, and with the two administrative roles (both the national and Lagos State capital) and their associated financial and administrative capacity, Lagos city had a much higher degree of infrastructural development than the larger Lagos State and the rest of Nigeria. Within Lagos, the model of infrastructure development adopted within the city itself favoured the white colonial settlements and largely ignored settlements inhabited by the indigenous African majority, resulting in unequal intra-city infrastructure provisions. Beginning in the late 1950s, a shift in Nigeria's economy from agriculture to crude oil trade made Lagos attractive to immigrants from all parts of the country, as well as from other neighbouring countries. The effect of a rapidly growing urban population was increased pressure on the existing infrastructure [4, 10, 11].

28.3.1 Urban Planning as a Tool for Segregation and Development in Lagos During the Colonial Era

Spatial planning in its general sense was part of local indigenous administration in Nigeria, long before the colonial administration. By the mid-1800s, many

indigenous cities in Nigeria, though not urbanized in the modern sense which gives population thresholds, had a form of arrangement of land uses in their domain, with deliberate spatial organizations done around palaces and to conform to community needs for defence, religion or trade. Cities such as *Kano, Zaria and Ondo* still retain their pre-colonial inner-city settlement structure [12, 13]. The traditional core area of Lagos had developed following a distinct urban design pattern that followed the typical Yoruba classical town plan which resembles a wheel, the Oba's (king's) palace being the hub, with the spokes consisting of a series of roads radiating out from the palace and linking the town to the centre [14, 15]. Some of these aspects are still evident to date [16].

Elements of European planning in Nigeria started to emerge with colonialism in Lagos in the early 1900s, but were restricted to towns and localities where the colonial administrators and European expatriates were residing [16]. The emerging planning legislation in Lagos throughout the colonial period aimed to create settlement zones throughout the city based on race. The 1863 Lagos Town Improvement Ordinance, which introduced the basis for control of development and urban sanitation in Lagos protectorate, was the first planning legislation in the country. This ordinance was followed by the 1902 Planning Ordinance which empowered the governor to declare areas as European Reservations with a Local Board of Health of their own [17]. The Cantonment Proclamation enacted later in 1904 was the first major legislation that ushered in segregation of expatriate officials and Europeans from the native areas in the guise of tackling the then prevailing public health problems in Lagos. The segregationist development would be later furthered by the Ordinance No. 9 of 1914 (on compulsory acquisition of land for public use) and the Township Ordinance No. 29 of 1917 (which classified urban settlements into different grades and established broad physical layouts of towns). The 1917 ordinance classified Lagos as the only first class township in Nigeria, giving it its own managerial authority in the form of a Town Council. Enforcement of this ordinance in Lagos advanced the segregation tendency along racial lines with the creation of European Reservation Areas for the expatriates and Europeans and encouraged subdivision of native areas into indigenes and non-indigenes [18].[1] Among the key developments undertaken during this period was the development of Apapa in Lagos in 1926 as a self-contained residential community that provided relief to Lagos Island of its original port functions to focus on being the Business District Centre [15], a function that the island plays to date.

With focus being put on the European areas, native areas remained largely unplanned and largely lacking in infrastructure development. Population increase in these areas subsequently led to congestion, and with lack of basic services, there was an outbreak of bubonic plaque in late 1920s in the native settlements of Lagos [16]. As a result, a new inclusive planning and development approach was urgently required and was drawn in the Lagos Town Planning Ordinance of 1928. Although

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[1]The Native Authority Law of 1954 defined a non-indigene or stranger as any native who is not a member of the native community living in the area of its authority.
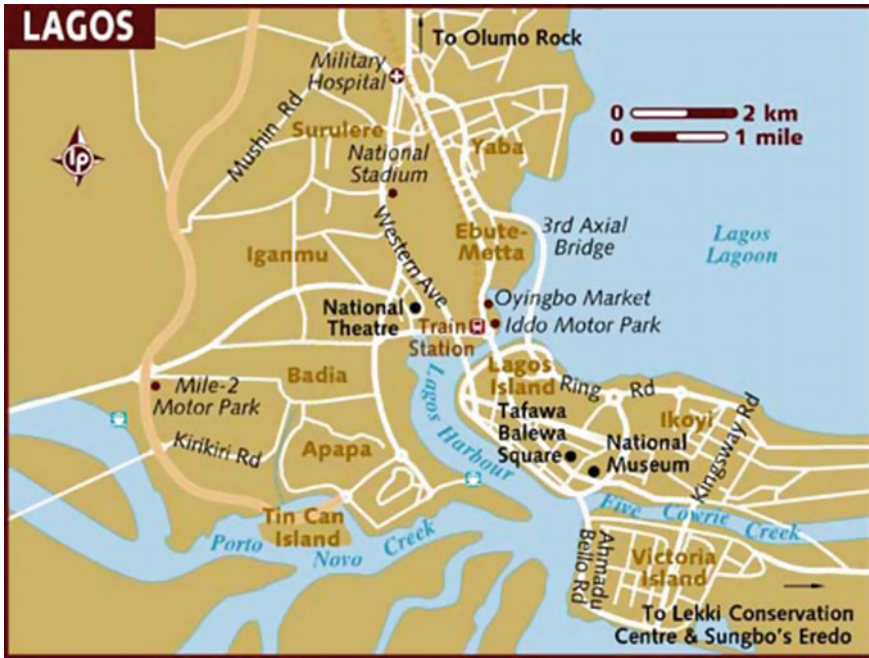
Fig. 28.3 Major historical growth areas in Lagos. *Source* [19]

this ordinance made Town Planning a government activity and resulted in recla-mation of swampy areas of Oko-Awo in the early 1930s and resettlement of the displaced people from the area to the south of Yaba estate in Lagos Mainland area, the focus of development still remained in the affluent areas. Yaba North estate was developed during this time to provide housing to government officials [16] (Fig. 28.3). Subsequent ordinances such as the Nigerian Town and Country Planning Ordinance No. 4 of 1946 continued to emphasize on the concept of zoning, which continued to favour development in the European areas at the expense of the poor settlements occupied by the majority locals.

Throughout the colonial era, more attention was devoted to the development of parts of Lagos (such as Ikoyi) as a garden suburb, coupled with the development of private commercial and club recreational grounds. Most of the facilities developed during this era continue to shape the urban landscape of Lagos, the most famous one being the European Reservation Areas, now known as government reservation areas (GRAs) [17]. The GRAs, which were the Europeans' version of the garden city in Nigeria, were developed under the principle of creating cool fruit and flower gardens where one could sit on a veranda in the privacy of their home, and extensive public open spaces with recreational grounds and sports fields would be near both office and home, reached by shady pathways [20].

28.3.2 Shifting the Focus of Urban Planning to Economic Development—Post-independence

At the time of independence, the focus of development in the country was simply sectoral and economic planning was favoured to conscious efforts aimed at resolving physical planning challenges. National development plans, whose adoption had started a few years before independence with an objective to create policies, programmes and projects for achieving economic development in the country, become the independent government's development pathway. Subsequent adoption of master plans to guide spatial development of Lagos did not yield much post-independence as a factor of limited capacity by the city authority to control growth; limited resources and investment in housing and basic service provision; an urbanization rate that was faster than the city could respond to; focus of planning on creating physically attractive layouts as opposed to functional spaces among other challenges.

The period of military administration (1966–1979) did not bring much change, and if anything resulted in increased inequalities and deterioration of physical infrastructure in Lagos and other urban areas [21]. Focus was more on provision of infrastructure and development of agriculture in the rural areas, with emphasis on development of new towns which led to the emergence of Abuja and other satellite towns to Lagos [16]. The Federal Military Government accepted a report to construct a more central federal capital in Abuja in 1976 further increasing Lagos' woes. When development started in the Abuja Federal Capital Territory in 1980, little investment was made towards Lagos's development despite the fact that the city continued to attract more immigrants and continued to function as the country's commercial hub. The second republic period (1979–1983) and the period of return of military rule (1984–1999) did not also come with much development for Lagos, although various legislations related to planning were developed. Inspite of formulation of these legislations, which were adequate at that time to promote sustainable urban growth, they were not fully utilized for the purposes they were designed for and the recurrent planning problems in Lagos remained intractable [22].

28.3.3 Urban Planning, Zoning and Land Development in Metropolitan Lagos

According to the Master Plan for Metropolitan Lagos, the urban land area was approximately 172 km^2 in 1976 The major part (97.5 %) of this land was in the contiguous built-up area, and the remaining 2.5 % of the total metropolitan area was separated from the contiguous area of the metropolis. Residential land use accounted for more than 50 % of the total metropolitan land area followed by transport and circulation (about 18 %), institutional and special use (about 14 %)

Table 28.1 Lagos metropolitan area land-use structure 1976 and 2008

Land-use classification	Land area occupied (ha)		Percentage of development	
	1976	2008	1976	2008
Residential	8939	9669	51.9	52.1
Commercial	821	1021	4.8	5.5
Industrial	1444	1448	8.4	7.8
Institutional and special use	2366	2784	13.7	14.0
Open space and recreation	453	520	2.6	2.8
Transportation and circulation	3205	3340	18.6	18.0
Total	17,228	18,782	100	100

Source [17, 23]

and open space and recreation facilities occupied the least land area (<3 %) (Table 28.1) [17].

The medium-grade residential areas, mostly developed for the Europeans and government officials during the colonial era, were characterized by gridiron patterns with bungalows set within a mosaic of small plots of about 300 m^2 [12]. Most of the original bungalows have, however, been replaced with multi-storey buildings in response to economic demands. The residential areas of Surulere, Yaba and Ebute-Metta are examples of this kind of housing developments that been reasonably improved and can be found in Ebute-Metta West, Ojuelegba, Obalende and Inner Ikeja. The poorest land grade areas which were never planned are in Mushin, Somolu, Ajegunle, Ajeromi, Agege and Yaba East (Fig. 28.4). These varying growth regimes have resulted in varying development trends, in which, when compounded by the metropolitan areas, rapid urbanization has promoted individualization and fragmentation of land leading to increasing housing density [17].

28.3.4   Urban Planning and the Environment

The Ministry of Physical Planning and Urban Development's stated vision is to make Lagos a place where people live, work and recreate in an environment featuring world-class infrastructure and services that support an improved quality of life and cultural diversity. Its mission is to plan and facilitate an organized, safe, green, dynamic, economically and culturally vibrant and sustainable city that supports optimal land use. The following initiatives have been undertaken in an effort to achieve the Ministry's vision and mission: preparation of district plans; draft of state town plans and regulations; preparation of layout plans for excised villages; preparation of interim regional and structural plans; resettlement of saw mills in Epe; preparation of the metropolitan master plan for Ikorodu. City model plans have been prepared for settlements such as Victoria Island, Ikeja and Ikoyi. Other initiatives include: creation of sites for motor dealers at Mowo-Badagry;
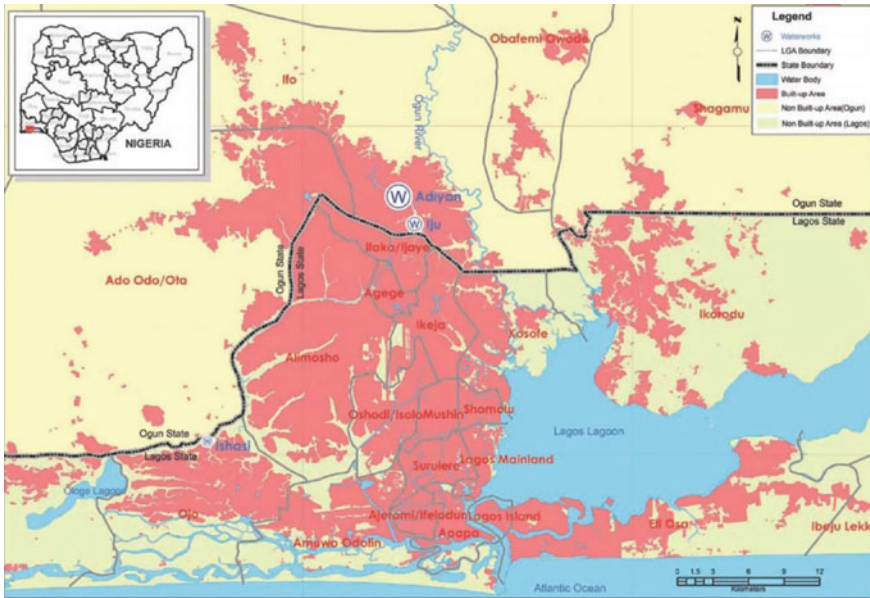
Fig. 28.4 Lagos built-up area. *Source* [24]

determination of alignment for proposed major state roads; setting up of the Central Lagos Redevelopment Scheme; renewal of urban areas; development of markets; creation of a new building control authority, ensuring the construction of safe, high-quality buildings; establishment of the Lekki Free Trade Zone, an international Public Private Partnership between a Chinese government-sponsored company and the Lagos state government.

Since 1999, the Lagos state government has overhauled planning activities, leading to the review of the Lagos State Regional Planning Law in 2005. Several commissions were tasked with preparing land-use plans for some of the state's districts and local governments, and a state building code was adopted. These plans and interventions have been based on the active consultation and engagement of all stakeholders. Contributions from individuals, community development associations, traditional rulers and interest groups formed critical inputs in the decision-making process. Upgrading of urban facilities is noticeable through the redevelopment of old regional markets, such as Tejuosho, Oluwole and Balogun, into shopping malls. Also, Local governments are mandated to begin redevelopment of the various local markets into modern shopping centres with small trading stalls (K-Klamps) to accommodate street traders—thereby reducing trading on streets, the bane of Lagos traffic and a cause of environmental degradation. As part of the state government's desire to transition the city of Lagos to a smart city, there is now a digital map of the entire Lagos state which is making it easy for several purposes including planning administration. As part of the digital map, building

designs and application for development permits to the Ministry of Physical Development and Urban Development are done electronically since January 2016. beginning in January 2016.

28.3.5 Slum Upgrading and Redevelopment

In the past decade and a half, the Lagos state government has progressively embarked on upgrading slum communities and making them conducive to sustainable development. Based on a 1985 World Bank study, the government created the Lagos State Urban Renewal Authority, which adopted a citywide approach supported by a $200 million credit intervention assisted by the World Bank's International Development Association (IDA). This seven-year upgrading project began in October 2006 and ended in March 2013 [25]. The project upgraded nine of the worst slum communities. The project, which targeted 1.1 million inhabitants and 150,000 households with an average monthly income of about $170, resulted in upgrading of nine of the worst slum communities in the state [25]. The intervention involved upgrading dilapidated roads or footpaths; providing public toilets and bathrooms; sinking boreholes; building new schools and improving existing ones; developing health facilities; and creating youth empowerment through skill acquisition and leadership development.

The Lagos state government has formulated and implemented a strategy of redeveloping slums with private-sector funding. The upgraded slums, in most cases, feed into the redevelopment scheme. Under this arrangement, the property owners and tenants of the slums are consulted. The owners contribute their properties for redevelopment through a cooperative and in return receive reasonable compensation. Property developers are brought in to build high-rise buildings on the property to prevent occupier displacement. Most properties are redeveloped from bungalows into three-to-four storey buildings, compensating for land-use allocation to roads, drainages and open spaces in the newly developed areas and avoiding displacement of slum residents [11].

28.3.6 Smart Streets Are Needed to Transform the City of Lagos to a Smart City

In recent years, streets have been recognized as an integral element of urban planning, and a key factor in the achievement of sustainable urban development. A connected street network reduces travel time and encourages walking and social interactions. With regard to planning, sufficient land should be allocated to streets and the street network should be sufficiently long to cover all areas of a city. There must be sufficient intersections available to facilitate shorter distances and reduce

travel times, and encourage walking and social interactions [26]. Well-connected streets enhance infrastructure development, environmental sustainability and economic and social development. They also make cities resilient and prepared to overcome natural disasters. A sustainable, inclusive and prosperous city expands multi-modal transport systems with sidewalks and bicycle paths, ensures eco-efficiency of infrastructural systems and supports density through integrated infrastructure development, thereby enhancing efficiency and access [26]. In addition to accommodating all kinds of users (pedestrians, cyclists, motorists), sufficient land allocated to streets promotes connections to services that contribute to good health and productivity, such as clean water, sewerage facilities, drainage systems, power supply and information and communication technologies [26]. Streets that provide space only to motorists are characterized by congestion and high carbon dioxide (CO_2) emissions [27].

The city of Lagos is not benefiting from all the multiple advantages associated with well-connected streets. While 14 % of land is allocated to streets in the Lagos city core, only about 6 % of land is allocated to streets in the suburbs [26]. One effect of this has been marginalization of the most vulnerable segments of society who rely mostly on public transport and non-motorized means of transport for their day to day operations. Lagos city is not well connected to the city's water, sewer and storm water mains. In addition, infrastructure for non-motorized transport (e.g. pavements or sidewalks for walking and bicycle lanes for cycling) is often lacking, poorly developed, on the decline or does not appear to rank high among city planners' priorities. This has led to high incidences of traffic congestion and often results in fatalities involving pedestrians and cyclists.

Over the years, emphasis has been on creating smart streets to transform the city of Lagos. Such efforts have brought about the Lekki–Ikoyi link bridge built through Public Private Partnership initiatives that was to ease the heavy traffic congestion usually experienced for many hours on a daily basis by commuters plying this axis of the metropolis. This Lekki–Ikoyi link bridge has reduced the several hours spent on commuting between Lekki and Ikoyi to a less than 20 min journey. The Lekki-Epe expressway has similarly facilitated easy access to the fastest growing area in the city. The number of roads constructed rose from 6 in 2006 to 29 in 2010 and 22 in 2012 amounting to about 150.8 km. The total length of rehabilitated roads from 2007 to 2012 was about 86.22 km. To improve safety and visibility at night, a total of 38 street lights were installed in 2008, and this increased to 1217 street lights in 2012 [28]. Since the new administration was installed in 2015, additional street lights have been restored (Fig. 28.5).

Additional effort taken by the government of Lagos State to achieve smart streets in Lagos is in the area of effective management of the chaotic traffic situation in Lagos metropolis. In order to achieve this, the Lagos State Traffic Management Agency (LASTMA) and Vehicle Inspection Office (VIO) were established to deal with traffic offenders. Other roles include issuance of roadworthiness certificate, issuance of automated vehicle licence, driver licence and insurance certificate to curb car theft, issuance of fake certificates. The exercise was able to discover 12,083 fake certificates in 2010, 17,862 in 2011 and 18,252 in 2012. Aside

Fig. 28.5 Lekki–Ikoyi link bridge. *Source* [29]

managing traffic problems in the city and issuance of fake certificates to unsus-
pecting vehicle owner, this initiative was also aimed at increasing government
revenue [28].

28.4   Smart Land Tenure, Key for Smart City Foundation and Smart Economy

One fundamental driver of a smart city foundation lies on the institutions and laws
that govern human settlements, be it a city, a town or a village. The way the city is
planned, land distributed and basic infrastructure laid down is governed and
administered within functioning institutions and laws. Providing security of tenure
depends on a range of policies related to institutions and laws put in place to protect
people against unlawful eviction; to ensure equitable distribution of basic services
to all communities; and to put in place transparent and accountable processes of
land regulation, key for secure land tenure [30].

In Lagos, as is the case in most Nigerian cities, land tenure is neither well
governed nor well administered. Poor land governance is surrounded by poor land
administration characterized by a poor determination, recording and dissemination
of information about tenure. In addition to being exposed to eviction, without legal
proof of ownership, households cannot enjoy the economic and financial
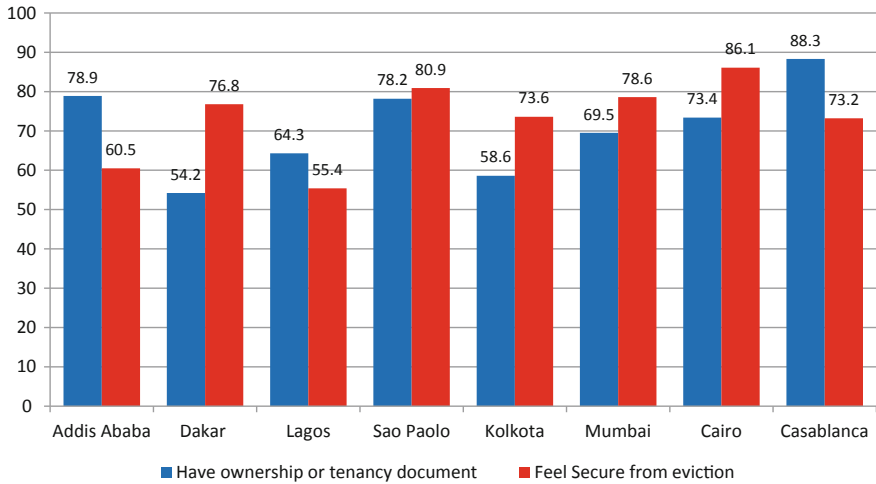
Fig. 28.6 Proportion of households with adequate document for proof of ownership or tenancy and proportion of households secure from eviction in selected cities, 2004–2007. *Source* [31]

opportunity associated with investment and savings using their property as collateral. At the community level, the municipality cannot also legally collect various taxes that can be used to improve basic infrastructures. Promotion of secure land tenure in Lagos will boost investment in property development, increase municipal tax collection and in turn promote economic growth.

Regarding security of tenure, UN Habitat and partners have now made considerable progress in developing a measurement method for security of tenure. The method had been implemented in 25 cities around the world through Urban Inequities Surveys. People or households are considered to have secure tenure when there is *evidence of documentation* that can be used as proof of secure tenure status or when there is either de facto or *perceived protection against forced evictions*. For owners, documents that are adequate for proof of security of tenure are: land registration certificate, title deed to dwelling, purchase agreement for land, lease agreement for land and certificate of occupation. For tenants, documents that are adequate for proof of security of tenure include registered or non-registered lease agreement and/or some form of written informal agreement.

From Fig. 28.6, possession of ownership or tenancy document varies widely across the eight cities, with 64.3 % of households in Lagos having proof of legal ownership or tenancy document [30]. However, despite the fact that nearly the two-thirds of households in Lagos have ownership or tenancy documents, only 55.4 % feel protected against eviction, implying a lack of adequate governance structures where tenure administration is clearly understood and respected. Measures to reduce the risk and stress associated with lack of documents and fear of eviction are based on recognizing and respecting a plurality of tenure systems, including intermediate forms of tenure arrangements and alternative forms of land

administration and land records [32]. The legal institutional framework in a given country or city plays a key role on various elements of security of tenure such as acquisition or adjudication which is the process of final and authoritative determination of the existing rights and claims of people to land.[2]

28.4.1 Secure Tenure Goes Beyond Protection Against Eviction and Includes Economic and Financial Advantages

Land shall not be seen only as a social asset providing shelter to people, but also as an economic and financial asset providing opportunity for investment and saving. At the economic and financial aspect, various social and economic advantages include access to the financial and economic market as demonstrated by De Soto [33]. De Soto argued that granting titles to the poor would liberate the plots they occupy and transform them into capital. This, in turn, could be used as collateral for loans to jumpstart their businesses, or improve their houses, among other gains that increase their quality of life. At the community level, the municipality can legally collect various taxes that can be used to improve basic infrastructures such as connection to water, sewerage facilities, energy sources and waste management facilities. This would also allow people to fully participate in the development of their communities instead of seeing proprieties as dead investments, which only serve as shelter. In a study by UN Habitat on "Urban Inequities in three cities: Addis-Ababa, Casablanca and Lagos", the security of tenure questions in Lagos was gauged based on the degree of perceived security on a four and a five-point scale. The question was posed in terms of "have you ever felt threatened with eviction?" which referred either to instances in which such threats were actually issued or to the perception that eviction could occur. The findings of the study suggested that, among owners, there is little to suggest widespread concern about security, with high percentages of owning households saying that they have never felt at risk. However, there is a sub-group of owners who admit to some degree of insecurity, with about one owner out of ten in Lagos expressing such feelings.

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[2]Once the land is acquired, another element that depends on legal institutional framework is the acquisition of a building permit, which is at the authority of the local governing body on land use and planning for construction or renovation of a property. Another element that lies to the authority is the cadaster system, which is a parcel based and up-to-date land information system containing a record of interests in land (i.e. rights, restrictions and responsibilities). Indeed, security of tenure depends heavily on the land governance that establishes the rules, processes and structures through which decisions are made regarding access to and the use of land, the manner in which those decisions are implemented and the way that conflicting interests in land are managed. In many cities of the developing regions, poor land governance is surrounded by poor land administration or registration characterized by a poor determination, recording and dissemination of information about tenure, value and use of land during the implementation of land management policies.

About 84 % of renters say that they have never felt at risk of eviction. The reason adduced to this may be due to the land and housing markets, or in the legal and political systems that confer protection or (alternatively) induce anxieties about tenure.

28.5 Basic Infrastructure—Key for Smart City Foundation

In a smart city foundation, provision of basic infrastructure such as piped water services, sewerage facilities electricity and solid waste management is considered along the city planning. These elements are a crucial part of the city planning and in an ideal situation are planned for and developed prior to (or concurrently with) housing development and human settlement. In a smart and sustainable city foundation, use of improved services such as piped water, sewerage facilities, solid waste management and electricity is quasi-universal.

28.5.1 Water Supply

Water supply in Lagos is not enough to meet the level of desired demand. Out of a total estimated water demand of 540 million gallons per day in Lagos State, only 33 % of water supply is met on a daily basis [28]. The Lagos State Water Corporation (LWC) has 20 mini waterworks which produced 2630.18 gallons of water in 2011, a figure which slightly increased to 2646.56 gallons in 2012. This is a major shortfall compared to the State's combined annual water production capacity of 26,775.75 gallons in 2010, 28,070.04 gallons in 2011 and 23,402.98 gallons in 2012 from its three major water works located in Adiyan, Iju and Isashi. Additionally, the state has 17 micro-water works that produced 1424.26 gallons of water in 2010, 1208.77 gallons in 2011 and 1451.99 in 2012. Accessibility to Lagos Water Corporation among the residents rose from 14 % in 2010 and 2011, respectively, to 16 % in 2012 [28]. The water supply coverage is about 40 % through a pipeline network that runs north–south and mostly services the eastern part of the city, and excludes the large population in the western part. The informal water supply sector is substantial, serving about 60 % of Lagos State residents [28]. Cases of groundwater contamination through seepage from buried petroleum pipelines have been reported.

In an effort to address this challenge, the Lagos State government has made significant investments to rehabilitate waterworks and to privatize the LWC. It has also focused on constructing and refurbishing micro- and macro-waterworks, improving power generation for water projects, providing efficient bill collection, and repairing/rehabilitating collapsed boreholes. At the moment, 15 micro- and

macro-waterworks have already been built with the capacity to produce 30 million gallons per day as part of a water project coordinated by the LWC [34]. For the purpose of sustainability, the Lagos State government is currently resuscitating the Adiyan/Iju waterworks, each with a total production capacity of 130 million gallons per day [34]. This is aimed at meeting the water need of the resident in a short while.

Meanwhile, fewer households in Lagos take their drinking water directly from piped sources into their homes. The most common sources of water in Lagos are boreholes and protected wells. Significant percentages of households draw water from unprotected wells or springs, or from a heterogeneous mix of "other" sources that are also likely to be at risk of contamination. Boreholes and protected wells are a more important source of drinking water for households in Lagos, accounting for 45 % of total household water sources [35]. Furthermore, the household's standard of living greatly determines the type of access to water. Among the very poor households of Lagos, very few are fortunate enough to have piped water in the home and only small percentages have access in the yard. Moving up the relative standard of living scale, there exists a steady improvement in the ease of access to water, with rising percentages of households having access directly in the home or the yard. According to UN Habitat's 2005 Urban Inequities Survey, the time needed to collect water for households without access to water in the home was short, with a median collection time of only 5–10 min across the city of Lagos and its neighbourhoods.

Supply disruptions are quite common in Lagos. The likelihood of disruption is highly related to the way in which drinking water is supplied, and also depends on the location of specific neighbourhoods within the larger state. While the average rate of service disruption is estimated at about 27 %, the values differ significantly between various Local Government Areas (LGAs). Lagos Island, for example, has a water disruption rate of 43.8 %, while Lagos mainland has a disruption rate of 17.6 %. Ibeju Lekki LGA has the lowest disruption rate of only 2.3 %, and Oshodi/Isolo LGA has the highest disruption rate in the entire state, estimated at 61.8 % [35] (Fig. 28.7). Households using piped water experience the highest rate of supply disruption (46 % for piped into dwelling, 44.6 % for piped into yard) against households using unprotected wells whose disruption rate was 24.2 %. Given that the very poor households in Lagos rely least on piped water sources (piped into dwelling—0.6 %, piped into yard 1.7 %, public tap 6.7 %) [35], they are somewhat less likely to experience disruptions in the service.

28.5.2   Power Supply

Like most Nigerian cities, the power sector in Lagos faces a chronic shortage and erratic supply. Although there are no reliable data to describe the power situation in Lagos, estimates indicate that the current demand for power in Lagos State stands at between 5000 and 8000 MW against a supply of between 900 and 1200 MW. The
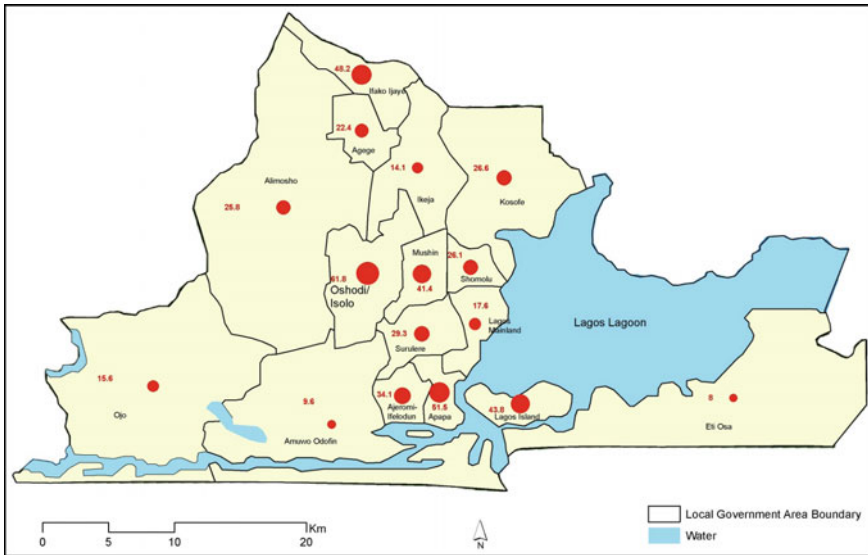
Fig. 28.7 Percentages of disruption of water supply by Local Government Area. *Source* Author representation using data from [35]

average supply deficit, which is only about one-sixth of the demand, leaves enormous supply gaps and is largely representative of the national supply pattern, which ranges from 3400 to 4200 MW against a demand of 25,000 MW [36].

Given the importance of power supply for economic development, the Lagos State government has made the sector a priority policy area since 1999. The major outcome from the ongoing interventions include growing partnerships between the state and independent power producers to help increase the state's supply capacity.

According to UN Habitat's 2005 urban inequities survey, access to electricity in Lagos and its reliability vary greatly among neighbourhoods and income levels. For example, while 98.4 % of non-poor households in Lagos have access to electricity, only 51.4 % of the very poor households have access to the service. Equally, while the average rate of household electricity connection in the Lagos is 92.5 %, the LGAs of Lagos Island and Lagos mainland enjoy connection rates of 99 and 98.9 %, respectively; and the Epe LGA has the least connection rate, recorded at 69 % [35] (Fig. 28.8).

Power supply in Lagos is largely unreliable, with the average household electricity average 8.5 h per day. Within Lagos Island and Lagos mainland, the average number of hours with electricity supply is 7 and 8.5 h per day (Fig. 28.9), which is a major impediment to economic and social productivity at all levels of the population. The effect has been a major reliance on fuel reliant generators, which have significantly increased the production costs for manufacturing firms, increased operational costs for commercial enterprises and reduced productivity at the household level (Box 28.1).
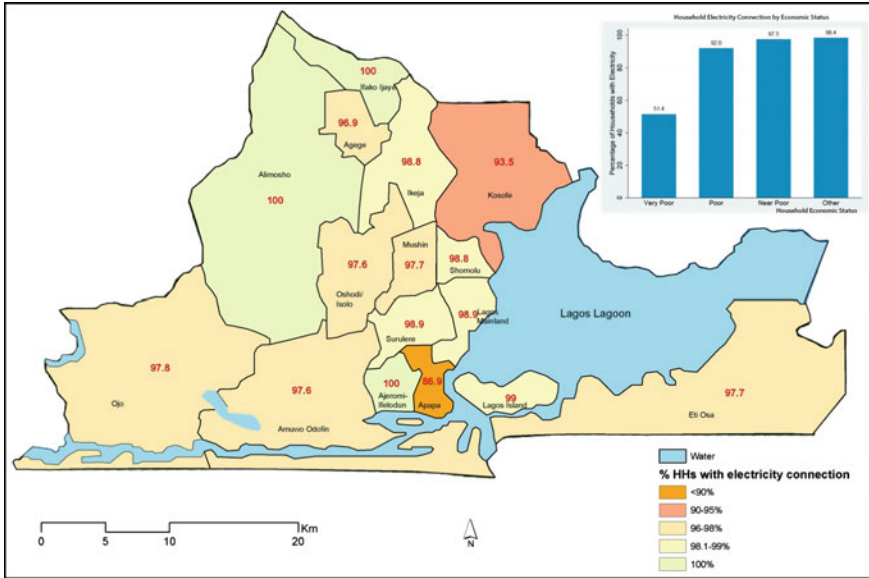
Fig. 28.8 Electricity connectivity in Lagos by LGA and household income status. *Source* Author representation using data from [35]
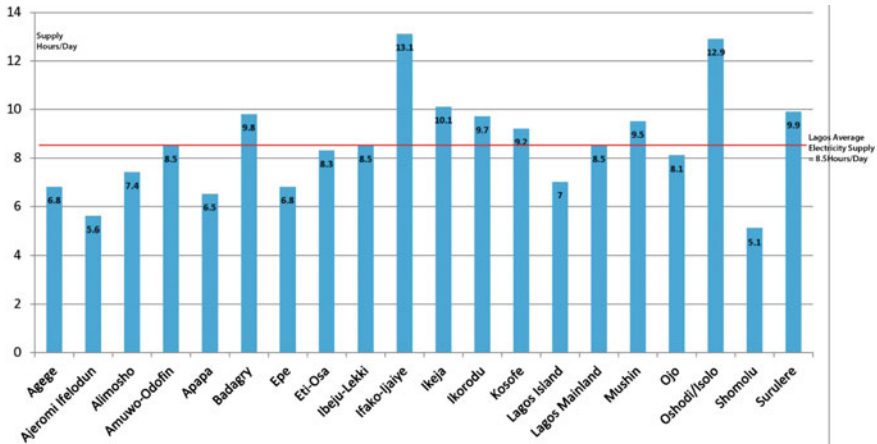
Fig. 28.9 Hours of daily power supply by local government area of Lagos—for households with an electricity connection. *Data Source* [35]

Several initiatives have been taken with a view to meeting the power supply challenge. In 1999 for instance, an independent power project implemented by AES Nigeria, a subsidiary of AES USA, is responsible for generating 270 MW of power through nine barge-mounted gas turbines, with an option of upgrading to 540 MW.

The US$12 million project was financed by a consortium of four foreign banks and three foreign institutions. In addition, another independent power producer is Akute Power Limited, responsible for installing the 12.15 MW plant that supplies electricity to the Adiyan-Iju waterworks [35].

The Lagos State government has embarked on power generation. About 120 MW of power was added to the National grid by the Lagos State government and plan is on the way for additional megawatts. The Rural electrification project of Lagos State government got a boost by successfully electrifying three communities in 2010 to thirty-two communities in 2011 and 148 communities in 2012 [28]. The statistics further showed that 100 transformers were distributed to all the 20 LGAs of the State in 2010, 226 transformers in 2011, 113 transformers in 2012 amounting to 439 transformers within 3 years. At present, installation of smart meters has begun in the metropolis and is enjoying a high-level patronage. However, current estimates indicate that a minimum of 15,000 MW of generating capacity is required to position Lagos City as Africa's Mega City of Choice and place Lagos City among the most promising cities in the emerging economies. The government has also partnered with AES Nigeria and El Sewedy Electric of Egypt, a major producer of cables and electrical products in the Middle East, to build a transformer production factory in Agbara-a suburb of Lagos city, for the production of oil-immersed distribution transformers from 50 to 1500 kV-A [28].

Box 28.1 Electricity Supply Challenge in Lagos

Lagos State is currently the largest consumer of power in Nigeria. Most power is consumed by industry and commerce. The Ikeja Industrial Area accounts for 35 % of total power consumption, while Lagos Island has the highest population of commercial end-users of power. Most of these businesses and individuals, faced with power shortages, have opted for generators as alternative sources of power. This places pressure on scarce resources and is expensive because it has raised the cost of electricity to the range of 45–90 Naira per kWh. Electricity constitutes on the average between 20 and 40 % of the cost of production in a typical manufacturing company. This suggests that it costs a Nigerian company more than double what a company in emerging or developed nations pays for the same unit of electricity, judging by current international figures.

Transmission and distribution technology is increasingly obsolete in a number of areas. This causes endless disruptions to power supply. Some generating stations are currently idle because of lack of turn-round maintenance, shortage of gas and limited transmission capacity. Criminal activity exacerbates problems. Vandalism has been reported in the form of damages or theft of transmission and distribution cables, not only in Lagos State but in other States. The centralized grid means sabotage at a transmission tower disrupts the entire network.

The transmission and distribution losses are estimated at 40 %, higher than the rest of the continent estimated at 11 %. Transmission and distribution

infrastructure needs rehabilitation to restore system stability and security. There is also some room to reduce demand. At present, the Lagos State Electricity Board (LSEB) is performing Energy Audit, which will help in developing more Independent Power projects to help match demand with supply. LSEB has also introduced Energy Calculator to help consumers manage their power consumption. Source: [36].

28.5.3 Solid Waste Management and Sanitation

28.5.3.1 Solid Waste Management

Solid waste management started to become a major challenge in Lagos in the early 1970s when the oil boom, which compounded the emerging industrialization and urbanization, resulted in high volume of waste which became increasingly difficult for the local government councils in Lagos State to manage [10]. With only 40 % sanitation coverage, and an estimated 10 % solid waste collection rate, garbage heaps on the city streets are a testimony to the logistical nightmare of clearing over 10,000 tonnes of refuse generated daily in the state [4, 5, 37].

In an attempt to address the inherent solid waste management challenge, the state government created the Lagos State Waste Management Authority (LAWMA), which works together with the local government authorities, the Ministry of Environment and private-sector participants to streamline and create an efficient waste collection, transportation and disposal structure. While LAWMA is responsible for managing waste generated within the city (including waste management enforcement and compliance, highway sanitation, landfill operations, managing landfills and dumpsites, etc.), the Ministry of Environment is the environmental policy regulator, and private-sector participants are the collection and disposal partners in the waste management chain [36]. In its effort to offer sustainable highway sanitary services, LAWMA's level of recruitment of highway managers (whose responsibility is cleaning highways throughout the metropolis) increased from 42,887 HMs in 2010 to 12,633 HMs in 2011 and 50,746 HMs in 2012. The Private-sector participants have greatly assisted LAWMA in domestic and industrial waste collection, with a record waste collection increase from 1,386,847 metric tonnes in 2010 to 2,356,634 metric tonnes in 2012; against LAWMA's collection of 907,298.75 metric tonnes in 2010 and 1,273,472 metric tonnes in 2012 [28]. Other LAWMA's responsibilities include, among others, evacuation and prevention of backlog, clearance of public and markets wastes, management of existing landfill sites, development of policy initiatives for future waste management activities, provision of counselling to private operators on waste management, identification

of sites for development of waste management facilities and appraisal of proposals on establishment of waste management activities [38].

Through partnerships between LAWMA and private-sector players, waste management alternatives which include conversion of waste into fertilizer and the construction of transfer-loading stations that serve as transit camps for refuse to be regularly compacted are being undertaken. As a result, Lagos has already become the largest producer of compost, which it supplies throughout Nigeria and to the Federal Ministry of Agriculture [38]. Other ongoing projects on solid waste management which the state government is implementing in a bid to create a safe, friendly, and sustainable environment conducive to residential, business, and recreational development include: (i) efficient community-based waste management, (ii) Aggressive "greening" and beautification of open spaces, decrepit loops, verges, and medians under Operation Green Lagos (iii) social rehabilitation and economic empowerment of so-called area boys[3] by engaging them in environmental beautification and landscaping projects (iv) Upgrading of the Olususun landfill (Ikeja) by constructing three access roads to tackle the perennial Oregun traffic, as well as installing deodorizers to eliminate pollution and enhance the air quality and public health of adjoining neighbourhoods (v) construction and equipping of eight waste transfer-loading stations at Yaba, Ogombo, Ebute-Elefun (Simpson), Oshodi, Ishasi, Ajegunle, Abule-Egba and Oba Ogunji Street (Agege) (vi) procurement of 240 waste collection trucks and three (3) Tana giant landfill compactors for efficient waste management at the landfills, and (vii) introduction of Dino bins in over 2000 locations across the state and evacuation of illegal dumpsites at ten locations including Obele Oniwala (Surulere), Oba Ogunji Street (Agege), Opebi (Ikeja), Ajah (Eti-Osa) and Festac Gates (Amuwo), as part of a new environmental and waste disposal project [34].

28.5.3.2 Access to Sanitation

Like in most cities in sub-Saharan Africa, sanitation provision in Lagos city is grossly deficient. Access to hygienic toilet is very low among the residents and this is likely to increase the level of infectious disease burden and quality of life [39]. USAID [40] opined that the deficiency of accurate data makes it impossible to determine whether Nigeria is making progress to meet its MDG targets which may also translates to lack of accurate data in Lagos. There is no sewerage system in Lagos except for very small systems serving institutions and private estates. Also, there are no major wastewater treatment facilities. About 35 million cubic metres of waste water is generated per day in Africa, and Lagos State alone generates 1.5 million cubic metres per day. This includes 119 million gallons per day (mgd) (66 %) from surface water—51 mgd (34 %) from groundwater [40].

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[3]The term *area boys* refers to able-bodied, unemployed and possibly drug-dependent men who harass pedestrians and motorists for money.

Less than 2 % of the population is served with off-site sewage treatment plants, and only toilet wastewater is connected to septic tanks and soak-away systems [40]. Other household liquid wastes are discharged directly into the mostly open gutters in front of houses or on the streets. The wastewater eventually percolates or is washed into the water bodies by rainstorms. Septic tanks and soak-away systems used in the collection of toilet wastewater often contaminate and pollute the shallow groundwater—a vital source of water to most low and middle income residents. Also, there is no sewerage treatment plant in the megacity and the untreated sewerage is mostly evacuated into the Lagos Lagoon [40]. The faecal contamination of the megacity's water system and the environment through the inadequate management of wastewater is an important health concern.

The sanitation situation is direr in the low-income districts and slum communities. About 70 % of Lagos residents are estimated to live in slum communities that are often subjected to severe flooding, and with population densities of 800–1200 people per hectare [40]. In these settlements, most people have no access to a hygienic toilet, and most faecal waste is discharged directly into the environment without treatment. The common sanitation solutions in these areas include open defecation, plastic-bag defecation, various types of latrine, and in some cases pour-flush toilets discharging into open drains. Much rarer are pour-flush toilets discharging to septic tanks. This has grave implications on the sustainable use of groundwater. The problem may worsen with the rapid sprawling and growth of the population if not properly developed and managed.

To check the challenge of massive inadequacies in wastewater treatment in Lagos, the state government set out a five-year sanitation plan in 2010, which includes a goal to improve water treatment infrastructure [34].

28.6 Conclusion

Lagos as a coastal city offers multiple opportunities as a hub of economic activities as well as a link to local, regional and global economies. Today, it has an added advantage associated with its high population density and its youthful population, two important drivers of economic productivity and growth. **Cities are built by people for people**; with their concentration offering agglomeration of economies starting from their land and housing assets that constitute more than half of their wealth. With functioning institutions and laws, land and housing assets contribute to the planning, management and provision of services in settlements. However, in absence of functioning institutions and laws providing legal propriety rights, most of these assets remain dead investments sheltering only people. To tap into the potential of high densities, the city of Lagos must formalize its land system, which will be the driver of many other components of its foundation such as streets and public spaces, and also aid in the provision of basic infrastructure such as water, sanitation, energy and waste management. To drive Lagos towards a smart city, it is urgent that national and local authorities recognize the wealth of their citizens and

involve them in the planning, building and the management of their city. No city can claim to be smart when the wealth of its citizens is not fully taken into consideration in the economy.

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Chapter 29
Smart Infrastructure Developments for Smart Economy

Femi Olokesusi, Femi Ola Aiyegbajeje, Gora Mboup and Dennis Mwaniki

Abstract Smart infrastructure development is an important measure of smart city's economy. This chapter examined the key infrastructural indicators such as Information and Communication Technology (ICT) transportation, education, health and security. The chapter also assesses the infusion of ICT into other critical infrastructure in Lagos in a way to better understand the potentials and efforts made in making Lagos a smart city. The study, however, concluded that with the ongoing efforts of the government of Lagos State, the metropolis is fast growing in developing its smart city foundation and infrastructural growth.

Keywords ICT · Transport · Education · Health

29.1 Introduction

Infrastructural development in Lagos has received serious attention under the various democratic governments since 1999. Heavy investment on infrastructural facilities is capable of widening the path towards smart economic development. This chapter takes a cursory look at various governments' infrastructural investments in different sectors of the economy in Lagos in the last few decades.

F. Olokesusi (✉)
University of Parakou, Parakou, Benin
e-mail: femioloke@yahoo.com

F.O. Aiyegbajeje
University of Ibadan, Ibadan, Nigeria
e-mail: femidavid2002@yahoo.com

G. Mboup
Global Observatory Linking Research to Action, New York, USA
e-mail: gmboup@gora4people.org

D. Mwaniki
Global Observatory Linking Research to Action, Nairobi, Kenya
e-mail: dmwaniki@gora4people.org

29.2 ICT Development for a Smart Lagos

Access to, and availability of information is a high-value resource for a city. A city that is rich in information creates opportunities for informed decision making, influences positive collaboration, promotes public engagement, identifies various opportunities for its citizens, and has more prospects for growth than one that does not. Advances in digital technologies over the past few decades have greatly expanded the information base, lowered information costs and created high-value information goods. This has facilitated searching, matching and sharing of information and contributed to greater organization and collaboration amongst economic agents (e.g. by influencing how firms operate, people seek opportunities and citizens interact with their governments), widened options for city residents (for both commerce and recreation) and also promoted inclusion of the previously disadvantaged groups [1]. The presence of efficient and affordable communication systems further promotes collaboration amongst the various parts of the population, improves access to markets for products, and creates an informed society.

ICT development was since the early 2000s identified as a key element for the achievement of the Millennium Development Goals (MDGs), particularly through creation of job opportunities (and hence lowering poverty) and helping countries and cities to meet their education and health goals. In line, and in a bid to tap into the potential for ICTs in helping meet the MDGs, there was a global drive towards aligning country development towards adoption of ICTs, whose result was widespread development of ICT policies and strategies through the early 2000s—particularly amongst the developing countries. In a bid to support countries achieve this goal, the Broadband Commission for Digital Development (a joint initiative by the International Telecommunication Union—ITU and the United Nations Educational, Scientific and Cultural Organization—UNESCO) set four targets which would help make broadband policy universal and which would boost affordability and broadband uptake [2]:

- Target 1: Making broadband policy universal. By 2015, all countries should have a national broadband plan or strategy or include broadband in their Universal Access/Service Definitions;
- Target 2: Making broadband affordable. By 2015, entry-level broadband services should be made affordable in developing countries through adequate regulation and market forces (for example, amount to less than 5 % of average monthly income);
- Target 3: Connecting homes to broadband. By 2015, 40 % of households in developing countries should have Internet access;
- Target 4: Getting people online. By 2015, Internet user penetration should reach 60 % worldwide, 50 % in developing countries and 15 % in Least Developed Countries.

Post MDGs, ICT adoption is a cross-cutting element, and a core pillar for the achievement of the Sustainable Development Goals (SDGs). Over the next 15 years,

ICT will hugely shape the developmental aspects of poverty reduction, provision of quality health and education, promotion of gender equality, basic infrastructure service development and provision, creation of expanded opportunities for work, income generation and economic growth. It will also be the backbone of industrial growth, innovation and infrastructure development; promote growth of sustainable cities and communities, and responsible consumption and production patterns; enhance the discussion on climate action; and create a platform for partnership and development of strong institutions; all of which will contribute to sustainable world, where all citizens have equitable opportunities for growth and prosperity.

29.2.1 Overview of Nigeria's ICT Sector Growth

Outside of South Africa, Nigeria is one of the largest and most complex telecoms and Internet markets in sub-Saharan Africa [2]. The development of telecommunication infrastructure in Nigeria dates as far back as 1886, when the first telegraphic submarine cable was laid by a British firm known as Cable & Wireless Ltd., to connect Lagos and the colonial office in London [3]. In spite of this, Nigeria's telecommunications sector remained as one of the most underdeveloped in Africa until the late 1990s when the sector was de-regularized. Liberalization of the sector through the promulgation of the National Communications Commission (NCC) Decree of 1992 removed the monopoly experienced by the Nigerian Telecommunications Limited (NITEL) and created avenues for private sector players and competition in the sector [3]. Subsequent changes made by the NCC through the 1990s and early 2000s, particularly the mobile licences auction have revolutionalized Nigeria's telecommunications sector and created the ICT environment being experienced to date (Fig. 29.1).
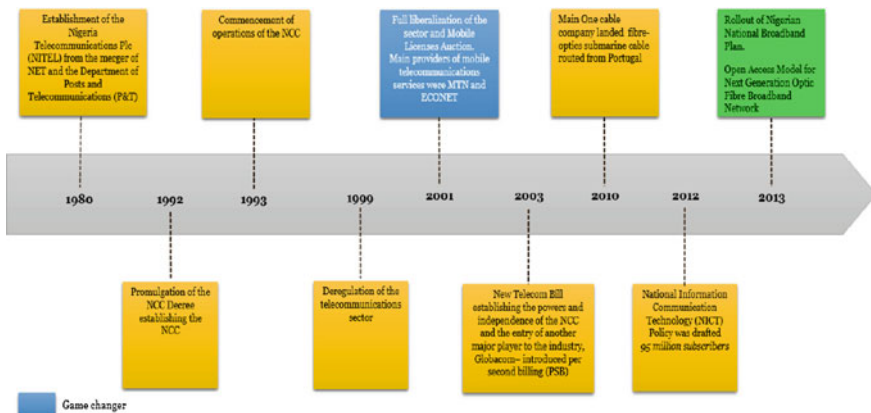
Fig. 29.1 Historical evolution of Nigeria's telecom sector. *Source* [3]

Like in many other sub-Saharan Africa countries, the two major ICT indicators—mobile phone penetration and Internet access—have been growing disproportionately in Nigeria over the last two decades, with mobile penetration enjoying more success than Internet adoption. Starting effectively in 1999 with its first transparent auction of licences, mobile phone uptake grew over 65 times from only 2,271,050 subscribers in 2002 to 151,017,244 in 2015 [2, 4] (Fig. 29.2).

Although little comparative data are available on Internet penetration, the general trend in recent years is indicative of the fact that Internet penetration has been much slower, though progressive. The total number of active Internet subscriptions in the country rose from 31,143,861 in 2012 to 76,492,866 in 2014 [5, 6], which was only about half of the total mobile phone subscribers. These numbers, however, also represent an increase in the percentage of people using the Internet, which is estimated to have grown from 29.8 % in 2012 to 42.7 % in 2014; which is itself a growth of over 700 times from the 0.06 % of individuals using Internet reported in 2000 [7] (Fig. 29.3).

With limited broadband infrastructure in the country (like in many developing countries), most Internet subscriptions in Nigeria are through mobile phones. Out of the 76,492,866 active Internet subscriptions reported in 2014, 76,324,632 (99.7 %) of the subscriptions were on mobile GSM platforms, and only 0.2 % were on the fixed wired/wireless platforms [8]. This is closely linked to the fact that the country's broadband penetration estimated at between only 3–6 %, and a personal computer penetration of only 4.7 % [2]. Although mobile data Internet subscriptions are aiding in Internet penetration, their high level of reliance is also seen as posing serious challenges for future Internet access, both in terms of speeds, costs and reliability of the services, particularly in areas with poor mobile network coverage [2].

In the 2016, Global Connectivity Index (GCI), which measures how 50 countries (that, in total, account for 90 % of global GDP and 78 % of the global population) are progressing with digital transformation using ICT, Nigeria ranks 48th, behind South Africa (rank 31), Egypt (39), Morocco (42), Algeria (45), Kenya (46) and
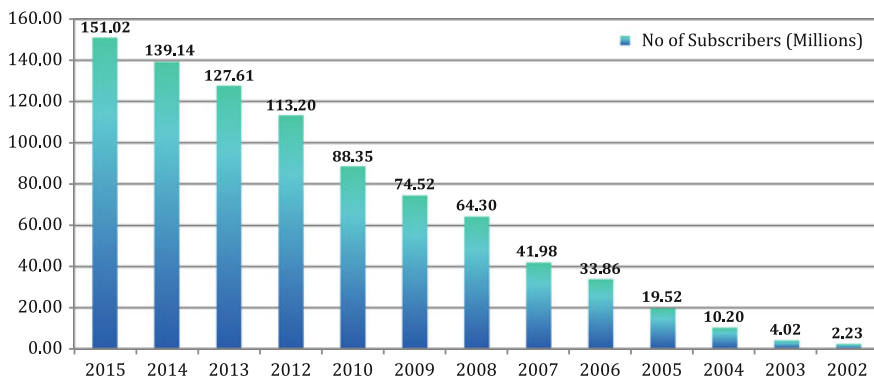
Fig. 29.2 Mobile phone subscriptions over time 2002–2016. *Data source* [4]
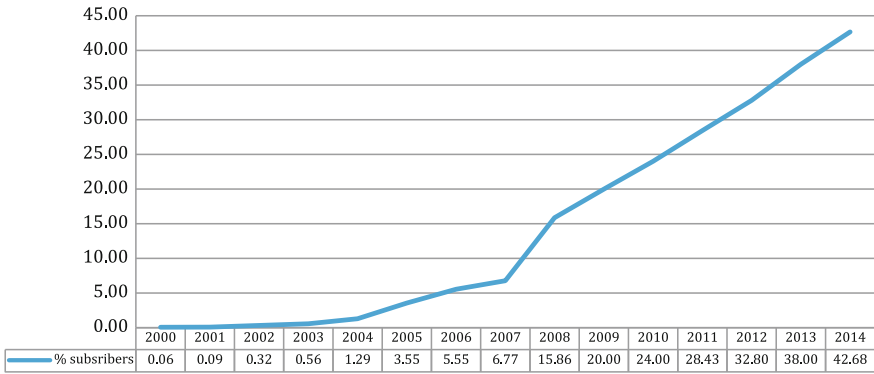
Fig. 29.3 Percentage of individuals using the Internet in Nigeria. *Data source* [7]

Ghana (47). Other than South Africa, the index ranks the African counties as starters, which is a list of countries with an average GDP of US$3000 and which are in the early stage of ICT infrastructure build-out. The focus of these countries is increasing ICT supply to give more people access to the digital world. These countries are weak in cloud, big data and Internet of things (IoT)—which hinder the productivity and scaling benefits of digitization [9]. Nigeria dropped one point in 2016 from 47th in the 2015 rankings, which had identified the country as having a small fixed base but huge potential in the uptake of mobile products since it is one of the world's largest mobile subscriber markets and offers impressive opportunities primarily in the mobile broadband space, where rapid m-Commerce uptake is driving market growth [10].

29.2.2   ICT Infrastructure Development for Smart Economic Growth

Nigeria's ICT sector growth is bright and promising, as a factor of a huge market potential, major structural changes and ongoing investments in the sector growth. While the country's Internet penetration is still below 50 %, the country has the highest number of Internet users in Africa. This implies that the country has an opportunity to immensely grow its economy by further developing its ICT infrastructure, which has been identified as contributing immensely to various economic sub-sectors. For example, a 20 % growth in ICT investment has been identified to increase a country's GDP by 1 % [10]; and a one point increase in a country's national GCI rating has been identified as contributing to: (a) a 2.1 % increase in competitiveness; (b) a 2.2 % rise in innovation; (c) a 2.3 % jump in productivity; and (d) an increase in GDP per capita—the pulse of economic health [9]. In Nigeria, the telecoms/ICT sector contribution to the national gross domestic product

Table 29.1 Percentage contribution of telecoms industry to GDP in Nigeria—2010–2015

	March 2015	2014	2013	2012	2011	2010
Percentage (%)	8.5	7.6	7.4	7.7	8.6	8.9

Source [4]

(GDP) has been on the rise, increasing from below 1 % in 2001 to 8.9 % in 2010 before declining to 7.7 % in 2012 and further rising to 8.5 % in (March) 2015 [3, 4] (Table 29.1).

Massive opportunities, however, remain untapped in the sector, which the government of Nigeria has been working towards tapping over the past decade. The area of ICT infrastructure development, for which total investment prior to 1999 totalled less than $50 million [6], has been of particular interest; with various interventions being adopted through direct local and foreign investment, partnerships and creation of enabling policies for the sector development. Some key attempts have been undertaken through projects such as [2]:

- *The computers for all Nigerians* initiative—whose aim was to achieve "a PC penetration drive into sections of the Nigerian Community which are currently underserved". In practical terms it sought to deliver 0.5 million PCs, largely through a purchase subsidy scheme for civil servants; and set out to work with two Internet service provisions (Suburban and Netcom) to deliver Internet access in Lagos and Abuja.
- *The Wire Nigeria Project (WiN)*—whose objective was to ensure that no place in the country was farther than 30 miles from the ICT backbone infrastructure.
- *State Accelerated Broadband Initiative (SABI)*—which offered government support and incentives to encourage the private sector to build and run a broadband infrastructure in all state capitals and selected major commercial cities in the country by the end of 2008. Over 4 billion Naira was budgeted for the project over the years.
- *Universal Service Provision*—which was established through the Universal Service Provision Fund (USPF) under the Nigerian Communications Act 2003 to provide subsidy for service delivery in high-cost areas especially the rural and under-served parts of the country. The initiatives supported by NCC to achieve this included creation of community communications centres; development of schools and universities access programme to digital lifestyle; development of a rural broadband Internet access platform; the accelerated Mobile Phone Expansion (AMPE) Project; and development of backbone transmission Infrastructures.
- *Various projects by mobile service providers to expand their infrastructure.*

Policy interventions have also played a crucial role in improving the ICT situation in the country. Amongst the key policy interventions adopted by the Nigerian Communications Commission (NCC) to ease the challenges in ICT development since the 1990s include;

- *Issuance of Unified Access Licence*—although the mode of licensing initially adopted by NCC was separate licensing for each telecom service (such that mobile service providers and providers of fixed wire/wireless services were differentiated), unified access licences (which enabled licence holders to provide all telecom services) were introduced. The motivation for this approach was to tap on the infrastructure and opportunities already created by the convergence in telecom facilities, and also to increase competition in the ICT industry.
- *Issuance of mobile interconnectivity exchange licences to operators*, which created a level playing field for various sector players. These licences serve as a hub for connectivity for all operators and also act as the interconnectivity clearing house for the purpose of settling interconnectivity charges amongst operators. In addition, interconnect price determination was also completed and instituted by NCC [3].
- *Establishment of an infrastructure sharing* policy with an aim to facilitate quick deployment of telecom services in an efficient manner by the new entrants. The policy allows operators to share facilities such as base stations sites, fibre ducts, fibre swamps and power to cut overhead costs; and also address concerns arising from multiple fees, taxation and proliferation of communications infrastructure amongst others.
- Other interventions have included *advocacy and enforcement of Subscriber Identity Module (SIM) registration and mobile number portability* to both promote user security and competition and improve quality of services.

In a bid to hasten the growth and increased investment in the ICT sector and reduce the cost of Internet services, the Ministry of Communications Technology developed the National ICT policy in 2012, with a goal to provide a framework for streamlining the ICT sector and enhancing its ability to help address some socio-economic and development challenges while facilitating the transformation of Nigeria into a knowledge-based economy. The policy would also be used to develop action plans, sub-sectoral policies and specific implementation guidelines [11]. The ICT policy is working towards enhanced ICT infrastructure development throughout the country. This is being implemented hand in hand with the National Broadband Plan (NBP), whose aim is to promote pervasive broadband deployment, increase broadband adoption and usage and ensure availability of broadband services at affordable prices with the long-term objectives of maximizing the socio-political and economic benefits of broadband to the people [12].

Positive results are already being witnessed in the country as a factor of the various policy alternatives. The percentage of Nigeria's population living within range of a GSM signal has for example grown rapidly, reaching about 90 % in 2013 [3]. The expansion of the country's ICT industry has also attracted over $25 billion in private capital that has gone into the development of new mobile phone networks across the country. Estimates indicate that capital investments in mobile networks and operations since 2001 have accounted for 80 % of total telecommunications foreign capital investments [3].

The arrival of the submarine fibre optic cables from 2010, and their subsequent roll out in the major cities such as Lagos has been creating a solid backbone network, which have not only brought about a reduction in the cost of ICT services, but also created local and international growth opportunities for cities like Lagos. By the end of 2014, for example, the telecoms operating companies (GSM and CDMA/Fixed telephony Operators) had deployed a combined total of 80,938 km of Fibre optics, which was an increase from 68,124 km deployed in 2013 and 56,505 km deployed in 2012. 65,433 km of the fibre optics deployed in 2014 was on land, while 16,506 km was submarine. The outcome has been a general increase in broadband and a reduction in broadband cost. Initial projections during the cable laying out indicated that the price of wholesale international bandwidth would fall to around US$100 per Mbps per month depending on volumes purchased from a price of over US$6,000 per Mbps per month in 2004 [5, 6].

This overall effect has been increased productivity in various economic sectors, with substantial growth being reported in the financial sector—where technologies in banking have increased the volume of financial transactions. The participation of various private sector players and mobile operators in ICT infrastructure development—such as fibre optic cable extension—is fast increasing the broadband penetration in the country, and extending the list of services available to the populations, and more in cities like Lagos. However, while these investments are aiding in the reduction of the country's huge deficit in ICT infrastructure capacity, inherent challenges such as unreliable power supply and complex taxation regimes are slowing the country's progress in ICT development.

29.2.3 ICT Application in Various Sectors in Lagos

The ICT revolution has proven to be beneficial to Lagos residents in the following ways:

(i)   Traffic Monitoring—many radio stations such as Eko FM, Wazobia FM and other radio stations within Lagos have found it expedient to use ICT media to monitor and disseminate traffic situation reports during critical commuting periods thereby assisting in preventing a worsening of the situation as in-coming commuters are advised to divert towards alternative routes.

(ii) Environmental Data Collection and Monitoring—this is made more effective by using information technology, especially the geographical information systems (GIS). This technology provides detailed and accurate digital maps in respect of various physical, economic and environmental data requirements

(iii) Security Controls and Crime Tracking—the Lagos State Government has been displaying some GIS-based video coverage of sections of the Metropolis which, when fully developed, could prove efficient in tracking criminals and unearthing events the type that had hitherto been considered mysterious.

(iv) Another important aspect of the application of information and communication technology was the introduction of the Lagos State Government Electronic Banking System of Revenue Cycle Management (LASG EBS-RCM) project. Partnering with the private sector, Lagos State used high-level technology to ensure more effective monitoring of collected revenue. Revenue performance-enhancing measures included creating a robust database of taxpayers, eliminating ghost workers and plugging tax loopholes. Still another application of ICT is the development of spatial digital maps of the entire Lagos state. Thus, it is now possible to identify parcels of land, the size and configuration, etc., for the purposes of urban planning, valuation and taxation.

29.3 Smart Transport for Smart Economy

The Lagos state government has invested in the critical infrastructures of the economy. The Lagos State Ministry of Urban Development through a Public–Private Partnership (PPP) initiative is currently embarking on developing smart cities at the fringes of the Lagos metropolis, e.g. the Eko Atlantic City. The PPP model is an attempt to upgrade infrastructure in most areas of the metropolis. Good examples of PPP projects are the expansion of the Victoria Island-Lekki dual-carriage expressway by the Lekki Concession Company. Also, the Lekki-Ikoyi link bridge built through PPP initiatives was to ease the heavy traffic congestion usually experienced for many hours on a daily basis by commuters plying this axis of the metropolis. The Lekki-Ikoyi link bridge has reduced the several hours spent on commuting between Lekki and Ikoyi to a less than 20 min journey. The number of roads constructed rose from six in 2006 to 29 in 2010 and 22 in 2012 amounting to about 150.8 km. The total length of rehabilitated roads from 2007 to 2012 was about 86.22 km [13]. In order to effectively manage the chaotic traffic situation in Lagos metropolis, the Lagos State Traffic Management Agency (LASTMA) and Vehicle Inspection Office (VIO) were established to deal with traffic offenders. A total of 38 street lights were installed in 2008, and this increased to 1217 street lights in 2012 [14]. In late 2015, the state government commenced the Light-up-Lagos Project which is aimed at providing all major roads with electricity on 24 h basis so as to improve mobility and security. Other roles include issuance of roadworthiness certificate, issuance of automated vehicle licence, driver licence and insurance certificate to curb car theft, issuance of fake certificates. The exercise led to the discovery of 12,083 fake certificates in 2010, 17,862 in 2011 and 18,252 in 2012 [14]. Aside from managing traffic problems in the city and issuance of fake certificates to unsuspecting vehicle owners, this initiative was also aimed at increasing government revenue.

The transportation sector is a very key factor for the economic development of any society because of the important roles it plays in the movement of people,

services and information. For the transport sector to be smart, heavy financial investment with a strong and effective policy must be committed to the cause. In this section, we review the road, rail, water and air transportation sub-sectors.

29.3.1   Road Transport

Road transport accounts for over 90 % of domestic passengers and freight movement in Lagos State, which has about 30,500 km State owned roads and 129,577 km of local government roads [15]. About six million passengers are moved between the Mainland and Lagos Island on a daily basis in about 75,000 unregulated mini-buses [14].

Following the chaos witnessed on the city streets, and in a bid to reform the chaotic public transport system in the city, the Lagos State Government in collaboration with the World Bank initiated the Lagos Urban transport Project (LUTP) in 2001, to create an efficient and effective integrated inter-modal mass transit system in the State. LUTP was designed to create an efficient, effective, integrated, intermodal mass transit system, involving land, water, and rail transport—and in the process, to contribute to poverty reduction. The Lagos Metropolitan Area Transport Authority (LAMATA) was established in 2002 to coordinate the transportation policies and activities of all transport related agencies. With a view to creating a new orientation in the public transport sector, especially the way in which transport services are managed and implemented, LAMATA developed a strategic Transport Master Plan. The plan specifies the infrastructure details of the modal routes required by 2020 and outlines how to achieve its targets, with an emphasis on integration. Since its inception, the agency has worked to improve the efficiency of Lagos' road network. It has maintained several kilometres of road network, rehabilitated and improved several junctions, established three transport monitoring units, and implemented transport system management along the bus franchise corridor to improve traffic flow. It has also enhanced bus service and traffic flow by creating bus by lanes, providing traffic management on routes and at bus depots, and establishing garages for the fleet. The government has also invested heavily in the periodic maintenance and expansion of roads, construction of new roads, and the construction of vehicular and pedestrian bridges.

In its effort to improve the public transport system LAMATA deliberately eased out the old para-transit buses popularly known as "Molues" to give way to brand new and more comfortable buses known as Bus Rapid Transit (BRT) and LAGBUS plying over dedicated lanes within the metropolis (Fig. 29.4). The BRT has in its fleets 270 buses as at 2011 with about 120,132 passengers per day [14]. Between 2008 when it commenced operation and January 2010, the BRT had moved more than 114 million passengers and helped bring order to public transportation by promoting the concept of an orderly waiting line at bus shelters [14]. Commute times also drastically reduced, as well as the per cent of household income spent on transportation. The system employs more than 2000 workers [16].

Fig. 29.4 Bus rapid transit in Lagos operates on dedicated lanes. *Source* [17, 18]

The LAGBUS has in its fleets, about 513 buses in 2010 and 719 buses in 2011 which enjoyed about 170,000 passengers per day in 2010 rising to 178,808 passengers per day in 2011 [13]. There were 102 designated bus-stops in 2010 and 106 bus-stops in 2011 [15]. LAGBUS is the outcome of a Memorandum of Understanding (MoU) between LAMATA and the National Union of Road Transport Workers Union (NURTW) Lagos State Chapter. Some local banks facilitated the purchase of the buses [15].

In pursuance of its drive towards a Smart City, LAMATA in 2013 introduced the use of e-ticketing payment to board BRT buses. With a view to improving road safety, five Drivers' Institutes were also established to train the drivers and other bus operators. To complement the BRT system, the state government also introduced the Corporate Taxi Scheme in the city to provide secure taxi operations that meet international standards and best practices. About 1225 of these taxicabs now operate in Lagos [13]. This includes operators of cabs called 'Red-cabs' and "Yellow-Cabs". On an environmental level, BRT has reduced carbon dioxide emissions by about 13 % and greenhouse gases by about 20 % [17]. Thus far, 6 % of car owners along the corridor have opted to use the BRT because of its affordability, reliability, timeliness and safety [17].

Today, the BRT is a key component of LAMATA's efforts to address transportation and other infrastructural problems in Lagos. Projects are underway to extend BRT service to other parts of the city, including system and highway improvements and the expansion of expressways. For example, operation of the Mile 12 to Ikorodu BRT route was flagged off in late 2015.

29.3.2   Rail Mass Transit

The Lagos Rail Mass Transit (LRMT) network is a major component of the Strategic Transport Master Plan (STMP) under the auspices of the Lagos Metropolitan Area Transport Authority (LAMATA). The LRMT is a network of

urban rail-based systems covering seven major corridors of high commuter traffic demand within and beyond the metropolitan Lagos extending to border areas of Oyo and Ogun States. The network, which is still under construction is a 35 km long and 1435 mm standard gauge railway line [14] and will complement the existing water transport and BRT routes in Lagos. It is owned by Lagos State Government through LAMATA and managed by Eko Rail under a concession agreement and will have two lines: (a) a blue line which runs from Okokomaiko to Marina and (b) a red line, which runs from Agbado to Marina via Iddo and Murtala Mohammed International Airport (MMIA). Future extensions for the network will include five more lines: (a) a green line, which will run from Marina to Lekki; (b) a yellow line running from Otta to Iddo; (c) a purple line running from Redeem to Ojo; (d) a orange line running from Redeem to Marina; (e) and a brown line running from Mile 12 to Marina [17].

29.3.3 Air Transport in Lagos

According to the Lagos State Public–Private Partnership Office, Lagos is the hub of Nigeria's aviation business accounting for the largest share of air traffic in Nigeria with 83 % of international and 47 % of domestic air traffic, at the Murtala Mohammed International Airport (MMIA) [19]. The importance of Lagos as the economic heartbeat of the country makes it the preferred international gateway by tourists and businessmen. According to the Federal Airports Authority of Nigeria (FAAN), the airport annual total passengers increased from 5,644,572 in 2009 to 20,225,448 in 2014 [20]. There are several airlines and helicopter services operating local flights from Lagos to other parts of the country. There is also an opportunity for additional domestic airport, heliports and helipads in the fast growing areas such as Lekki, Victoria Island, Badagry and Maryland all in Lagos metropolis. There are ongoing plans by the Lagos State Government to develop additional international airport to be known as Lekki-Epe International Airport on 2000 ha of land in the Eastern axis of Lagos State. The project is projected to be implemented under Design-Build-Finance-Operate and maintain Concession Agreement for between 15 and 25 years [21]. The proposed airport is part of the Lekki Free Trade Zone and it is been proposed to ease the pressure on MMIA apart from improving accessibility to people living in the Eastern axis of the city.

29.3.4 Water Transportation

The chaotic traffic congestion in Lagos has forced many commuters to begin to explore the services of ferries and speed boats as alternative modes of transportation. This is possible because Lagos is surrounded by several inland waterways creating a good opportunity for ferry shuttles between Lagos Island and the

Mainland, as well as the riverine areas. In 2015, the Lagos State Government through the Lagos State Waterways Authority built a total of 57 jetties called "metroferry" to boost water transportation system across the State [21]. Some of the places provided with jetties are Ojo, Ikoyi, Ikorodu, Ijegun, Badore, Ijede and Oworonshoki. Presently, three modern Ferry Terminals are nearing completion and 10 major routes are being operated by 19 franchises [21].

For water transport, LAMATA has identified six corridors for water transportation: Badore, Badore-Admiralty-Osborne-Marina, Ikorodu-Oworonsoki-Marina, Ijegun-Egba, the Oke-Afa-Festac-Mile 2-Marina, and Iddo-Ota area-Marina [21]. Two of these corridors (Ikorodu-Oworonsoki-Marina and Badore-Admiralty-Osborne-Marina) have already been opened with a daily passenger service. Old jetties have been rehabilitated and new ones built in Ipakodo, Badore and Osborne. New terminals have also been constructed to accommodate the watercraft, and some of these terminals will feature park-and-ride facilities as well as banking, shopping and dining [22]. The development of water transportation has helped in integrating transportation modes in the city and brought relief to heavy traffic congestion occasioned by the high dependency on road transport. It has also opened up new avenues of investment and employment opportunities. Furthermore, the PPP models have been developed for new initiatives like franchising for additional jetties and watercraft. The Lagos State Waterways Authority is the regulatory agency responsible for ensuring water safety and the use of best practices in achieving sustainable water transportation [21].

29.4 Smart Education and Health Infrastructure for Smart Economic Development

29.4.1 Education Infrastructure for Smart Economic Development

The Education system in Lagos State is made up of 9 years of compulsory basic education (6 years of primary and 3 years of junior secondary education), 3 years of senior secondary or technical and vocational education and 4 years of tertiary education. The rationale behind basic and senior secondary education is to allow the beneficiaries to function as competent and productive members of the society, while that of the tertiary is to ensure professional and manpower development.

Currently, there are 1001 public primary schools (PS), 321 public junior secondary schools (JSS), 310 public senior secondary schools (SSS) and 9762 private primary schools and 4025 private secondary schools in Lagos State [17]. The private education sector is, therefore, by far the major player in the school sector. Enrolment in schools is high and increasing. A comparative analysis of enrolment by level between 2009/10 and 2010/11 revealed an increase in the total number of pupils and students in public schools. For instance, as at November 2009, the

enrolment was 1,019,815, while that of 2010 was 1,152,095 [17]. The explanation for such high enrolment is rapid population growth in the State compounded by in-migration of families with school aged children. Lagos State offers free primary education, and this attracts children from neighbouring States.

29.4.2 Health Infrastructure for Smart Economic Development

In view of the enormous health problems precipitated by the demographic and geographical features of the Lagos State, the health care system organized at primary, secondary and tertiary levels is positioned to drive the health care policy and programmes of the State focused on: free community-based primary health care services; provision of comprehensive secondary health care services; institution of the Health System Reform Programme, including the State Health Insurance Scheme; improvement of the health care system and its management; reduction of disease burden and improved access to health care services; fighting HIV/AIDS as a development issue; improvement in health resources and their management; improvement in the quality of health care services; improvement in consumer awareness and community involvement; promotion of effective partnerships along with collaboration and coordination; establishment of a communication strategy for the Health System Reform Programme; and the establishment of a performance monitoring and evaluation system. The Lagos State government established emergency medical services through the Lagos State Emergency Medical Service (LASEMS) and Lagos State Ambulance Services (LASAMBUS). In addition, the construction of maternal child care centres in six locations as well as the Lagos State University Teaching Hospital (LASUTH) is geared towards providing qualitative healthcare services [17].

The achievements of the Lagos State government's healthcare policy and programmes focus on the following: Free community-based primary health care services; Provision of comprehensive secondary health care services; Institution of the Health System Reform Programme, including the State Health Insurance Scheme; Improvement of the health care system and its management; Reduction of disease burden and improved access to health care services; Fighting HIV/AIDS as a development issue; Improvement in health resources and their management; Improvement in the quality of health care services; Improvement in consumer awareness and community involvement; Promotion of effective partnerships along with collaboration and coordination; Establishment of a communication strategy for the Health System Reform Programme; and Establishment of a performance monitoring and evaluation system. As part of its efforts to achieve the above-mentioned goals, the Lagos state government established pro-poor health care programmes such as the Eko Free Malaria Programme, the Blindness Prevention Programme, and the Limb Deformity Rehabilitation Programme. These

initiatives provide free treatment for expectant mothers, children up to age 12, and elderly persons age 60 and above; the establishment of emergency medical services through the Lagos State Emergency Medical Service (LASEMS) and Lagos State Ambulance Services; and the construction of maternal child care centres in six locations as well as the Lagos State University Teaching Hospital (LASUTH).

29.4.3   Health Infrastructure in Lagos

Tertiary Healthcare Centres: There are three tertiary hospitals in Lagos metropolis (Lagos University Teaching Hospital (LUTH), Lagos State University Teaching Hospital (LASUTH) and the National Orthopaedic Hospital. These facilities are owned by both the state and federal government. While LUTH and National Orthopaedic Hospital are owned by the Federal Government, LASUTH is owned by the Lagos state Government. They provide referral services to other smaller hospitals and serves as training centres for residency programmes.

Secondary Healthcare Centres: The Healthcare Facilities Monitoring and Accreditation Agency (HEFAMAA) of the Lagos State Ministry of Health provided the list of registered hospitals in Lagos State. These are 24 General Hospital, 904 private hospitals, 803 private clinics, 73 ophthalmic centres, 57 Dental clinics, 299 Nursing homes, 525 Medical Labs and four Radiology centres [23]. The list of the General Hospitals in Lagos Metropolis includes: Agbowa General Hospital, Ajeromi General Hospital, Alimosho General Hospital, Apapa General Hospital, Badagry General Hospital, Ebute Metta Health Centre, Epe General Hospital, Gbagada General Hospital, General Hospital Lagos, General Hospital, Akodo, General Hospital, Orile-Agege, Harvey Road Health Centre, Ifako-Ijaiye General Hospital, Ijede Health Centre, Ikorodu General Hospital, Isolo General Hospital, Ketu Ejinrin Health Centre, Lagos Island Maternity Hospital, Mainland Hospital, Yaba, Massey Street Children Hospital, Mushin General Hospital, Onikan Health Centre, Somolu General Hospital and Surulere General Hospital [24].

Primary Healthcare Centres: There are about 221 maternity homes spread across the State [23]. Well over 200 of these maternity homes are found in the Lagos Metropolis.

29.4.4   Ongoing Initiatives for Smart Health Care in Lagos

The Lagos State eHealth project is an Interactive Hospital Information System Software which is being implemented by the Ministry of Health in collaboration with the Ministry of Science and Technology in some of the State owned hospital facilities. The Health Management Information System (HMIS) project is a broad-based modular Hospital Administration System Database solution that allows the operational procedures and patients' flow in a health facility to be harmonized

thus ensuring prompt and effective healthcare delivery [24]. The project which is in furtherance of the state government's vision of promoting effective service delivery is being implemented in phases to involve all state-owned secondary and tertiary health facilities. The pilot phase has commenced fully at the Lagos State University Teaching Hospital, (LASUTH), General Hospitals Isolo and Lagos and is currently in its second phase which involves 10 General Hospitals as follows: General Hospital Alimosho, General Hospital Badagry, General Hospital Ikorodu, General Hospital Epe, General Hospital Somolu, General Hospital Surulere, Lagos Island Maternity Hospital, General Hospital Gbagada, General Hospital Orile-Agege and General Hospital Ajeromi [24].

The system registers all patients in Lagos State hospital on a central computer server and since it is an integrated system, it will affords the doctors the opportunity of having simultaneous access to the up-to-date medical records and treatment information of patients [24]. The links to the diagnostic modules ensures tests can be ordered by doctors online while results can be returned via the same channel. The system comes with a complete billing system that will ensure proper accounting and transparency. The reporting and statistics has also been built to conform to international standards. The solution is Web based and is being complemented with a wide area computer network linking all the hospitals. Authorization levels would be determined for all relevant workers to ensure patient confidentiality.

29.4.5   *Online Doctor Consultation*

Online doctor consultation in Lagos metropolis is still very low compared to the high level of teledensity of 99.8 % given by the Nigerian Communication Commission. In a 2016 study by Aiyegbajeje [25], online doctor–patient interaction was established in Lagos metropolis. Online doctor consultation involves the doctor's use of mobile telephone to dispense healthcare services to patients. The study reported that online doctor–patient mobile telephone interaction/consultation was 33.2 %. The reason for this low online doctor consultation may be due to abuse of such privilege as reported by Akadiri, Olusanya and Omitola in 2009 [26]. They opined that patient often abuse the privilege by calling doctors at odd hours of the day while some patients call for flimsy excuses.

29.5   **Physical Safety and Security**

Lagos accounts for a sizeable proportion of crime in Nigeria, a situation that is further exacerbated by a low police to citizen ratio (1:1000 against the UN recommended target of 1:100 [27]). In a study on security perception in various cities, 70 % of respondents in Lagos were fearful of being victims of crime, and 90 %

were fearful of the prospects of being killed in a criminal attack. The study further suggests that the high-violence rates in the city is related with institutionalized youth gangs [28], which is further related to the high levels of youth unemployment in the city. Land disputes and extortion, usually accompanied by widespread violence, are quite common in the emerging settlements around the metropolis; political skirmishes are also widespread in low-income areas [29], and city is increasingly facing threats from terrorism. The numerous layers of culturally diverse ethnic templates, the high-population densities and high levels of unemployment in the city have already resulted in severe inter-racial conflicts resulting in the loss of lives, particularly in the majority informal settlements [28]. The levels of crime and social unrest are generally higher in the low income areas than in the middle- and high-income areas. The security situation in Lagos is further discouraging investment in the city, and in turn reducing the city's prospects of smart economic growth.

To address the insecurity challenges in the city, various strategies have been developed, including:

- Establishment of a State Security Trust Fund, in partnership with the private sector;
- Development of a comprehensive security strategy (the *Safe City project*) to enable central security surveillance;
- Expanding, reorganizing, re-kitting, and re-motivating the state's Rapid Response Squad;
- Creation of a surveillance and command centre at Alausa (Ikeja);
- Purchase of more than 200 new patrol vehicles;
- Development of a new communication system for security agencies;
- Comprehensive insurance for all members of the Rapid Response Squad;
- Development of Nigeria's first dedicated emergency call centre;
- Establishment of an efficient enforcement force—which includes a joint military–police patrol code named *Operation Mesa* to complement State police efforts;
- Improved road signage to facilitate expedient emergency relief to crisis points and centres;
- Development of new streetlights on major roads to deter criminals and increase effectiveness of security cameras;
- Beefing up the Neighbourhood Watch, a complementary community security initiative and creation of community security assemblies, a programme to educate people about safety;
- Publication of telephone numbers of senior police officers for public usage in case of distress;
- Development of New police information and complaints boxes at strategic locations all over the state.

All these interventions have significantly reduced crime in the city, especially armed robberies, carjacking, and riots. They have also increased public confidence in the police's ability to respond to emergency situations across the city.

29.6 Conclusion

This chapter is an attempt to detail the facts that were largely unknown regarding functionality of the smart city concepts in Lagos city of Nigeria. It is apparent from the above that Lagos is moving fast in conforming with the smart city standards and more work still need to be done in order to achieve the minimum standards as obtained in notable advanced cities of the world. Therefore, there are still gaps visible in many aspects of the essential elements of smart city system. For instance, in the area of e-governance, the level of participation in decision making and transparent governance is still very low. Also, problem of local accessibility due to poor road condition and inconsiderate use of road by road users, poor electricity supply, inefficient ICT infrastructure, poor sustainable resource management, individual safety, inadequate shelter and poor housing quality is still a serious challenge. In view of this, there are still a lot of efforts to be made, if the sustainable development goals are to be achieved in the city.

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Part XII
Senegal-Dakar

Chapter 30
Smart City Foundation—Driver of Smart Cities

Gora Mboup, Momar Diongue and Samba Ndiaye

Abstract A smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centric approach based on three core components and seven dimensions. The three core components are *Smart City Foundation*, ICT and Smart Institutions and Laws, which in turn are the pillars of the seven dimensions of a smart city: Infrastructure Development, Environmental Sustainability, Social Development, Social Inclusion, Disasters Exposure, Resilience, and Peace and Security. The three components together with the seven dimensions make a Smart Economy. A smart city foundation is composed of three elements: *Urban Planning and Design, Land Policies and Basic Infrastructure*. For a city foundation to be smart, it must be inclusive at the onset of the urban planning and promotes mixed neighborhoods where social clustering is discouraged. The chapter's first section analyzes the planning of the city of Dakar, an agglomeration of 3.2 million people in 2015. During these past two centuries of growth of the agglomeration of Dakar, urban planning has served as a tool of social exclusion with poor living in unplanned wetland settlements characterized by lack of sufficient land allocated to streets and public spaces, and lack of security of tenure, the latter being the focus of the second section. These settlements are also characterized by insufficient coverage of basic infrastructure such as connection to piped water facilities, sewerage and drainage systems, energy source and solid management; this is analyzed in the third section. Building in unplanned wetlands without adequate drainage systems exposes the population of Dakar, particularly of the suburbs, to flooding that causes various material and financial damages and losses. The fourth section focuses on the flooding: occurrences, causes, consequences and responses. Today, national and

G. Mboup (✉)
Global Observatory Linking Research to Action, New York, USA
e-mail: gmboup@gora4people.org

M. Diongue
Université Cheikh Anta Diop de Dakar (UCAD), Dakar, Senegal
e-mail: dionguem@hotmail.com

S. Ndiaye
Agence Nationale de la Statistique et de la Démographie (ANSD), Dakar, Senegal
e-mail: samba.ndiaye@ansd.sn

local authorities are working together to make the city of Dakar a smart city through Urban and Territorial Development Programmes. Taking back the city of Dakar where it belongs, a green, smart city, will require transformative policies and actions including establishing new planned settlements and a re-planning of the city itself where agriculture activities and green spaces have their effective places. The Plan Directeur 2035 of Dakar as adopted in 2014 explores the foundations for sustainable urban development, with establishment of six new urban centers around the capital. The fifth section of this chapter focuses on analysis of several policies and programs initiated by national and local authorities under the ambitious program, the Senegal Emerging Plan "Plan Senegal Emergent," aim to make a Dakar a smart city with a smart economy.

Keywords Dakar · Smart city · Smart economy · Smart city foundation · Urban planning · Streets · Public spaces · Secure tenure · Basic infrastructure · Flooding · Adaptation · Mitigation · Policies · Programs

30.1   Introduction

A smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centered approach based on three core components and seven dimensions. The three core components are *Smart City Foundation*, Smart ICT and Smart Institutions and Laws, which in turn are the pillars of the seven dimensions of a smart city: Infrastructure Development, Environmental Sustainability, Social Development, Social Inclusion, Disasters Exposure, Resilience, and Peace and Security. The three components together with the seven dimensions make a Smart Economy (Fig. 30.1).

A smart city foundation is composed of three elements: Urban Planning and Design, Land Policies and Basic Infrastructure. For a city foundation to be smart, it must be inclusive at the onset of the urban planning and promotes mixed neighborhoods where social clustering is discouraged. Having all the poor living together creates slums and fuels instability and insecurity. Inclusive urban planning eases access to basic services (water, sanitation, housing, education and health) and to decent employment for all. A key element of smart urban planning is a smart street network that reduces travel time and encourages walking and social interactions. Smart urban planning enhances infrastructure development, environmental sustainability, economic and social development; makes cities resilient and prepared to overcome natural disasters; and promotes mixed neighborhoods where services are walking distances from people's residences (Fig. 30.2).

Together with smart institutions and laws, the smart city foundation is the key pillar to the other seven dimensions of a smart city. **Infrastructure Development** includes transport, ICT, industrial energy, school, health, etc., in addition to the basic infrastructure as elements of the city foundation: water facilities, household energy sources, sanitation systems, solid waste and water waste management.
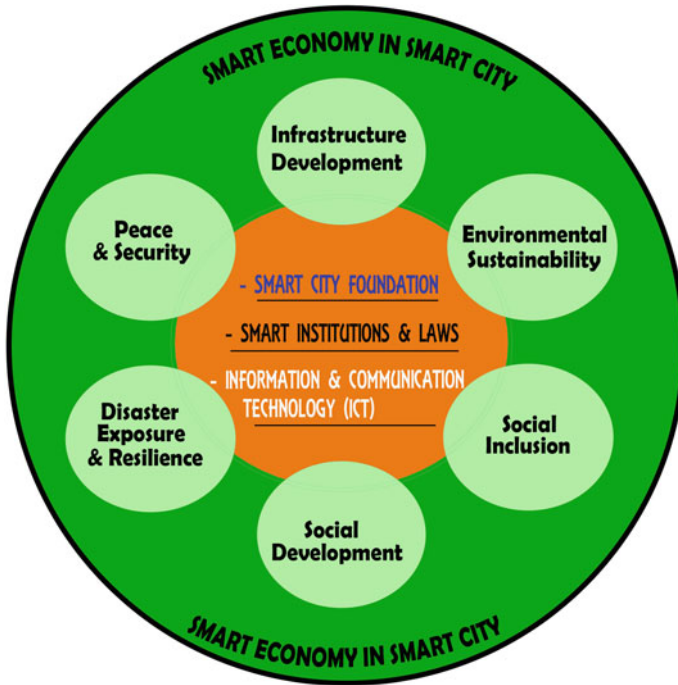
Fig. 30.1 Conceptual framework—smart economy in smart cities in the African context. *Source* [1]

Fig. 30.2 Conceptual framework—smart city foundation. *Source* [2]
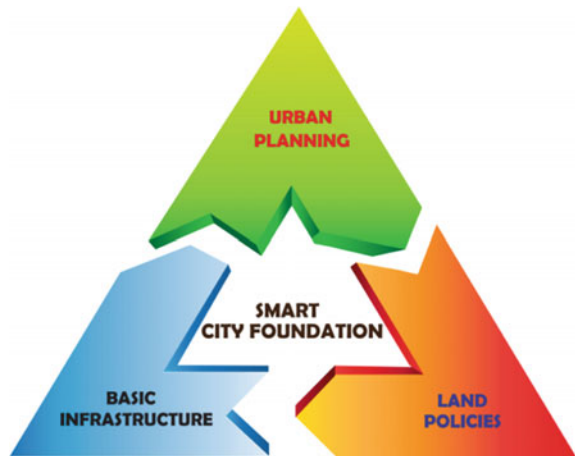
Environment Sustainability is composed of elements of energy, transport, building and pollution. **Social Inclusion** includes aspects of participation in decision making as well as according all city residents equal opportunities for growth

and prosperity. **Social Development** is composed of elements of education, health, public spaces, social inclusion and social capital. **Disaster Exposure** incorporates elements of exposure, mitigation and adaptation to various disasters such as flooding, droughts, storms and earthquakes. **City Resilience** is composed of elements of City Foundation, Environment, Social Capital, and Social Development. **Peace and security** incorporates all forms of violence and conflicts, including domestic violence, violence in public places, crime, armed conflicts, terrorism and policing. An insecure city limits opportunities for investment and economic growth and cannot be a smart city.

30.2 Two Centuries of the Planning of the City of Dakar

The city of Dakar is located to the extreme west of Senegal. Its history is marked by several migrations dating back to the fourteenth century. The most prominent recorded settlements were however in the fifteenth and sixteenth centuries when the Lebou group settled in the area called "Yoff" located to the north of the city and in other areas such as Ouakam, Ngor and Camberene [3]. The second major settlement was recorded later in the nineteenth century when the French colons started to settle to the extreme south of the city, which later became the center of the city—hosting most administrative and state buildings (*including the State house, the Parliament and the Court house*) [4]. Both settlement eras had varying influence on the city form of Dakar, which has resulted into two unique spatial organization patterns—an organic pattern evident in the Yoff area and a grid system evident in the French occupied southern parts.

30.2.1 Decentralized Administration and Governance Start with the Lebou Decentralized Social, Economic and Political Organization

Settlement in Yoff was influenced by the Lebou group's system of governance that advocated for decentralized social, economic and political setups aimed at promoting integration among various ethnic groups that formed the group (*Lebou was a symbiosis of various ethnic groups*). The Lebou system of governance, which was the opposite of the kingship system practiced in other parts of Senegal, promoted equality among community members, and creation of autonomous villages. Each village was under the leadership of the "Djaraf," assisted by the "Ndeye ji Rew" for interior and foreign affairs, and the "Saltigue" who was in charge of land, water and local collectivities. With the influence of Islam, the function of Serigne Ndakarou was introduced in late eighteenth century to provide justice based on the Quran. Until today, the Lebou community conserves its sociopolitical structure where the
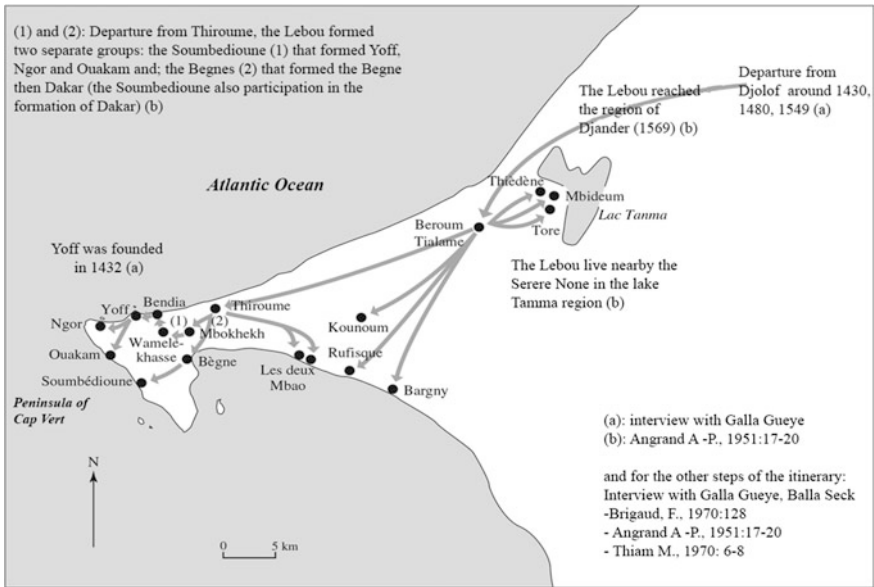
Fig. 30.3 Settlements of the Lebou group in fifteenth and sixteenth centuries in the Peninsula of Cap Vert (Dakar). *Source* [7]

Serigne Ndakarou and other local authorities still play a key role [5]. Although many new urban elements such as transport, cybercafés and a motorway form part of Yoff today, the area has largely managed to preserve its village atmosphere and community organization. This is largely evidenced by the area's sociopolitical setup, and also by the spatial organization in which in-between spaces (central places) are still evident [6] (Fig. 30.3).

30.2.2   Colonialism and Emergence of a New Form of Settlement Structure

The settlement of the French colons in Dakar in the nineteenth century brought forth a new form of settlement pattern, one which was influenced by the French norms and regulations in urban planning and architectural design. The path of development adopted by the French was one which planned the city with streets designed along the principles of French Roman grid style; and with provisions for basic infrastructure (connection to piped water, sewerage system and to electricity sources). The most notable development during this period was the development of a new settlement, which hosted large administrative buildings including hospitals, juxtaposed to the social and spatial organization of the Yoff settlement [8]. This settlement was later named the "Plateau" of Dakar. Due to its unique geographical

Fig. 30.4 **a** Organic settlement pattern in Yoff. **b** Grid settlement pattern in the Plateau of Dakar. *Source* [9]

position and easy connection to Paris and Europe in general, Dakar became the capital of the Federation of French West Africa—"*Afrique Occidentale Francaise*" by early 1900, boosting it as a regional hub for the West African region. The city was connected to the rest of the country via railway, the first line being the Dakar–Saint-Louis railway. The railway system later became a very important inter-region communication link within Senegal and also linked Dakar to Mali. In addition, the Port of Dakar linked Senegal to the rest of the world (Fig. 30.4).

30.2.3 Urban Planning as Tool for Spatial and Social Segregation

The urban planning policies adopted during the colonial period only served the needs of the French as the indigenous communities were relocated from "favorable areas" for the colonial masters to other settlements of the city. One such settlement to which indigenous communities were moved to in 1914–1915 was Medina [10]. This spatial segregation was accompanied by other types of segregation, particularly in access to services such as piped water, sewerage systems, education facilities and health centers. Medina soon became densely populated due to high levels of immigration, and since the area lacked basic services, disease outbreaks became the norm. In response, most of the indigenous communities were further relocated to the outskirts of the city, in a new settlement called Pikine. Just like in Medina, neither this new settlement was properly planned nor were there adequate basic service provisions. This marked the second phase of proliferation of slums and sidelined the indigenous communities from benefitting from the comparative advantage of the city. Today, Pikine remains haunted by this early spatial and social segregation [11].

A city plan that covers the Plateau and Medina was put in place in 1914–1915 in order to give an institutional and legal character to the spatial segregation. There was another territorial plan in 1937 whose aim was to zone the city and create a clear distinction between the administrative and commercial center and the rest of the city's residential use as well as other activities. This approach to modern urban planning emphasized more on the esthetic of the city in clear social and spatial demarcation and was practiced in other European colonies throughout Africa.

In Senegal, this form of segregation started to erode with the World War II that diverted French colons to other interests—protection of the French Territory with the support of French colonies. This diverted focus also reduced the efforts on progressive planning for the city of Dakar and caused a housing crisis in the city. At the end of the war, France enforced urban and territorial planning in her colonies, and in 1946 the master urban plan of Dakar, associated with massive infrastructure development was put into effect, marking one of the series of changes initiated by the French government [12]. At the same time, there was increasing power struggle between France and its colonies, with the colonies increasingly calling for their autonomy. In Senegal, the local elites started taking over the administration of the local, cultural, social and political affairs of the country. This institutional and legal change also affected the urban sector with more inclusive urban planning and housing being adopted. These changes however also increased the housing challenges experienced during the war. The political solution adopted during this period was to pursue the relocation of people termed as "illegal" to the outskirts of the city, where they could build their own houses. Pikine was one of the areas that received this population, and has since surpassed Dakar city proper both in population size as well as built-up area. Today, Pikine hosts 1.6 million inhabitants in an area of 99.6 square km compared to 1.2 million in an area of 79.7 in the city proper of Dakar.

30.2.4 Migration, Population Growth, Peripherization and Slum Proliferation in Post-independence Dakar

Rural–urban migration and its correlate, urbanization, are inevitable. People will always move to cities to take advantage of the opportunities they offer. Basic services make a significant contribution to the "urban advantage," and together with employment feature high among the aspirations of those who move to cities in search of a better life [13]. The newly built city of Dakar attracted massive migration from rural areas, for people coming to seek jobs in the newly built city center. Most of these immigrants lived in Pikine. After Senegal became independent in 1960, Dakar became the country's capital giving it an additional political function. Further rural–urban migration was reported, drastically increasing the population of Pikine. The relocation policy continued post-independence, in which the poor urban residents were relocated to newly developed settlements such as Grand Yoff and Dagoudane Pikine, Pikine-extension (in 1967) and Guediawaye (1971). Like other parts of Pikine, these new settlements were neither planned nor served with basic infrastructure, making them slums from the onset; pointing to the fact that the creation of irregular settlements in Dakar was a result of political decisions made both during the colonial days and after independence. Certain migrants integrated family members while others created their own juxtaposed settlement with full irregularities at the place level, the policy level and the people level. The multiple faces of slum became a reality in the agglomeration of Dakar, particularly in Pikine. Today, a mix of irregular settlements characterized by irregularities at the place, the people and policy levels are evident all over Dakar, even in the city proper. Whereas some settlements lack proper housing and basic infrastructure, other enjoys these services but the residents live in title-less land with the fear of eviction.

30.2.4.1 Peripherization of Urban Growth

In most settlements of Pikine and settlements in the city core such as Parcelles Assainies, Colobane, Grand Dakar and Camberene, urban growth is marked by "peripherization" with informal or illegal patterns of land use, combined with a lack of infrastructure, public facilities and basic services. The formation of these settlements is the consequence of poverty, not affluence, as informal unplanned settlements on the periphery spring up in response to a lack of affordable housing options within the city itself. It resulted from the inability of city and national authorities to anticipate urban growth, including through provision of land for the urban dwellers, particularly to the poor. Denial of permanent land rights to the urban poor is one of the main factors behind the "peripherization" associated with urban expansion in Dakar. In these settlements, the street network is characterized by irregular street patterns with multiple unplanned dead-end roads. These dead-ends are not the result of city planning but the result of the addition of plots by
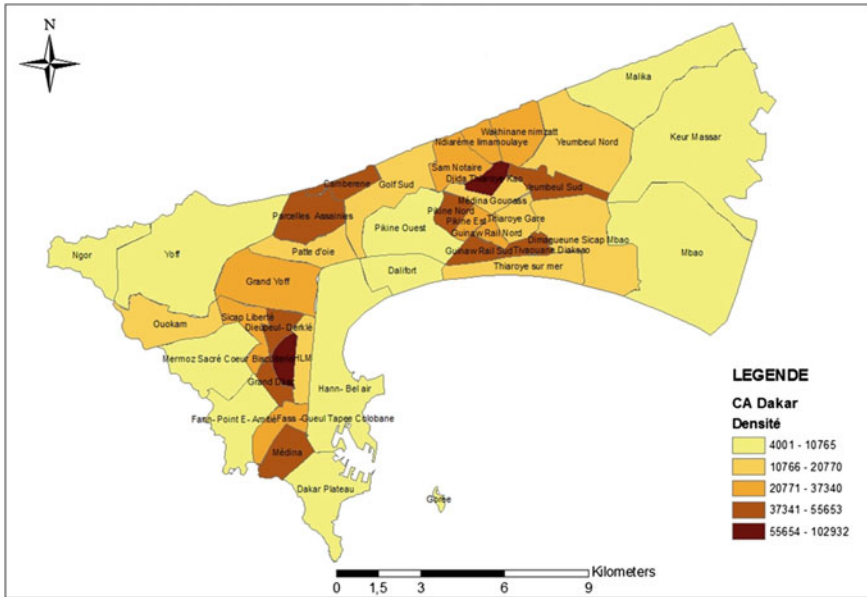
Fig. 30.5 Dakar population density map. *Source* [14]

land owners who subdivide land, mostly traditional land, in search of non-agriculture revenues along the decline of agriculture activities. Indeed, it is observed a steady decline of the agriculture land from 30 % in 1964, to 15 % in 1980, 5 % in 1990, and less than 1 % in 2015. The street planning has finally taken   on a hybrid or irregular nature, resulting in haphazard urban development (Fig. 30.5).

When well planned, high population densities constitute opportunities for smart growth rather than challenges. The level of urbanization is generally associated with numerous positive social and economic outcomes such as technological innovation, various forms of creativity, economic progress, higher standards of living, enhanced democratic accountability and women's empowerment. This makes cities places of opportunities where people tend to concentrate [15, 16]. From an economic point of view, cities with high densities have the potential for a concentrated, large labor and consumer market. Dakar with its population density of more than 15,000 habitants per square kilometer is relatively compact and is well placed to enjoy the benefits of concentrated labor and consumer markets. The city's compactness and its associated economies of scale and agglomeration of economies must thus be viewed as an opportunity rather than a challenge to be tapped on as means of promoting economic growth. However, since they are not well planned and managed, high densities have become liabilities to the city of Dakar. High densities not accompanied with provision of streets and other public spaces, and basic infrastructure often leads to high exposure to diseases and to epidemics such

as cholera. In fact the average population density of over 15,000 inhabitants per square kilometer masks densities as high as 40,000 inhabitants per square kilometer observed in certain municipalities of Dakar city proper as well as in the suburban areas of Pikine. Despite the early relocation of people from Medina to Pikine, today the municipality of Medina holds a very high population density (43,579 inhabitants per square kilometer) similar to many other municipalities in Dakar city proper such as Colobane, Grand Dakar, Camberene and Parcelles Assainies. The situation is alarming in many municipalities in Pikine where densities exceed 50,000 habitants per square kilometer. Yeumbeul Sud (51,468 habitants per square kilometer), Djidah Thiaroye Kao (102,932 habitants per square kilometer) and Pikine Sud (49,665 habitants per square kilometer) are among the municipalities with very high population densities in Pikine. In all these very highly populated settlements, few streets are built, and they are lacking other public spaces. This can explain the permanent high prevalence of infant and child diseases in Dakar compared to other cities and the rural areas of Senegal. On the other hand, the municipalities of Plateau, Fan-Point E, Ngor, Yoff, Mermoz and Sacre Coeur (located in the city proper) have densities as low as 10,000 inhabitants per square kilometer. These numbers are indicative of a segregated city and point to a need for the national authorities to consider a balanced urban and territorial planning coupled with provision of basic services in their urban development programs. National and local authorities must improve the foundation of the city of Dakar with smart planning, smart basic infrastructure and smart institutions and laws. Smart basic infrastructures, which are particularly of great urgency in the city, include connection to water, connection to sewerage facilities and connection to energy sources, as well as development of efficient waste management systems. Affecting this will enhance the economic value of land, encourage investments, reduce risks from natural hazards and increase resilience and minimize the costs of infrastructure maintenance among various other positive impacts.

The urban population of the region of Dakar is estimated at 3.3 million in 2015. The urban agglomeration of Dakar (excluding Rufisque) has a population of 2.8 million in 2015 [17]. It is densely populated with 15,780 habitants per square kilometer in an area of 178.3 km^2 [18] that represents only 0.1 % of the national territory. Today, the urban agglomeration of Dakar comprises the city proper (with a population of 1.2 million in 79.7 km^2) and the suburbs Pikine (population of 1.6 million in 99.6 km^2). With 2.8 million people, the agglomeration of Dakar represents over half of the urban population of Senegal [19]. The total population of Senegal is estimated at 14.4 million in 2015 with 45 % living in urban areas.

The population is relatively young with more than aged below 25 years as shown the age pyramid at Fig. 30.6. The age pyramid with high proportion of young people aged 20–29 years shows clearly that migrant population for both sex from other regions of the country contribute substantially to the rapid growth of the agglomeration population.
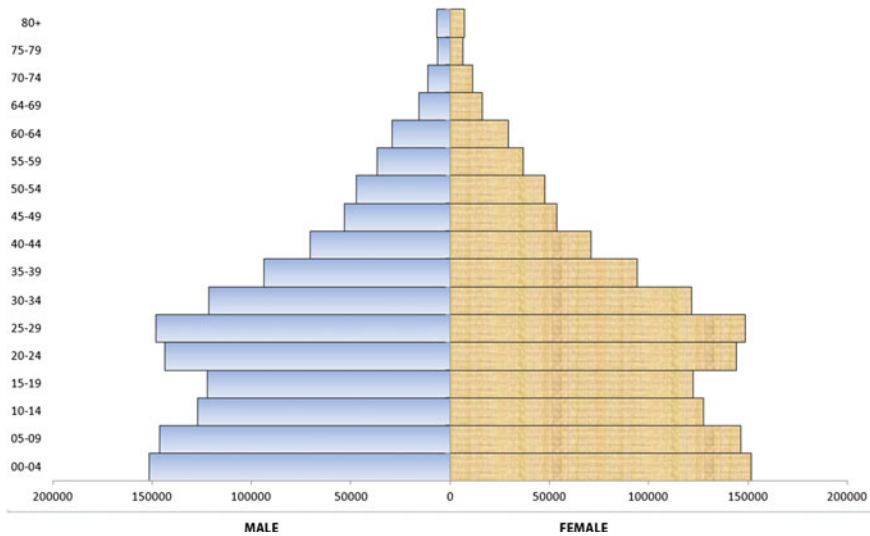
Fig. 30.6 Age pyramid—Dakar Urban agglomeration. *Source* [20]

30.2.4.2 Smart Streets are Needed to Transform the City of Dakar to a Smart City

In recent years, streets have been recognized as an integral factor in the achieve-ment of sustainable urban development. One key element of urban planning is the street. A connected street network reduces travel time and encourages walking and social interactions. One fundamental feature of smart streets is their connectivity in terms of planning as well as design. With regard to planning, sufficient land should be allocated to streets and the street network should be sufficiently long to cover all areas. There must be sufficient intersections available to facilitate shorter distances and reduce travel times, and encourage walking and social interactions. It enhances infrastructure development, environmental sustainability, and economic and social development. It makes cities resilient and prepared to overcome natural disasters. A sustainable, inclusive and prosperous city expands multimodal transport systems with sidewalks and bicycle paths, ensures eco-efficiency of infrastructural systems, and supports density through integrated infrastructure development, thereby enhancing efficiency and access. In addition to accommodating all kinds of users (pedestrians, cyclists, motorists), sufficient land allocated to streets promotes con-nections to services that contribute to good health and productivity, such as clean water, sewerage facilities, drainage systems, power supply, and information and communication technologies. Streets that provide space only to motorists are characterized by congestion and high CO_2 emissions [21].

The city of Dakar is not benefiting from all the multiple advantages associated with well-connected streets. Indeed, the city of Dakar is poorly served with streets, which is a characteristic that reflects the spatial segregation adopted during the
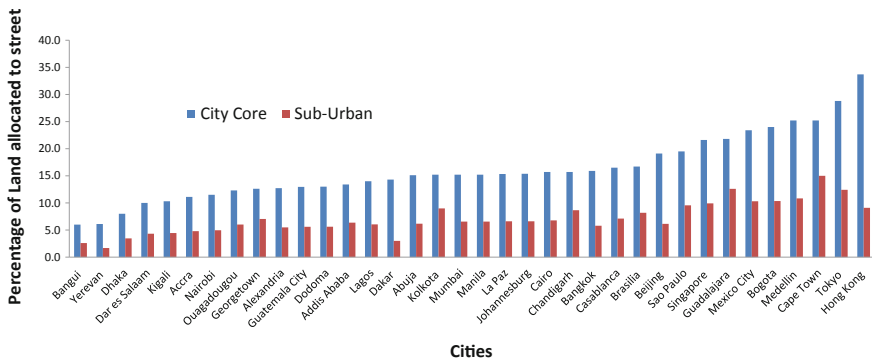
Fig. 30.7 Land allocated to street (LAS) in cities Africa, Asia and Latin America and the Caribbean. *Source* [23]

colonial era. While 15 % of land is allocated to streets in the central business district of Dakar, less than 5 % of land is allocated to streets in the suburb Pikine [22]. One effect of this has been the further marginalization of the most vulnerable segments of society who rely the most on public transport and cannot afford private alternatives. The low level of land allocated to streets is also evident in other parts of Dakar, even in the more affluent residential neighborhoods such as Almadies. Since many basic infrastructures rely on street networks for their laying out, many parts of Dakar are not well connected to the city's water, sewer and storm water mains. In addition, infrastructure for non-motorized transport (e.g., pavements or sidewalks for walking and bicycle lanes for cycling) is often lacking, poorly developed, on the decline, or does not appear to rank high among city planners' priorities. This has led to high incidences of traffic fatalities involving pedestrians and cyclists (Fig. 30.7).

30.3 Smart Land Tenure—Key for Smart City Foundation and Smart Economy

One fundamental driver of a smart city foundation lies on the institutions and laws that govern human settlements, be it a city, a town or a village. The way the city is planned, land distributed and basic infrastructure laid down is governed and administered within functioning institutions and laws. Providing security of tenure depends on a range of policies related to institutions and laws put in place to protect people against unlawful eviction, to ensure equitable distribution to basic services to all communities, and to put in place transparent and accountable processes of land regulation, key for secure land tenure [24].

However, in Dakar as in most Senegalese cities, land tenure is neither well governed nor well administered. Poor land governance is surrounded by poor land
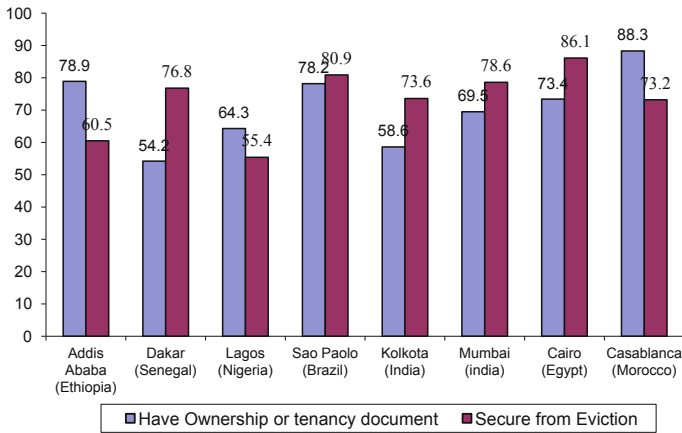
Fig. 30.8 Proportion of household with adequate document for proof of ownership or tenancy, and proportion of households secure from eviction in selected cities (2004–2007). *Source* [25]

administration characterized by a poor determination, recording and dissemination of information about tenure. In addition to being exposed to eviction, without legal proof of ownership, households cannot enjoy the economic and financial opportunity associated with investment and saving using their property as collateral. At the community level, the municipality cannot also legally collect various taxes that can be used to improve basic infrastructures. Promotion of secure land tenure in Dakar will boost investment in property development, increase municipal tax collection and in turn promote economic growth.

Regarding security of tenure, UN-Habitat and partners have now made considerable progress in developing a measurement method for security of tenure. The method had been implemented in 25 cities around the world through Urban Inequities Surveys. People or households are considered to have secure tenure when there is *evidence of documentation* that can be used as proof of secure tenure status or when there is either de facto or *perceived protection against forced evictions*. For owners, documents that are adequate for proof of security of tenure are: land registration certificate, title deed to dwelling, purchase agreement for land, lease agreement for land and certificate of occupation. For tenants, documents that are adequate for proof of security of tenure are: registered or not registered lease agreement and informal agreement (written) (Fig. 30.8).

Possession of ownership or tenancy document varies widely across the eight cities, with the lowest proportion reported in Dakar where only 54 % have proof of legal ownership [24]. During the Demographic and Health Survey conducted in Dakar in 2005, proof of ownership includes title deed, sale certificate, power bill and other documents. When disaggregated, less than 15 % of the household reported having a title deed, which is considered the most secure document. However, it is interesting to note that in the city of Dakar, despite the low

proportion of households with ownership or tenancy document, a large proportion feel protected against eviction (77 %). Measures to reduce the risk and stress associated with lack of documents and fear of eviction are based on recognizing and respecting a plurality of tenure systems, including intermediate forms of tenure arrangements and alternative forms of land administration and land records [26]. The legal institutional framework in a given country or city plays a key role on various elements of security of tenure such as acquisition or adjudication which is the process of final and authoritative determination of the existing rights and claims of people to land.[1]

Secure tenure goes beyond protection against eviction and includes economic and financial advantages. Land shall not be seen only as a social asset providing shelter to people, but also as an economic and financial asset providing opportunity for investment and saving. At the economic and financial aspect, various social and economic advantages include access to the financial and economic market as demonstrated by Hernando De Soto (2000). De Soto argued that granting titles to the poor would liberate the plots they occupy and transform them into capital. This, in turn, could be used as collateral for loans to jumpstart their businesses, or improve their houses, among other gains that increase their quality of life. At the community level, the municipality can legally collect various taxes that can be used to improve basic infrastructures such as connection to water, sewerage facilities, energy sources and waste management facilities. This would also allow people to fully participate in the development of their communities at the policy as well as the implementation level instead of seeing proprieties as dead investments serving only for shelter.

Tapping in the Triangle of Economic Productivity—People, Land and Infrastructures. Dakar as a coastal city offers multiple opportunities as a hub of economic activities as well as a link to local, regional and global economies. Today, it has an added advantage associated with its high population density and its youthful population, two important drivers of economic productivity and growth. **Cities are built by people**; with their concentration offering agglomeration of economies starting from their land and housing assets that constitute more than half of their wealth. With functioning institutions and laws, land and housing assets contribute to the planning, management and provision of services in settlements. However, in the absence of functioning institutions and laws providing legal

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[1]Once the land is acquired, another element that depends to legal institutional framework is the acquisition of a building permit, which is at the authority of the local governing body on land use and planning for construction or renovation of a property. Another element that lies to the authority is the cadaster system, which is a parcel based and up-to-date land information system containing a record of interests in land (i.e., rights, restrictions and responsibilities). Indeed, security of tenure depends heavily to the land governance that establishes the rules, processes and structures through which decisions are made regarding access to and the use of land, the manner in which those decisions are implemented and the way that conflicting interests in land are managed. In many cities of the developing regions, poor land governance is surrounded by poor land administration or registration characterized by a poor determination, recording and dissemination of information about tenure, value and use of land during the implementation of land management policies.

propriety rights, most of these assets remain dead investments sheltering only people. To tap into the potential of high densities, the city of Dakar must formalize it land system, which will be the driver of many other components of its foundation such as streets and public spaces, provision of basic infrastructures such as water, sanitation and energy, and management waste. To drive Dakar toward a smart city, it is urgent that national and local authorities recognize the wealth of their citizens and involve them in the planning, the building and the management of their city. No city can claim to be smart when the wealth of its citizens is not fully taken into consideration in the economy.

30.4   Basic Infrastructure—Key for Smart City Foundation

In a smart city foundation, basic infrastructure such as piped water services, sewerage facilities electricity sources and solid management is considered along the city planning. They are part of the city planning prior to settlements of households. In a sustainable city foundation, use of improved water from piped water services, sewerage facilities, solid waste management, energy for lightning is quasi-universal. For the city of Dakar, only connections to piped water facilities and to electricity are quasi-universal with levels of 92 and 95 %, respectively. The coverage of sewerage facilities and solid waste management is still very low, below 50 % in 2015.

30.4.1   Universal Access to Water Services and Electricity Is Fundamental for City Smartness

During these past 20 years, there is steady progress in the coverage of water connection from 64 % in 1993 to 77 % in 1997 and 90 % in 2005. At this level, it is clear that the coverage of connection to water facilities and to electricity sources did not follow the rapid progress of unplanned settlements characterized by lack of documented land tenure. Considering that the water and electricity services governed public administrations until recently, their high level of coverage shows a de facto secure tenure which was highlighted earlier. Indeed, in order to have connection to these services, the application must obtain the approval of the Ministry in charge of housing (Fig. 30.9).

Connections to water services and to electric sources often go together though processed by two different entities, the SDE (Sénégalaise des eaux) and the SENELEC (Société nationale d'électricité du Sénégal), respectively. Therefore, it is not surprising to have similar figures for both amenities. Here the only problems that arise are during the supply which is more a demand–supply equation than a city foundation matter. During the foundation of the city what was important was to
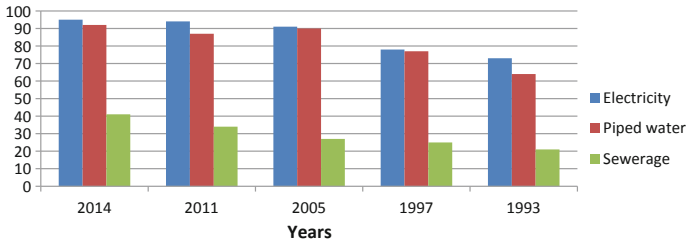
Fig. 30.9 Percentage of household connected to electricity sources, water piped and sewerage facilities, Dakar 1993–2014. *Source* [27]

ensure that connection to water services and electricity are established along the planning of the city. For instance due to poor infrastructure development, many households of Dakar may stay one week without water according to the Demographic and Health Survey conducted in 2014 in Dakar [28]. Though connection to water exists, the use is not neither sufficient nor affordable [29]. Similar situation occurs for the electricity where households can stay hours and days without electricity.

30.4.2 Sewerage Facilities Are Fundamental for Dakar Smartness

Data on connection to sewerage facilities have been collected from the Demographic and Health Surveys held in Dakar between 1990 and 2015. During the last twenty years, there has been important progress on the connection to sewerage facilities with the proportion of people living in household connected to sewerage facilities almost doubling from 21 % in 1993 to 41 % in 2014. With similar progress, it is expected that by 2020, 2030 and 2035, the coverage of connection to sewerage facilities will be 49, 64 and 72 %, respectively. However, with an aggressive sanitation program, this progress can be boosted and the majority of households connected to sewerage facilities before 2020, and the universal access before the year 2035. The achievement of this will however require re-planning of the city of Dakar. At the moment, the majority of the city residents rely on sanitation facilities such as septic tanks and pit latrines. Along with the lack of sewerage system, the city of Dakar lacks a properly developed drainage system —both in the rich and poor neighborhoods. Lack of adequate investment in these two basic infrastructure components exposes the city to challenges such as management of surface water, flooding and vulnerability of the population to waterborne diseases, especially during the rainy seasons. In Dakar as in most cities of developing regions where there are few streets built, sewerage facilities and storm drainage are not factored during the planning of the city. The situation is worse in the suburb of Pikine where the level of connection to a sewerage facility is less than
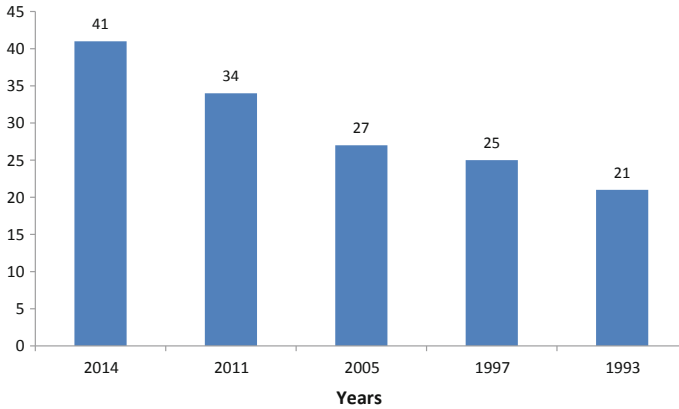
Fig. 30.10 Percentage of household connected to sewerage facilities. *Source* [27]

10 % in most settlements. To be a smart city, Dakar needs to take into consideration the urgent need of a sewer system (Fig. 30.10).

Lack of access to sewer system in overcrowded urban areas has negative impact on health as a factor of proliferation of diseases. Waterborne diseases such as diarrhea and respiratory infections are frequent in cities. A series of demographic and health surveys conducted in the city of Dakar during these last twenty years show consistently high levels of diarrhea diseases and respiratory infections than in the rural areas [30]. This can be associated with low coverage of sewerage facilities, with its correlate, high frequency of floods during raining seasons. In addition to that, households are frequently crowded in tiny houses hosting kitchens without adequate ventilation.

30.4.3 Better Management of Waste Key for City Smartness

One main characteristic of Dakar's weak city foundation is poor waste management. Due to lack of a comprehensive drainage system, wastewater flows in the streets of Dakar. Due to lack of regular solid waste collection, household waste also finds its way to the streets. Indeed, Dakar has very limited waste disposal sites, and the few that exist are poorly managed. Dakar's main solid waste disposal site, the Mbeubeuss (located in Pikine), receives 475,000 tons of garbage per year from both domestic and industrial sources [31], yet its designation as the city's dumpsite in 1968 was not well informed by robust feasibility studies. To date, the landfill remains as an unfenced open pit where garbage is not covered with an inert material and where intense recovery activities are practiced. Proposals are however being

developed to start the conversion of the waste in the dumpsite to wealth through recycling and other means. Currently, Mbeubeuss receives on average of 3500 people per day (33 % of recyclers, resellers and other buyers of recovered materials) whose activities mobilize financial mass of nearly thirteen million francs (13 million FCFA) [32].

Poor management of waste impacts negatively on people's health and exposes children to multiple diseases. Senegalese Demographic and Health Surveys conducted in 1993, 1997 and 2005 constantly show that diarrhea and acute respiratory infections are more frequent among children living in Dakar than those living in rural areas [33]. This high exposure to diseases in Dakar is also associated with the fact that households are overcrowded and are more affected by indoor as well as outdoor pollution than their counterparts in the rural areas and small towns.

30.5 Transforming the City of Dakar—From a Seasonal Flooded City to a Green, Smart City

As a peninsula in the Atlantic Ocean, Dakar is located in a very low zone with an average elevation of 20 m above sea level and with several watersheds mostly backfilled. Considering its geographical location, Dakar has the potential to be an agriculture, green city in addition to its huge potential of fish production. Wetlands areas are sources of income from agriculture, livestock, crafts, among other activities. They play an important role in maintaining the water quality and the prevention of natural hazards. These are also ideal places for reception and reproduction of waterfowl which are indispensable elements for the ecological balance of aquatic environments and key links in the food chain, hence the importance the preservation of wetlands. If well planned and designed, Dakar can be a smart city where citizens enjoy high quality of life. This will require policies and actions beyond the current practices of the use of pump to drain the water and to create retention basin, or to temporarily relocate a tiny portion of households. Preparing Dakar as a smart city will require a transformation of the city to be what it was meant for, a green city combining, human settlements, agriculture, green spaces with reserves not meant for any type of uses.

30.5.1 Flooding in Dakar: Causes, Occurrences, and Damages and Losses

The risk of catastrophic losses due to flooding is becoming significant as a result of deforestation and the increasing proximity of large populations to coastal areas,

river basins and lakeshores [34, 35].[2] Floods are the most common natural disaster and the leading cause of natural disaster fatalities in Dakar and in the world generally.[3] In Dakar, the vulnerability to flooding is particularly related to the fact many poor households have been forced to settle in flood prone areas due to inaccessibility to planned land in the city of Dakar during the colonial era as well as post-independence.[4] Due to poor land administration and governance, there is no compliance with standards of occupancy of the space leading a high building density and irregularity of the urban fabric. Wetlands in Dakar cover an area of 40 square km of which nearly 72 % (29 km^2) are hosting human settlements [36]. During the drought of the 1970s and later the 1980s, most of these immigrants use abandoned low lands of water bodies' catchments (lakes, small rivers, etc.). As there was no big issue raised with the occupation of these wetlands as long as these are dry, the state has done very little to control the occupation of these unsuited lands. From 1954 to 2003, 95 % of these areas have been converted into habitation [37].[5]

In addition to the fact that settlements are flood prone areas, the climate change made the situation worse. Climate change contributes, indeed, to the increase in sea levels as recently noted in several coastal cities such as Dakar. Rise of the sea level accelerates coastal erosion and causes the loss of farming land and habitable areas. In Dakar, every year, the sea level increases 4 mm causing a loss of 1 m of coastal land [38] and an increase in prone flood areas. Climate change has also made the

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[2]United Nations Office for Disaster Risk Reduction (UNUSED). The reporting gaps underline the need for UNISDR and partners to continue working with governments to establish robust and well-maintained national disaster loss databases to improve record-keeping and accountability. Universally acceptable loss indicators are currently under development to measure progress in reducing disaster losses as set out in the Sendai Framework for Disaster Risk Reduction 2015–2030.

[3]The term hazard refers to a severe or extreme event such as a flood, storm, cold spell or heatwave which occurs naturally anywhere in the world. Hazards only become disasters when human lives are lost and livelihoods damaged or destroyed. Rises in the global population increase the risk of disasters because more people live in harm's way (Reference: Centre for Research on the Epidemiology od Disasters (CRED) and UNISDR; The Human Cost of weather related disasters (1995–2015)).

[4]Some are exposed to the threat of eviction as it recently happened, in 2015, at the City Tobago near the international airport.

[5]Flood risk and land occupation in Dakar outskirts. Does climate variability reveal inconsistent urban management? Cheikh Mbow, A Diop, AT Diaw University Cheikh Anta Diop, Institute of Environmental Sciences, Laboratoire d'Enseignem, Dakar, Senegal. An integrated analysis has been made using land use maps, local topography using DTM (SRTM) and field surveys to show factors and implications of flooding in the outskirts of Dakar called Yeumbeul. Physical and human driving factors are integrated in the analysis. The impacts on environment and health are analyzed against policy for flood aftermath and beyond with the so-called Diaxaay State plan for flood prevention.

rainy season in Dakar and Senegal generally unpredictable and so its intensity. In 1970–1980s, the rainy season started in June–July and continued until September–October, while nowadays, rains in some regions such as Dakar start as late as end of August. In this situation, it is often that low intensity of rain be followed by a heavy rain that cannot be contained by a city which is not well planned with a water storm system and where people have settled in wetlands not meant for human settlements. Floods have become more recurrent, more dangerous and less manageable [39].

Over the last fifteen years, floods have been a recurring problem in Dakar, especially in suburban areas of Pikine and its extension Guediawaye. Most areas of the agglomeration of Dakar face greater vulnerability of irregular housing areas with frequent occurrences of floods, particularly severe in 2001, 2002, 2005, 2009, 2012 and 2015. However, statistics on flooding are seldom available due to lack organized system of collection and analysis of occurrences. Apart from habitat degradation, floods cause considerable economic losses on the various activities performed by people across various income and social connections. In 2009 alone, 44 % of Pikine's population was directly affected by floods. In the 2015, despite the lack of statistics, report from main national media shows occurrences of flooding in various cities as illustrated here [40]. Heavy rains which were supposed to produce wealth in a planned city cause damages and losses, and claim people's lives. The impacts of floods on people and communities are enormous ranging from economic, social and health issues to environmental aspects. Asset losses degrade the quality of life of households and reduce the housing value. People are exposed to shock hazard associated with poorly installed electrical facilities. Flooding affects the few existing social and community facilities such as schools, health centers and markets. This means during the flooding, social development is severely hampered with people trapped in their houses. By Affecting social development with inaccessible of most services, the economic development is also severely affected with significant decline of productivity of the active population. In 2009, the Post-Disaster Needs Assessment (PDNA) estimated damage and losses to total 44.5 billion FCFA nationwide, of which 35.5 billion FCFA was for damage and loss in the Dakar region alone, with the most significant damage being on housing (61 %), transport (11 %) and health (10 %) [41, 42]. In terms of losses, the trade sector suffered the most losses, with 23 % (mostly informal trade), followed by housing (18 %), urban community infrastructure (18 %), energy (17 %), and transport (16 %) sectors. At the household levels, an estimated 30,000 houses were affected in the Dakar region, most of which are now uninhabitable and often abandoned [43], and nearly 360,000 people representing 44 % of the population of Pikine were affected. Further floods in 2012 resulted in higher numbers of people affected as well in more damage to houses and infrastructure, and in losses incurred. Due to heavy flooding, 26 deaths, 264,000 people and 7737 damaged houses were reported. In addition, floods displaced over 5000 families and contaminated 7700 drinking water sources nationwide, with Dakar remained with heavy toll. In 2015, flooding has also been the headlines of all Senegalese media.

30.5.2 *Adaptation, Resilience and Mitigation of Flooding to Boost Economic Development*

Adaptation is assessed both at the household level (physical, human, financial and social assets) and at the community level (infrastructure and utilities, common environmental resources) [44]. Adaptation is a "reaction of natural or human systems to actual or expected climatic stimuli or their effects, in order to mitigate harm or exploits beneficial opportunities" [45]. It can be proactive or reactive, private or public, individual or collective, spontaneous or planned. Though there are several adaptation strategies, they differ in their effectiveness associated with financial constraints, technical, cognitive, behavioral, political, social, institutional and cultural factors [46].

The impact of flooding-related disasters remains a significant challenge to sustainable development of the city of Dakar [47]. As noted in the Hyogo Declaration and Hyogo Framework for Action (HFA) 2005–2015 ,"It is critically important that the Building the Resilience of Nations and Communities to Disasters be translated into concrete actions at all levels and that achievements are followed up through the International Strategy for Disaster Reduction, in order to reduce disaster risks and vulnerabilities." However, instead of managing underlying risk drivers for disaster risk reduction, the city of Dakar as many countries and cities focuses on managing disasters. As shown previously, in 2009, Dakar spent billion of CFA francs to manage damages and losses due to flood leaving risk factors for flooding growing. However, as recommended in the Sendai Framework for Disaster Risk Reduction of the Third UN World Conference on Disaster Risk Reduction held in March 2015, disaster risk management needs to be about managing the risk inherent in social and economic activity, rather than simply mainstreaming disaster risk management to protect against external threats such as natural hazards.[6,7] The city of Dakar must undertake a transformative move to a green, smart city where fighting floods and their consequences are no longer in the city agenda, but in history books. While the city is looking for a long-term solution, better management, mitigation and deployment of early warnings can save more lives in future. Better flood control for poorer communities at high risk of recurrent flooding would be another step forward. This will require an establishment of a flooding observatory collecting and analyzing events prior, during and after flooding for informed policies [48].

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[6]A United Nations Office for Disaster Risk Reduction Perspective. A major stocktaking exercise took place on the learning from implementation of the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters (HFA) starting in 2012.

[7]The Sendai Framework's seven targets focus on substantial reductions in (1) disaster mortality, (2) number of affected people, (3) direct economic losses and (4) reducing damage to critical infrastructure and disruption of basic services. The Sendai Framework also seeks a substantial increase in (5) national and local disaster risk reduction strategies by 2020, (6) enhanced cooperation to developing countries, and (7) a substantial increase in multi-hazard early warning systems, disaster risk information and assessments.

Effective low-cost solutions exist, including afforestation, reforestation, floodplain zoning, embankments, better warnings and restoration of wetlands [49].

People have been undertaking various actions to make their neighborhood and home more resilient to flooding. Households use several adaptation strategies before and after flooding occurrences to preserve their assets of households and those communities. They concern mainly backfill (with sand, rubble, waste), evacuating water with rudimentary means (buckets and basins), drainage, pumping, laying precarious lines (trenching or use of PVC pipes) and protective dikes, land access houses. Adaptations to homes concern the height of the construction work on the roofs, and other strategies such as paving, floor covering, enhancement walls, clogging of the cracks, the change the slope of the roof. The costs of adaptation exacerbate household poverty by capturing most of their financial resources to the detriment of economic initiatives, health and nutrition.

The government responses to disasters related to flooding have been progressive with three major faces: Prior to 2006, the government response consisted of emergency pumping operations in neighborhoods and the temporary resettlement of the victims in public buildings, such as schools. This strategy proved to be very expensive (for fuel and maintenance of pumping equipment, deploying field teams, sheltering flood victims and repairing the buildings where victims had been sheltered). Besides, such a strategy was not sustainable because similar actions were being repeated each year at the same sites with huge losses, unforeseen expenses and reorganization in the state budget. In Dakar, the post-disaster strategies that have allowed affected populations to recovery from the series of floods were reconstruction activities, such as drainage systems, restructuring of flood zones and new housing. In 2006, the project for construction of social housing and the fight against floods and slums was aimed at implementing the "Jaxaay Plan" and the "One Family, One House" program.[8] From 2006 to 2012, the "Jaxaay plan" built houses for flood victims and installed water drainage systems using emergency pumps. The plan has helped build more than 3000 housing units in Dakar and other regions of the country, as well as retention ponds, as part of PROGEP, along with gravity-based drainage systems [50]. Faced with recurring floods in most cities across the country and especially in the Dakar region, public authorities felt the urgent need to find a solution in 2009. The year 2009 marks the turning point with the government understanding that responses to flooding go beyond managing damages and losses but preventing occurrences of floods.

In August 2010, the Government of Senegal decided to prepare an urban development project for rainwater management and climate change adaptation, known as PROGEP, aiming to reduce floods through an integrated and sustainable approach.[9] The PROGEP, officially launched in November 2012 with a five-year term (2013–2017), has five main components: (a) preparation of a master plan for

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[8]The project hosted by the Ministry of Architectural Heritage, Housing and Construction, following the dissolution of the National Agency against Floods and Slums (ANLIB).

[9]This project was supported by the World Bank.

storm water drainage and construction of drainage structures; (b) construction of storm water drainage on the outskirts of Dakar; (c) mapping of flood risks and within detailed urban plans (PUD); (d) developing a flood prevention geographic information system (GIS); and (e) involving communities in flood reduction and climate change adaptation through information campaigns to raise public awareness and support micro-projects for reducing local flood risks. In 2012, the Government also introduced a sustainable recovery and flood management policy with three steps: (a) Assess damage, losses and post-disaster needs for 2009; (b) Initiate a storm water management and climate change adaptation project; and (c) Prepare a ten-year flood management program (2012–2022). Following the floods of August 2012, the government launched the ten-year flood management program (PDGI) and created the Ministry for Restructuring and Managing Flood Zones Creation (MRAZI). This Ministry is in charge of the coordination among all stakeholders in the fight against flooding [50]. However, all these projects require financial supports that divert funds from other priorities and needs. For instance, the PROGEP is a five-year project (2013–2017) funded for USD 72.9 million [50].[10] In 2012, the emergency relief plan (ORSEC) was activated after the heavy rains in August of the same year. With most urban areas of the country affected by flooding, the Government of Senegal adopted strong measures, starting with a ten-year program for flood management whose total cost is estimated at more than 700 billion FCFA (USD 1.4 billion) in 2014.

Despite all these initiatives and projects with billions of CFA francs invested, flooding still causes damages and losses among people and communities. In 2015, several settlements were flooded, and roads were deemed impassable, forcing many motorists to rely on alternative means of transport so as to protect their vehicles from being washed away or damaged by water. Buildings that were in formal settlements were also affected (Fig. 30.11). A basketball event between two national teams in the *Marius Ndiaye* stadium was delayed for 4 h due to the fact that the field was unusable. If we just limit our analysis to the period of the Millennium Development Slum Target (2000–2015), the government has spent trillions of CFA francs to fight flooding, an amount much higher than the funds mobilized for water, sanitation and solid management. According to the Minister of Urban Renewal, Housing and living Environment, Government of Senegal allocated a budget of 3 billion CFA francs in 2015 to assist people in emergency areas affected by natural disasters during the rainy season.

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[10]The PROGEP is being implemented together with priority measures such as: The Government designated the Municipal Development Agency (ADM) with PROGEP preparation and implementation, PROGEP was officially launched in November 2012, but preparation of the master plan for storm water drainage in the outlying areas of Dakar and the preparation of technical drainage studies began in 2011. The budget of PROGEP is USD 72.9 million of which USD 55.6 million through the World Bank; USD 10.6 million from the Senegalese government, USD 4.1 million from the Nordic Development Fund and USD 2.6 million by ADM. Additional funding was being negotiated with the World Bank, IDB and AfDB.

Fig. 30.11 Images of flooding in Dakar in 2015. *Source* [51]

The fight against flooding in Dakar will be won beyond the current adaptation practices of retention basins or use of pumps. Even outside the raining season, some settlements of Pikine and Guediawaye are exposed to high risk of flooding due to rise of the sea level associated with climate change and coastal erosion. In Dakar, despite the authorities' commitment to the restoration and rehabilitation of these ecosystems, deteriorating trend is not reversed due to lack of good national wetlands policy. It is prohibited for human settlements in disaster risk areas such as flood zones, landslide and other disasters or any other factor specific to the nature of the places that can be considered for reasons of public health and safety. However, this place can a play crucial role in the urban ecosystem in becoming green areas, protected areas for environmental or recreational purposes, which if well integrated, enhance the character their ecological value [52, 53].

30.6 Re-structuring the City of Dakar to Be Sustainable, Inclusive and Prosperous

The compactness of the city of Dakar and its associated economies of scale and agglomeration of economies must be viewed as an opportunity rather than a challenge to be tapped on as means of promoting economic growth. However, since high densities are not well planned and managed, they have become liabilities to the city of Dakar. High densities not accompanied with provision of streets and other public spaces, and basic infrastructure such as sewerage and drainage systems often lead to high exposure to diseases in Dakar. Over the last fifteen years, floods have been a recurring problem in Dakar, especially in suburban areas of Pikine and its extension Guediaway. Most areas of the agglomeration of Dakar face greater vulnerability of irregular housing areas with frequent occurrences of floods.

National authorities have made progress in development of policies and programs to promote sustainable urban growth. The two policy reforms/plans that stand out are the "Act III of Decentralization" in 2013—an administrative reform, and the "Plan Senegal Emergent (PSE)" in 2014—a holistic framework for sustained development and economic growth. The provisions of these two frameworks offer guidelines for both urban and national development. They have also introduced a Master Plan of Dakar in 2001 (Plan Directeur Urbain (PDU) 2025), another Master Plan of Dakar in 2014 (Plan Directeur de Dakar 2015–2035) in 2014 and a national territorial planning (Plan National d'Amenagement du Territoire) in 2014.

Dakar under the ACT III of Decentralization—Under the Act III of decentralization, the country is subdivided into 14 regions, 45 departments and more than 500 municipalities (communes); with Dakar being one of the 14 regions [54]. The region of Dakar is subdivided into four departments: Dakar, Pikine, Guediawaye and Rufisque. The first three departments form the urban agglomeration of Dakar which is analyzed here; Pikine is composed of the department of Pikine and the department of Guediawaye. Each department is subdivided into municipalities headed by a mayor, who is the representative of the local community and is responsible to among other things, preserve, maintain and administer the properties and assets of the municipality. In addition to creating the structure for decentralization from the national to the local level, Article 170 of the Act III creates the framework for decentralization of municipal services such as waste management and hygiene, protection and conservation of historic sites and monuments, promotion of national and local cultures, preparation and implementation of various kind of plans (including master plans), and management of health and education programs. Article 193 of the Act further gives guidelines on municipal finance, which is key in the implementation of urban programs.

Dakar under the Plan Senegal Emergent (PSE)—The PSE is strategically based on three axes: (1) structural economic growth and transformation; (2) human capital, social protection and sustainable development; and (3) governance, institutions, peace and security. At the sectorial level, the PSE is glued around six main sectors: energy, infrastructure, business environment, telecommunication, human capital and finance [55]. Flagship projects under the PSE include developing Dakar as a regional logistics hub for production and distribution of industrial products and services in West Africa; development of multi-services and touristic hubs; development of Dakar as a referential regional campus with five world-class international schools; creation of business parks hosting international companies and institutions; and making Dakar an international medical city. The plan anticipates that these flagship projects will result in strong convergences and synergies within the region and improve the attractiveness and competitiveness of Dakar, and Senegal at large (Fig. 30.12).

The major plans with an urban focus include the Urban Master Plan named "*Plan Directeur Urbain (PDU)*" of Dakar agglomeration (the Grand Dakar), initiated in 2001 and ending in 2025. However, the "PDU 2025" encountered various obstacles in its implementation that necessitated its revision to the "Plan Directeur 2035." Among the major obstacles that faced the PDU 2025 were delays in the plan
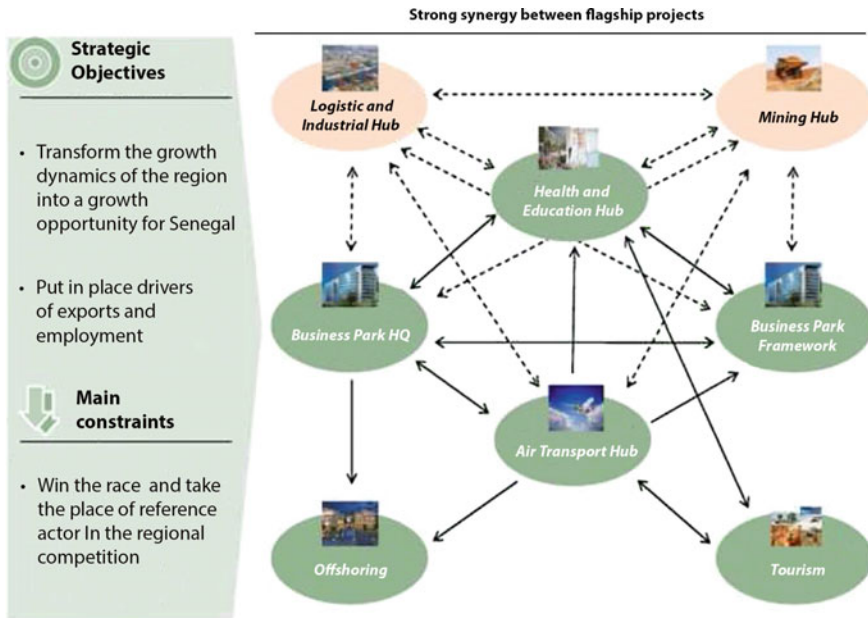
Fig. 30.12 Flagship projects of the PSE "Plan Senegal Emergent." *Source* [56]

preparation process (initiated in 2001, the project was only approved in 2009); lack of involvement of stakeholders such as local communities; lack of relevance of some management guidelines; and lack of anticipation of current urban changes [55]. The Urban Development Master Plan named "*Plan Directeur de Development Urbain—Plan Directeur 2035*," initiated in 2014 and ending in 2035, aims at urban development of the region of Dakar and its surroundings for the period 2015–2035 [57]. Its main objectives are: Sustainable Urban Development; Compact cities connected with a transport network; Robust and Resilient city and; Vibrant city with active interaction between information, goods and people. In addition to urban plans, the Senegal initiated plan with national coverage such as the National Territorial Development Plan named "*Plan National d'Amenagement du Territoire*" prepared in 2014 and the "*Sustainable Development Plan of 2015.*"

In order to transform Dakar to be green and smart, it is important to follow guidelines such as the one prepared by the National Plan for Territorial Development "PNAT" that proposes five development areas: Urban areas; Areas for economic activities; Areas for agriculture activities; Areas for touristic activities; and Areas for conservation [52]. The PNAT also identifies areas with high risk for habitation and any other activity. In these areas, modification of the land including by residential structure or any cadastral operations is prohibited. These areas are prone to disasters such as flooding, landslides, other disasters or any other factor specific to the nature of the places that can harm public health and safety. This plan also promotes green areas and other protected areas for environmental purposes or
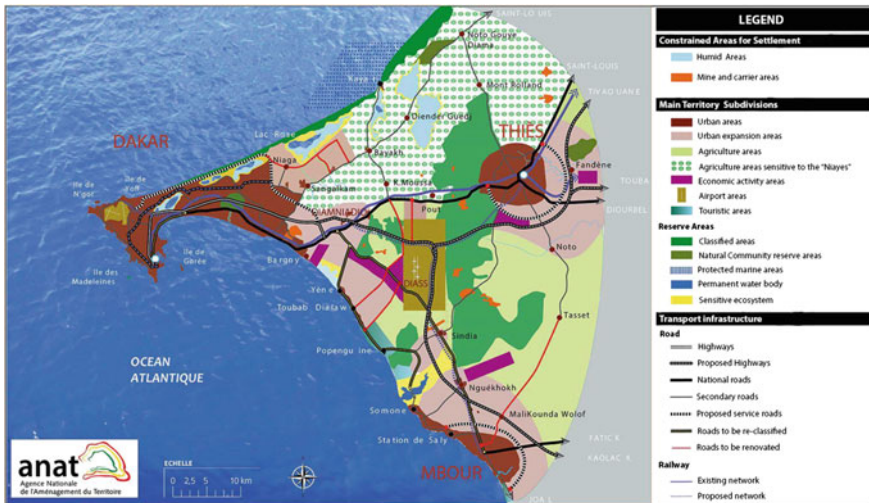
Fig. 30.13 Territorial planning of Dakar, 2014

spaces with light recreational facilities, which, when well integrated enhance the character or the ecological value of the area. Specific focus areas of the PNAT also aim at: controlling the internal urban growth; reducing the proliferation of slums; promoting a balanced urban development; and meeting the housing demand. Regarding the latter, several actions are planned such as promoting housing in the urban and economic expansion in the areas of Diass and Lac Rose. In order to decongest Dakar, three categories of urban centers will be promoted: *Urban centers of the "Massif"* structured around national sport centers and an international exposition center; *Coastal urban centers* structured around coastal touristic areas; and *Eco urban centers at the "Lac Rose"* characterized by the presence of micro-organisms and mineral elements. In order to promote a balanced urban development, secondary urban centers will be promoted in the urban agglomeration of Dakar, and polycentric urban centers will be promoted in the Triangle constituted by Dakar and two other bordering cities, namely Thies and Mbour (Fig. 30.13).

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Chapter 31
Smart Infrastructure Development Makes Smart Cities—Promoting Smart Transport and ICT in Dakar

Gora Mboup

Abstract A smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centric approach based on three core components and seven dimensions. The three core components are Smart City Foundation, Smart ICT and Smart Institutions and Laws, which in turn are the pillars of the seven dimensions of a smart city: *Infrastructure Development*, Environmental Sustainability, Social Development, Social Inclusion, Disasters Exposure, Resilience, and Peace and Security. The three components together with the seven dimensions make a Smart Economy. Infrastructure development has several elements across various social, economic and environmental dimensions. Here, our analysis focuses on those connecting people to several categories of services, particularly transport and ICT infrastructures. The first section analyses the classical option of connecting people to services through non-motorized means or motorized means of transport. The interaction between the development of urban spatial patterns and transport is thus a key factor shaping accessibility in cities both in physical and in socioeconomic terms. To access to services such as work, to the health centers, to the school or to the market among several other destinations, the share of motorized means is 40 % (public an private) compared to 60 % for the non-motorized means, mainly by walking. The public transport sector is predominantly informal (95 % against 5 % for the formal sector). Turning informal transport sector challenges to opportunities in the smart city making is a call along with the enhancement of the public sector with the introduction of Bus Rapid Transit (BRT) and other higher efficient means of public transport. In the absence of affordable, reliable public transport, the poor are no choice rather walking to access to services. It is urgent to make streets friendly to pedestrians with sufficient public spaces for social interactions. Today, it is recognized that the information and communication technology (ICT) development is an important enabler of accessing to services and must be integrated in the planning and management of transport systems. For these past 15 years, the Senegalese government has taken various steps to create an environment favorable to the development and use of ICT at all levels. It has created

G. Mboup (✉)
Global Observatory Linking Research to Action, New York, USA
e-mail: gmboup@gora4people.org

legal institutional framework to support regulatory mechanisms on the development and use of ICT and has also introduced ICT platforms such as E-Governance, E-Education, E-infrastructure and supports education and training on ICT. The second presents different forms of ICT infrastructures in the creation of smart, digital city.

Keywords Dakar · Smart city · Smart economy · Infrastructure development · Transport · Public · Informal · Streets · Walking · Information · Communication · Technology · Government

31.1 Introduction

Infrastructure development has several dimensions across various social, economic and environmental components. The analysis in this chapter focuses on those connecting people to several categories of infrastructure, particularly transport and ICT infrastructure. Rapid urbanization in developing countries has increased pressure on infrastructure such as road networks and transportation systems which are key for linking services such as workplaces, health centers, schools and markets. The ability of people to access job markets and social services determines the level of urban economy smartness. The Sustainable Development Goals (SDGs) recognize that sustainable transport is crucial for urban economic development. According to Goal 11 "*Make cities and human settlements inclusive, safe, resilient and sustainable*" member states have committed themselves to "by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" [1]. Transport will also play a large role in achieving commitments in the COP21 as a critical part of the climate change solution where it contributes to 23 % of global CO_2 emissions. It can contribute to both reducing greenhouse gas (GHG) emissions and building economy-wide resilience to the impacts of climate change [2]. It is urgently needed to increase the sustainability of existing and new transport systems and shift policies and investments in the design of public transport systems, vehicle efficiency, demand management and land use. The major transport question is how to sustainably meet the rising global demand for greater interconnectedness and mobility [3].

It is also recognized that the information and communication technology (ICT) development is an important enabler of accessing to services and must be integrated in the planning and management of transport systems. Developments in ICT have made virtual access to services such as employment, education and business opportunities possible, hugely changing the dynamics on physical distance limitations. ICT indeed offers a promising sustainable solution to access to different social and economic sectors, to perform duties or receive services. Considering this significant way of linking people to services through ICT infrastructure, cities must

anticipate in the digital world where most services will be accessed online as already are social interactions in the social media such as Facebook, Twitter, LinkedIn, WhatsApp and Viber.

31.2 Smart Transport for Smart Economy

The classical option of connecting people to services is through non-motorized means or motorized means of transport. The interaction between the development of urban spatial patterns and transport is thus a key factor shaping accessibility in cities both in physical and in socioeconomic terms. To access to services such as work, health centers, schools or markets, the share of motorized means is 40 % compared to 60 % for the non-motorized means, mainly by walking.

31.2.1 Promoting Public Transport for a Smart City

Public transport implies increase in people's mobility with fewer vehicles, less energy and smaller space consumption. It contributes to environmental sustainability with lower emissions of airborne pollutants and greenhouse gases. Public transport has several social, economic and environmental effects on city smartness. It is demonstrated that people with access to public transportation work more days annually than those without such access. Access to jobs, education, health services and other facilities through an affordable public transport is central to social inclusion for the urban poor [4] and particularly for the youth who have limited financial resources to cover most of their needs. With affordable public transport, youth can travel independently, and in some cases, delay their decision to drive private motorized vehicles. Community cohesion through interactions between people is also eased by public transportation. Public transport tends to increase physical activity as most trips include walking or cycling links. It demonstrated that people using public transport walk three times more than those that rely on private cars, a duration that meets the required criteria of the moderate daily physical activity for health reasons [4]. Public transport can get large numbers of people to their destinations efficiently. It is space efficient in terms of area per traveler, which can free significant amounts of land in prime locations that would otherwise be allocated for uses [4].

The main motorized means of public transport are: buses, Bus Rapid Transit (BRT), light rails and metro systems. Buses are adaptive to the spatial structure and require low investment in infrastructure. However, they are generally slower than the other means. The Bus Rapid Transit (BRT) runs on semi-exclusive lanes and has a higher passenger capacity than buses. After the pioneering experiences in Curitiba (Brazil) and Bogota (Colombia), BRT systems have been implemented in hundreds of cities around the world and adapted to local circumstances on all

continents [4]. Light rails and metro systems require higher infrastructure invest-ment but are very reliable and have a high capacity. Rail transport induces more intensive land development around nodes and is emissions free if running on electricity [4]. In Dakar, only buses are now operating in the public sector with little railway contribution. These buses are being operated by entrepreneurial individuals or small-/medium-sized companies. Indeed, in the share of public transportation, 95 % are from the informal sector with 70 % of minibuses and 25 % of taxi (shared or metered) [5]; only 5 % are from the formal sector.

31.2.1.1 Formal Public Transport

Despite various efforts taken by national and local authorities to boost the formal public transport, it remains with a very low share (5 %) in the total public transport, which is heavily dominated by informal means of mobility. There was a subsidized public transport with the public company SOTRAC with buses in early 1970. But it was discontinued during the structural adjustment period imposed to Senegal as in many African countries by the IMF and the World Bank in mid-1980s. However, in 2001 public transport was reinforced with the introduction of newly public transport company named "Dakar Dem Dikk" (3D), with the share of three quarters from public resources and the rest from private investors [6, 7]. The 3D is essentially composed of few medium-sized buses that must follow a specific itinerary, but they are barely seen in the streets submerged with the informal motorized means of transport. The efficiency of the public company 3D has faced, indeed, various difficulties to be sustainable in terms of supply as well as in terms of demand: lack of institutional coordination between the city council and the company 3D; struc-tural deficit associated with the gap between the affordable fares and the operating costs leading to operating deficit; and poor operational and commercial perfor-mances associated with public service obligations without the corresponding resources. Other constraints are low commercial returns in congested roads, low productivity of employees and attempt to serve the whole urban area without having enough buses (Fig. 31.1).

The public company 3D as its sister company SOTRAC was meant for the civil servants and students that enjoy reduced fares compared to other users, particularly the urban poor with the only choice of walking or using the informal public transport such as the "Car rapide." Other formal public transport means is the railway composed by the urban train created in 1998 "Petit Train de Banlieue" with a little share (less than 1 % in 2009) to the total public transport. Efforts to mod-ernize the urban train under the Urban Mobility Improvement Programme, "Programme d'Amélioration de la Mobilité Urbaine—PAMU," include transfer of track provision and maintenance to Transrail, a new autonomous body for opera-tion, track improvement and building fences along the track (compensated by new footbridges) [9]. Despite all these efforts, the share of the railway in the public transport remains little compared to the demand of passengers from Dakar to its suburbs.

Fig. 31.1 Dakar Dem Dikk (3D) buses. *Source* [8]

31.2.1.2 Informal Public Transport

Considering the lack of capacity by the formal public transport systems to meet the mobility demand of the residents of Dakar, dominance of the informal sector operators remains irreversible. The informal transport sector, composed of small-scale economic activities with unregulated employment, is largely dominated by buses operated by private entrepreneurs. It represents 95 % of the public transport. It supplies small vehicles with low investment and minimal public support, low-performance services that fill the niche between formal taxis and the 3D buses [10]. They are mainly composed of minibuses called "Car Rapide," "Ndiaga Ndiaye" and "Tata." Their operational status is legal, as the vehicles are licensed for the purpose of public transport with a specific capacity limit. Informal fleets can be a lifeline to making a living where poor municipal public transport resources have led to limited or no service to outlying residential areas and high fares. It represents the only accessible means available to the poor and provides an important service that is often well adapted to local conditions. It delivers affordable services in instances where scarce municipal resources have led to a deteriorating service and higher fares. Informal fleets reach outlying residences in sprawling areas.

However, the buses as means of public transport come with enormous externalities that authorities must not overlook in the transport planning process. In this sector, most vehicles do not fit to be in the road technically and with respect to traffic rules and regulations (technical control, license, insurance, etc.). This contributes significantly to congestion, air and noise pollution and traffic accidents. In addition, passengers, particularly women, are exposed to harassment from the bus operators and other passengers. Violence against women is common in the public transport sector [11]. In a city like Dakar where the formal public transport sector is quasi absent, the role of informal transport in generating broader social and economic benefits must be assessed together with the costs entailed. Prohibiting

Fig. 31.2 Traffic in Dakar: "Car rapide," taxis and private cars—the 3D buses are barely seen.
Source [12]

informal transport is not a viable solution as it destroys jobs and blocks access to employment, but externalities must be assessed and reduced significantly. A combination of valuing the service and regulating them can be effective in managing related issues, such as traffic congestion, accidents and pollution (Fig. 31.2).

31.2.2 Increased Use of Private Cars Hampers Efforts to Make Dakar a Smart City

In the absence of reliable public transport systems, households that can afford it, usually the upper middle class and the richest, possess private means of transportation or use taxis which offer comfort compared the public means of transport. The perceived advantages of convenience, privacy and status continue to make the private car an attractive means of transport in Dakar as in many African cities [4]. The growth of private motorized transport during the twentieth century had major impacts on the growth and development of the city of Dakar as many cities in developing countries. The rate of motor vehicle ownership in Dakar has significantly increased during these past 20 years, from 5 % in 1995 to 13 % 2014. The major factor behind the growth of car ownership in Dakar is at a cost that is becoming affordable for a growing number of people of the middle class that cannot tolerate the discomfort of the public transport with the "car rapide" and seek individual freedom. With the continuous urban growth, it is expected that Dakar will be an exclusive motorized city if the public transport is not reinforced and

mixed neighborhood promoted, considering the creation of six new urban centers as part the extension of Dakar [13].

While private cars offer the convenience of individual choice, this advantage is traded for much more land being used for road space and parking. Cars' land consumption and infrastructure costs can be a significant part of a city's budget, and this costs heavily subsidized by both drivers and passengers. Emissions of pollutants in Dakar seem to be higher than the thresholds defined by international standards. Estimates of safety costs from the World Bank show that in Dakar these costs represent 2.7 % of the national GDP [14]. A city submerged with cars is prone to more accidents, which generate economic and human costs. Without adequate public transport systems in place, and good planning choices that increase connectivity and proximity, congestion, pollution and energy consumption will also increase exponentially with the growth in car ownership. Unless authorities introduce rules and regulations such as road pricing, parking management and circulation policies to reduce car demand, ownership of private will continue to rise.[1]

Two major impacts associated with low coverage of public transport and increased use of private cars are traffic congestion and pollution. The monocentrism of the city of Dakar is a source of traffic congestion and an obstacle to smartness. The mobility in Dakar is heavily affected by the fact the city was conceived as a monocentric city where residential areas and workplaces are distinct, with the later concentrated in the center of the city. Residential areas were also designed along economic class lines. This has led to social and economic fragmentation that disadvantage lower income in accessing basic services and prevent social interaction and integration. This has impacted the traffic with every morning and evening people have to share a main street network to and from the downtown of Dakar, which is named the "Plateau." The urban structure of Dakar illustrates an unsustainable travel structure of the city and focuses on the historic center called Plateau that hosts the main commercial and administrative services. This leads to congestion and long trips from the periphery (Pikine, Guediaway and Rufisque) to the center. However, this monocentrism has started to erode with the emerging on new commercial and administrative centers outside the Plateau.

Traffic congestion is a major indication of the disjuncture between land use planning and transport systems. It not only exposes the limitation of a transport-oriented bias to mobility, but also reveals the inefficiency of land use systems in a given city. Limited road capacity, in the face of growing demand for motorized mobility, partly explains deteriorating traffic conditions. Congestion has widespread impacts on the urban quality of life, consumption of fossil fuels, air pollution and economic growth and prosperity. Congestion accounts for significant

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[1]Road pricing policies have been implemented in Singapore, London (England) and Stockholm (Sweden) where drivers pay to enter the city center or use special lanes. Parking management has the potential to modify demand on an area-wide basis yet, despite being relatively easy to implement, is often under used. Rationing policies, which restrict cars with license plate numbers ending in specific numbers during rush hour, have been implemented in Bogotá (Colombia), La Paz (Bolivia), Santiago de Chile (Chile), São Paulo (Brazil) and Quito (Ecuador).
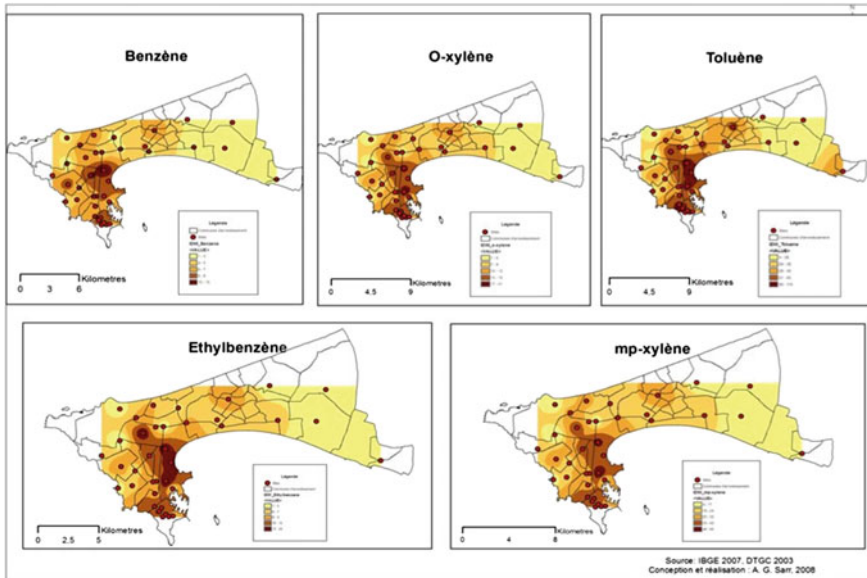
Fig. 31.3 Dispersion of pollutants in Dakar in June 2007 (Senegal). *Source* [15]

percentages of the gross domestic product in many major cities as noted in World Bank studies from the 1990s. About 90 % of the cost comes from the value of the time lost by drivers, 7 % from the fuel consumed and 3 % from gas emissions. In addition to economic costs, congestion causes significant numbers of early deaths from respiratory illnesses, stress and physical and mental fatigue. It also degrades green areas which, in turn, diminishes their carbon sequestration properties (Fig. 31.3).

31.2.3 Turning Informal Transport Sector Challenges to Opportunities in the Smart City Making

Public transport systems have a positive impact on the economic, environmental and social fabric of urban life and are the defining factors for the sustainability and inclusiveness aspects of a smart city. Dakar's smartness will be achieved or lost in the development of public transport. While playing a critical role in the public transport sector in Dakar, the informal motorized means of transport face a number of constraints, ranging from administration and managerial issues to financial obstacles. Efforts should be made to interlink them as well as much as possible with the formal systems. In Dakar, transport economic sustainability is hampered by several factors such as high energy costs, age of vehicles, low productivity of employees, deteriorated conditions of the street network and poor administration

and governance of traffic. In order to have friendly transport environment, it is urgent that Dakar finds a way to strengthen public transport through the public–private partnership. Some actions already taken must be reinforced. The formalization of minibuses' activities includes a renewal program of the fleet minibuses as well as their administration. This also includes assisting in creating better conditions for loans to transport operator such as creating "Economic Interest Groups," financial structures—the Urban Transport Financing Group, Mutual Guarantee Fund, Credit for transport operators of the region of Dakar "Mec-Trans," that can make car loan possible to operators.

Rather than discouraging informal operators, national and local governments can set incentives and regulations that capture the benefits they may bring while mitigating negative factors, such as road safety and pollution. However, poor coordination between the numerous institutions involved in urban transport leads to problems in developing unified and integrated urban transport policies to formalize informal means of transport. Many ministries are involved through actions which sometimes prove to be contradictory. Another observation deals with the insufficiency of the decentralization process in the field of urban transport which stays very controlled by the states and not enough by local authorities. Indeed, urban transport is not included in the sectors concerned by the decentralization process as in the "Act 3 of Decentralization" of December 2013 in Senegal. In 1997, the Executive Council of Urban Transport in Dakar (CETUD) was established to resolve the dispersion of jurisdiction between various central and local institutions concerned by urban transport in Dakar and to coordinate urban transport policy making. The CETUD fundamentally aims at: resolving the problem of dispersion of jurisdiction between the various central and local institutions concerned by urban transport in Dakar and organizing a better coordination for definition and decisions on urban transport policy, with the vital participation of the local authorities [16]. The CETUD has been assigned the following responsibilities: decide which routes to be served, the corresponding authorization quotas for public transport and their technical operating terms; prepare "call for tender" documents, sign agreements with the registered transporters and control implementation of contracts; propose tariff policies to the appropriate authorities; and identify the constraints of the public service and determine the relative financial compensation; develop criteria for admission to the profession of public transporters; implement studies and initiatives for training, information and promotion for urban public transport; coordinate the different types of public transport; and in particular, arbitrate the division of profits in the case of tariff integration; develop and support the creation of shares and investment programs to improve infrastructure, traffic and road safety services; improve the condition and quality of the transport fleet to reduce pollution [17].

Many minibus operators have entered into an organizational scheme proposed by the organizing authority (CETUD) with positive results. With the help of overseas development assistance, an organizing authority was created and resourced to upgrade the minibus fleet and grant tightly controlled concessions to private companies. At the administration level, this will include concession agreement through CETUD, personal contribution (of about 25 %), introduction of

paid tickets by users replacing payment of cash to controllers, remuneration of drivers and controllers on the basis of wages through contracts. Despite various difficulties, some progresses have been made. Training and information activities targeting drivers and controllers as implemented with minibus and taxi drivers by CETUD is another response [17].

31.2.4 Walking—Key for Dakar Smartness

In the absence of affordable, reliable public transport, various options exist depending on level of economic conditions or purchasing power. Those that can afford it will own a car or ride a taxi, while those that cannot afford it, who constitute the majority, will use their foot. Those using their foot have limited opportunities compared to others that have access to public transport. They would not accept job where they have to walk very long distance, or they accept they will encounter several days of absenteeism, and they end up by quitting their job. Despite lack of comparative data, it seems that the share of walking to access services remains the first option in Dakar due to two main factors, namely: low coverage of public transport infrastructure and unaffordability of public transport for the poor where various needs compete. While in cities of developed countries, it is assumed that a walkable street is more attractive to people for various reasons and even defines the "livability" of a city, in the city of Dakar walking is not a choice, but a necessity due to lack of other affordable transport alternatives.

Available information shows that 60 % of residents of the city of Dakar walk to their place of work, to health centers, to schools or to the market. However, the streets of Dakar are not designed for pedestrian use. First, the land allocated to the streets is low, only 15 % in the city core and less than 5 % in many sub-urban settlements. The streets are also narrow, not paved, lack sidewalks; this results in competition for space with motorists, often exposing pedestrians to accidents. In total, 95 % of the city streets also have high pedestrian flows but only 20 % have pedestrian footpaths [4]. In addition, streets in the suburbs are poorly connected with less than 40 intersections per square kilometer. Lack of sufficient intersections makes the street network of Dakar not friendly to pedestrians. It is demonstrated that for a street network to be well connected and walkable, at least 100 intersections per square kilometer are required [18].

In areas such as Yeumbeul Nord, Camberene and Colobane which are densely populated with densities of more than 50,000 inhabitants per square kilometer, there is no space left for mobility except very tiny streets where people have to squeeze through. In many settlements, public transport services are accessible in few arterial streets where people have to walk several kilometers to reach them. During the raining season, the already limited walking spaces are flooded, forcing people to stay at home, losing many productive hours. This in turn has serious social and economic impacts on the city's economy.

Despite challenges, walking has enormous economic, social and environmental advantages. Dakar of the twenty-first century must be planned as walkable with affordable means of public transport. Walking is an enabler of social cohesion and environmental sustainability with enormous social, economic and environmental benefits. It is now recognized and advocated that walk is the most efficient means of mobility for environmental sustainability as expressed in global agendas such as Rio+20 (2014), SDGs (September 2015) and COP21 (December 2015). In addition to its social and economic benefits, walking has a major advantage in reducing energy consumption, greenhouse gas emissions and pollution (air, water and noise) substantially, as it does not rely on fossil fuels unlike other modes of transport in cities. Furthermore, as walking requires significantly less road space and parking, it enables the preservation of natural habitats and open spaces. Walking also provides the daily physical activity required for a healthy lifestyle. Based on this, many motorized cities of developed countries have been changing their street planning and designing, and promoting public transport in order to reduce private motorized use and boost walking and cycling. With the 60 % of people that are already walking in city, Dakar is indeed in a good position for a healthy society in a sustainable environment. However, in order to sustain this advantage, it is high time to give to pedestrians their right share in the transport infrastructure. Providing adequate infrastructures to pedestrians is cost-effective considering the enormous benefits from walking.

31.2.5   Integrating Public Transport, Walking and Cycling in the Extension of the City of Dakar

Though Dakar is a compact city, it does not benefit from the multiple advantages of compactness due to its unplanned urban growth and land expansion. While the advantage of a compact settlement is to ease accessibility, reduce cost of provision of basic infrastructures and other urban services, reduce erosion of natural resources, lower business costs and improve social equality, in Dakar none of these benefits are present or they are little. Considering the very high population density in many unplanned settlements of Dakar where the urban growth is still high (more than 2 % annual growth), there is urgent to develop and implement city extension at the fringes of the built-up area. The extension of the city of Dakar will specifically host inhabitants of densely populated areas and settlements built in flood-prone areas. Every year, flooding causes enormous economic, social and environmental damages and losses among people and communities. As presented in Chap. 30—Basic infrastructure, disasters and resilience for smart city foundation—for these past ten years, flooding had been a disaster for damages and losses estimated at billion of CFA Francs. As recently observed in 2015, flooding remains the risk disaster for the city of Dakar, particularly in densely populated settlements built in wetlands. With the climate change associated with rise of sea level, there is urgent

to operate a city extension that was supposed to be in the twentieth century when the density is still manageable. Planning an extension requires vision and commitment [19]. National and local authorities have already identified areas where the extension of the city of Dakar will be implemented. Six distinct urban areas have been identified, and work has already started.

Mixed-land use approach to integrate pedestrians' needs in the smart city making. When preparing a city extension, it is important to integrate the mixed-land use approach that has proven efficient with high economic, social and environmental returns. It is important to recognize that all settlements are born where people live together and services are in walking distance. This is still the norm in villages and towns. Even though, at the beginning of the city development, services and residences are kept together as all start-up of settlements, the question is to make a plan where the population growth will be coordinated with services geographically balanced, avoiding the start-up become the city center of the future city. Therefore, there is nothing new of having people and services together, and the challenges are how to keep them growing in a coordinated manner where the mixed neighborhood approach is preserved. It is noted that along urbanization, the city center and the periphery become distant, and if urban expansion is not well coordinated, we will end up with the formation of residential areas without services distinct from the city center without residences. "Mixed-land use approach has various social benefits by improving accessibility to services and urban amenities for a broader segment of the population, and increasing housing options for diverse household types. It enhances the perceived safety of an area by increasing the number of people on the street. Economic benefits, increasing the business potential of transactions and trade as co-location of activities attracts more potential customers during more hours of the day. This is reflected in increased income from business taxes. Commercial uses in close proximity to residential areas are often reflected in higher property values, helping raise local tax revenue" [20].

In the process of the extension of the city of Dakar, it is important to consider the enforcement of urban planning and particularly for transport infrastructures (land in reserve and to keep inbuilt for future transport infrastructure) [20]. By combining spatial planning and transport policies, local governments would reduce people's need to travel; improve travel conditions with affordable and efficient public transport options; and manage supply and demand traffic to curb congestion, which is a major barrier to productivity and a headache for residents. It is recommended to link land use and transport planning in the extension of the city of Dakar. A city's spatial pattern is enabled by transport, and the development of transport networks shapes cities over the long term. Investment in transport will have higher impact if it is linked to spatial planning from the start. For example, intermodal stations are focal points for property development and economic activity; they increase demand for public transport and reduce land consumption. A critical mass of users (e.g., above 50 p/ha) is vital to achieve economies of scale for public transport services. Mixed-use land policies can reduce the distance between residential and employment areas which lessens dependency on cars and travel demand altogether.

Density and mixed-use around public transport stops will increase use and, hence, system viability[2] [21]. Linking job location and transport needs increases land efficiency. A compact pattern adjacent to a public transport node has many benefits. Nodes bring together public space and health, shopping and community facilities[3] [20]. Higher densities along corridors increase the feasibility of a public transport system. Rail in particular has a density-inducing effect around stations that can be leveraged to connect dispersed people. If public transport is accessible, there is an adequate land use mix and density. Car-free zones can also operate on a temporary basis, providing a good setting for markets. Initiatives to limit car access are often received negatively by commerce and other businesses; however, they have been proved to increase commercial revenue and property values.

Box 38.1: Transport Planning: Connecting to Six New Urban Centers and to the Rest of the Country

Faced with the failure of a public company to satisfy the mobility demand, national and local authorities are exploring the introduction of various transport options, including BRT, along with the extension of the city of Dakar as expressed in the "Plan Senegal Emergent" (PSE) and the National Territorial Planning (PNAT). For instance, the toll highway Dakar to Diamniadio (and then to Thies), a public–private partnership project, is now functional and managed by APIX (*Agence nationale pour la Promotion des Investissements et les Grands Travaux*) [22]. Another example is the Dakar—Thies toll highway is under construction after studies and cautious procedures for managing the houses expropriations and preserving the accessibility of the crossed areas. The objectives of the highway between Dakar and Thies are, among others, greater traffic flow, a simplified connection between Dakar and within the country and the improvement of urban mobility in the Dakar conurbation. The infrastructure will provide a connection between the new Blaise Diagne International Airport (AIBD) and the center of Dakar, as well as the future city business under the site of the present airport. It will also

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[2]For example, in China, central Hong Kong's high density results in 85 % of all trips being made on public transport but in areas with density below 35 p/ha, trips on public transport are only 10 % of the total. Different densities support different service levels of public transport: A basic bus service needs a density of around 35–40 p/ha; an intermediate bus service is viable with a density of 50 p/ha; light rail transit would be viable in areas with a density of 90–120 p/ha. The distance from origin is a key determinant of travel demand with one study in the UK estimating that with a density of 150 p/ha, more than 80 % of people could walk or cycle to services.

[3]Most dwellings would be located within 800 m of the transport node; streets are designed for walking and cycling, with traffic calming features, bike lanes and carefully designed pavements. Parking is minimized. Transit-oriented developments (TODs) have an average density of about 60 p/ha and above, and combine office, retail and housing uses. The   use mix varies with location. TODs increase public transport use, improve access to jobs   and reduce commuter times per household worker. A TOD can reduce car use per capita by half and save households around 20 % of their income since they would cut car-related expenditures.

foster a reorientation habitat eastward and reduce the real-estate pressure and saturation from the center of Dakar [22].
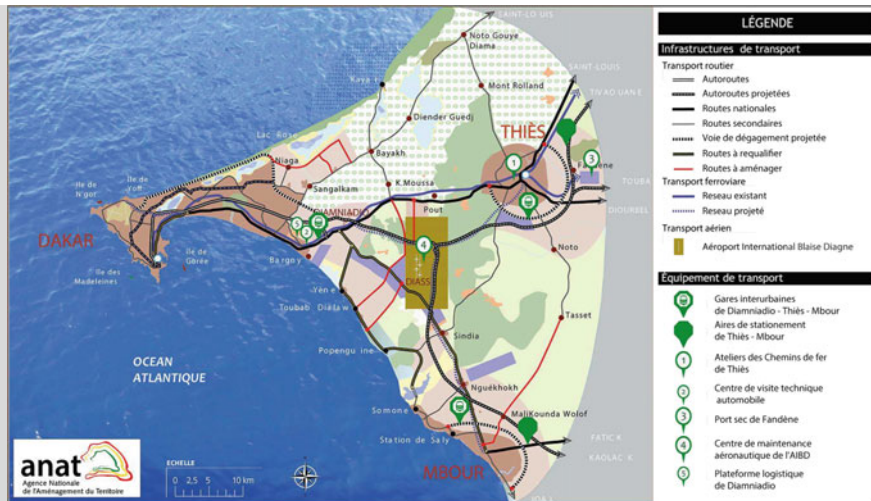
Structuring transport infrastructure and equipment (road, rail, air and water). *Source* [23]

31.2.6 Promoting Smart Streets to Transform the City of Dakar to a Smart City

A smart street must promote infrastructure development, enhance environmental sustainability, support high socioeconomic development and promote social development, equity and social inclusion. They are, indeed, the fabric of social and urban life. Safety, security, social interactions are among the key components of smart streets [24]. The notion of inclusiveness encompassed in "complete streets" where the needs of all users must be considered and factored (ages, gender, economic status, modal means, etc.) [25]. In a smart street network, mobility is multidimensional, easy, comfortable and safe [26].

Smart streets contribute to provision of basic infrastructure and to infrastructure development. Connectivity includes prioritizing streets as the basic element of mobility and accessibility accompanied by the progressive provision of services (connections to water, to sewerage facilities, energy, drainage, etc.). As connectivity increases, travel distances decrease and route options and travel modes increase (e.g., more use of non-motorized and public transport), allowing more direct travel between destinations, thereby creating a more accessible and resilient system. A smart street network expands multimodal transport systems with sidewalks and bicycle paths, ensures eco-efficiency of infrastructural systems and
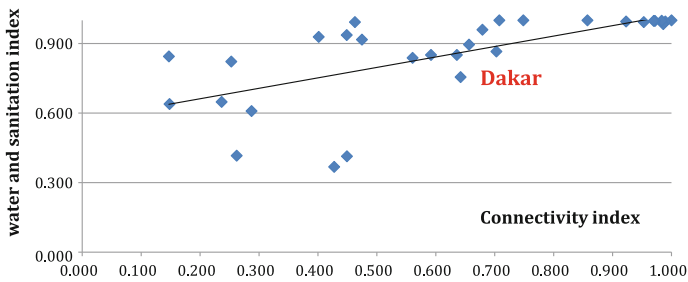
Fig. 31.4 Relationship between street connectivity and water and sanitation facilities. *Source* [27]

supports density through integrated infrastructure development, thereby enhancing efficiency and access. Streets that provide space only to motorists are characterized by congestion and high CO_2 emissions. This means that in order to move toward a successful implementation of the COP 21 agenda, the city of Dakar needs to change the design of its street network with the constraint of the limited share of street area.

When plotting the Street Connectivity Index against basic infrastructure with the information of Dakar included, we found a significant relationship between the two (Fig. 31.4).

Besides easing mobility, streets provide pathways for pipes, power lines and drainage systems, among other amenities. Evidence from most cities across the world shows that areas of the city endowed with adequate streets are also areas with laid down pipes for water supply, drainage and sewerage networks. In various areas of the city of Dakar where the amount of space allocated to streets is insufficient (less than 5 %), provision of basic services is significantly hindered, as there is no network in place that allows for the provision of water, sewerage, storm drainage and electricity, among other services.. At the opposite, settlements planned pre-independence and by semi-public housing suppliers (HLM and SICAP), enjoy water facilities, sewerage, storm drainage, sanitation/waste collection and power supply partially because of advanced and accessible road infrastructure. Most of the slum areas with more than 50,000 inhabitants are not only extremely overcrowded but, due to lack of streets, they suffer from crumbling and/or over-stretched basic services characterized by regular water shortages, leakages, burst water pipes, leaking sewers, power outages and uncollected refuse. Indeed, the absence of streets hinders accessibility and infrastructure provision in slum areas of Dakar.

Smart streets safeguard environmental sustainability. Environmental sustainability is another dimension of city smartness. Smart streets contribute to safeguarding environmental sustainability. The natural assets of cities should be preserved for the sake of future generations and create sustainable environment. Research shows that street design patterns greatly influence level of pm10 air pollution. In Africa studies measuring air pollution emissions on the street indicate that poor roads, fuel quality, vehicle maintenance and roadway dust are the most

Fig. 31.5 Relationship between street connectivity and environment sustainability (ES). *Source* [28]

common sources of pm10 and pm2.5 emissions. Dakar is among the African cities with high pm10 emission emitters (145 μg/m³), lower than the level Gaborone in Botswana (216 ug/m³), but higher than many cities such as Lagos in Nigeria (122 μg/m³).

When plotting the Street Connectivity Index against basic environmental variable (PM10) with the information of Dakar included, we found a significant relationship between the two (Fig. 31.5).

The impact of pollutants on the ecological state of the city makes it imperative that streets as a "zone of maximum exposure" take center stage when the study of environmental sustainability toward the achievement of a smart city is assessed. Pollution emissions released on the street contribute to the most harmful effects on climate change, ozone depletion, ecological damage, street aesthetics and human health. Re-designing streets of Dakar to promote a lower rate of pollutants will include: (1) adequate percentage of land allocated to streets that has provision for alternative means of transport; (2) efficiently designed streets that support traffic movement to reduce congestion; (3) street design that allows for shorter trip configurations with multiple choices; (4) mixed-land use patterns that allow for shorter travel distances.

Smart streets promote economic development. It has been well documented that location matters for economic activities. One determining factor of location is street connectivity. Streets facilitate economic activities such as street vending, retail and wholesale shops, filling stations, as well as a range of services. A well-connected location attracts more businesses and customers. On the other extreme, locations that are difficult to access attract less business and have lower volume of sales than in well-connected areas. In addition, in well-connected locations, there are higher volumes of business transactions as the co-locating businesses attract more potential customers and the businesses themselves provide demand for each other's services

during more hours of the day. Well-connected streets also increase the value of land around them by attracting amenities, such as shopping malls, schools and hospitals. Houses located in these areas have higher values with higher property taxes and better city services. All this contributes to more economic activities.

When plotting the Street Connectivity Index against the city product variable with the information of Dakar included, we found a significant relationship between the two (Fig. 31.6).

Well-connected streets are to enhance smart economy with the following economic advantages: (a) harnessing the benefits of agglomeration economies; (b) improving access to productive advantages (knowledge, quality of the environment, etc.); (c) providing sufficient public spaces for circulation of goods and people; (d) encouraging polycentric urban development; (e) allowing synergies between centers and sub-centers; and (f) intensifying urban nodes and corridors to maximize the benefits of concentration. Good street connectivity can increase economic productivity and competitiveness through increased transport system efficiency that reduces traffic congestion and commuting costs. Efficient and fast transport, in turn, can increase labor productivity by reducing commuting times and increasing worker productivity. When re-designing the streets of Dakar such as the VDN, these six comparative advantages of smart streets must be emphasized. Today, most streets of Senegal are falling very shorts against these six comparative advantages of smart cities.

In Dakar, where there are few spaces remaining for commercial activities, and where city authorities are closing few the remaining markets such as Sandaga and HLM5 without adequate alternative locations to businesses, it is advisable to re-design streets in a way that they accommodate businesses without hampering to people's mobility. This calls to put people first in the design of streets in terms of mobility as well as in terms of social and commercial interaction.

Smart streets enhance social development and social inclusion. Social development is increasingly associated with an inclusive, well-planned, healthy and supportive environment. Smart streets as public spaces help to enhance health and social well-being. Smart streets also promote social inclusion by ensuring high-quality public spaces that promote interaction among communities; by improving safety and security; and by promoting green spaces. Streets that promote walkability and cycling as elements of an active lifestyle contribute to healthy living, as well as reduction in vehicle emissions. Increased outdoor activity and reduced air pollution translate into better public health. No city can claim to be smart when large segments of the population do not have access to streets. Due to the lack public spaces, the citizens of Dakar are also taking to the street for their various religious and social functions. It is urgent that the city authorities recognize the multiple functions of streets as public spaces. The first rule is to "think of streets as public spaces" [30] and then to plan and design them to serve communities for their social interactions as well as mobility. To be smart, streets must be livable, friendly and healthy. The notion of streets as public spaces, indeed, embraces the notion of livability and completeness as well, which constitute to street smartness.

Fig. 31.6 Street connectivity and city product. *Source* [29]

31.3 Information and Communication Technology— Transforming Dakar to a Smart, Digital City

The Sustainable Development Goals (SDGs) recognize that information and communication technology is crucial to achieve sustainable development. According to Goal 9 "B*uild resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation,*" member states have committed themselves to " *significantly increase access to information and communications technology (ICT) and strive to provide universal and affordable access to the Internet in Least Developed Countries by 2020.*" [1] Most public institutions are now supported by the ICT systems. The ICT revolution since the 1990s has triggered and sustained the rapid diffusion of e-government systems to automate core administrative tasks, improve the delivery of public services and promote transparency and accountability. By 2014, all 193 member states of the United Nations had national Web sites: 101 enabled citizens to create personal online accounts, 73 to file income taxes online and 60 to register a business. In all, 190 countries had automated government financial management, 179 had automated customs, and 159 had automated tax systems. In total, 148 countries had digital identification schemes, although only 20 had multipurpose digital identification for such services as voting, finance, health care, transportation and social security.

Adoption of broadband internet is quasi universal in firms of developed countries, and there is increased use in developing countries though its coverage remains low. Enormous efficiency gains emerge in the ICT sector as well as in other sectors particularly in the e-commerce sector. The share of digital economy is increasing in many countries and considerably affects the transport sector. In the OECD countries, digital economy accounts for about 6 % of GDP [31]. The ICT sector in developing countries is fairly small, accounting for only 3–4 % of GDP and 1 % of the total labor force. But when ICT firms enter traditional sectors such as retail, banking, manufacturing and transport, they spur competition, raise productivity and expand opportunities [31].

Over the past 15 years, the Senegalese government has taken various steps to create an environment favorable for the development and ICT at all levels. It creates legal institutional framework to support regulatory mechanisms on the development

and use of ICT. It also introduces ICT platforms such as E-Governance, E-Education, E-infrastructure and supports education and training on ICT.

31.3.1 *State of Access and Use of Basic ICT Infrastructures in Dakar*

ICT infrastructures have various components ranging from hardware categories such as mobile phone, computers and tablets to soft categories such as internet connection, cloud storage and multiple applications. In this chapter, we present the basic components of ICT hardware which are mobile phones and computers, as well as internet connectivity that allows global and local inter-linkage. Whereas the other aspects are equally important, data on them are seldom available and comparable in the context of Dakar and will thus not be discussed.

Data on mobile phone, computer and internet had been collected in series of DHS conducted in Senegal over the past 20 years. The advantage of using the DHS surveys is that they allow for association of ICT components with economic as well as social variables such as education and literacy using the same of source of information. The DHS data show that almost every household in Dakar has access to a mobile phone, easing potential access to internet and multiple apps. With a level of 58 % in 2005, the coverage of mobile phone is quasi universal in Dakar with a level of 99 % in 2015. This spectacular boom of mobile phone makes some authors to feature Senegal as the next Silicon Valley [32]. Recently, it was demonstrated that revenues of the telecommunication companies are much higher than total costs of consumption of water and other basic goods, pointing that households in Dakar take communication via mobile top in their agenda compared to other household needs. Considering the fact that the mean household size in Dakar is 6, and considering the fact that each person has at least a mobile phone, we can forecast that there are at least 18 million mobile phones in the city of Dakar. This makes mobile phone business and mobile telecommunication very attractive in the city. In addition to making phone calls, the mobile phone is used to access various internet-based commercial opportunities (e.g., jobs and business opportunities through online trading) as well as social communication platforms (e.g., Facebook, Viber and WhatsApp) (Fig. 31.7).

Along the boom of mobile phones, there is increase in other ICT infrastructure such as computer and accessibility to internet, but in a lesser extent. With only 5 % of level of possession in 2005, in 2015 more than one-third of people live in a household with at least a computer (37 %). With similar trends, the coverage of computer is estimated at 57, 75 and 92 % in 2020, 2025 and 2030, respectively. The possession of a computer is not yet generalized in Dakar and feature in richest families and in household where some members are with high education. The association between computer possession and level of education shows that people
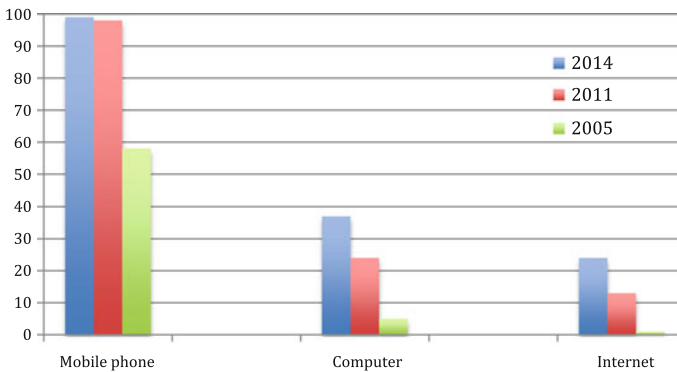
Fig. 31.7 Percentage of households with at least a mobile, a computer, a connection to internet, Dakar 2005–2014. *Source* [33]

with high education are more likely to live in a household with computer. In these households, computers may be needed for school as well as for work activities.

Along the boom of the mobile phone coverage which is already universal and the computer coverage which will be generalized in 15 years or before depending on policies, access to internet at the household level has also increased from less than 1 % in 2005 to 13 % in 2011 and 24 % in 2014. The coverage of an internet connection has drastically increased since 2005 where the percentage of people living in a household with an internet connection was less than 5 %. Six years later, the same percentage was multiplied by six with 24 % of people living in a household with internet in 2011. The trend is irreversible with an absolute increase of 13 points in 3 years; in 2014, more than one-third (37 %) of people lived in a household with an internet connection. With similar trends, this percentage of household with internet connection will reach 62 % in 2030 and 75 % in 2035. However, with the desire to make Dakar a digital city, this trend can be boosted and the availability of an internet connection at the household level can be generalized way before the year 2030, and this will be in line with the increase in education and literacy observed in Dakar during these past 20 years. Today 85 % of young women and 95 % of young men 15–19 years have at least a primary education level. Investing in infrastructure goes hand and hand with investing in education. Today there are 63 % of young women 15–19 years and 71 % of young men 15–19 years old who have an education level but live in an household where the internet connection is not available. This represents a real missed opportunity from education. The situation is more dramatic if we consider that only 38 % of young women 15–19 years old and 47 % of men 15 years with secondary education or higher live in a household without accessibility to internet. This represents a double miss of opportunity for ICT use as well as for ICT development. It is much easier to make the internet accessible to train educated people to use it and develop apps than
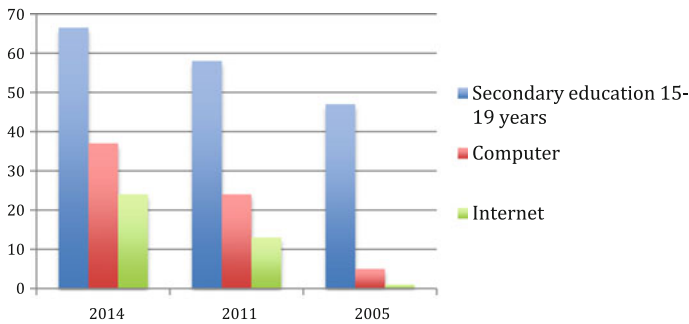
Fig. 31.8 Percentage of population 15–19 years old with at least secondary education, percentage of people living in a household with a computer, with an internet connection. *Source* [33]

otherwise [34]. There is also a missed opportunity with households that have computer but do not have access to internet (13 % of households). Finally, the only option of these households is to use internet via mobile phone as other households without a computer. With the boom of social media platform such as Facebook, WhatsApp and Viber, the use of an internet via mobile is almost universal in Dakar (Fig. 31.8).

31.3.2 National and Local Policies and Programs in Use and Development of ICT

Legal and Institutional Framework: Since 2001, national authorities have elaborated the legislative and regulatory component of new technologies to create a legal environment favorable to their development [35]. The first step was the establishment by law No. 2001-15 of December 27, 2001, as amended, of the Code of Telecommunications and the Regulatory Agency for Telecommunications and Posts "Autorité de Régulation des Télécommunications et des Postes (ARTP)" responsible for providing the telecommunications sector with an effective and transparent regulatory framework, promoting fair competition to the benefit of users of telecommunication networks and services [36]. Another key step in the process of ICT development in Senegal was the creation of the State Information Technology Agency "Agence de l'informatique de l'Etat (ADIE)" which has the mandate to stimulate public action in the treatment and dissemination of information in accordance with international legal and technical standards for quality, availability, safety and performance (decree N° 2004-1038 of July 23, 2004) [37]. ADIE launched a process that led to the adoption of appropriate laws and regulations in 2005, followed by several laws on: orientation law on information society

(law No. 2008-10 of January 25, 2008); electronic transactions (law No. 2008-08 of January 25, 2008); cybercrime (law No. 2008-11 of January 25, 2008); the protection of personal data (law No. 2008-12 of January 25, 2008); establishment of a voluntary contribution of one percent (1 %) on public procurement of goods and digital services (law No. 2008-49 of September 23, 2008); establishment of a royalty on access or use of public telecommunications network—RUTEL (law No. 2008-46 of September 3, 2008); and cryptology with the creation of a National Commission of Cryptology, attached to the General Secretariat of the Presidency of the Republic, and whose permanent secretariat is provided by the Central Technical Services of Numbers and Security of Information Systems—STCC (law No. 2008-41 of August 20, 2008). The Privacy Protection Commission (CDP) is an Independent Administrative Authority (IAA) established under law No. 2008-12 of January 25, 2008, on the protection of personal data. The year 2011 marked the adoption of a telecommunication code implementing most of the directives adopted by the Economic and Monetary Union of West Africa (UEMOA) and additional acts that the Treaty of the Economic Community of African States (ECOWAS) to create a legal environment conducive to the emergence of a regional market [35].

The establishment of a legal and institutional framework for the administration, implementation and use of ICT infrastructure shows clearly the commitment of the national authorities in the use and the development of ICT in various development sectors. If well coordinated and articulated the laws and institutions that govern the use and development ICT should yield to efficient digital, smart economy. Indeed, the establishments of various laws and institutions governing the use and the development of ICT have been followed by en effective integration of the ICT in several publics as well as private sectors with the adoption of: E-Governance, E-commerce, E-Education, E-infrastructure, etc.

E-Governance: ICT initiatives are currently ongoing at national level in the areas of e-government (eSenegal, Universal Service Fund) with the development of communications infrastructure linking all government departments. The platform eSenegal has the following priorities: setting up a government information system integrating the various information sources of the administration and definition of organizational entities responsible for managing the IT policy. The expected results are: interconnect by WIMAX 665 administrative buildings located in 35 departments; local network (LAN) in all 665 buildings using WiFi or Ethernet; video-conference platform between 11 regions; interconnection of universities and research centers; and data center building. The Universal Service Fund considers Internet and telephony as integral part of a universal service with the following major objectives: bridge the access gap in networks and telecommunication services (telephone and Internet) throughout the national territory; promote the economic and social development of rural populations and those in disadvantaged areas through the provision of appropriate ICT applications; expand access to the Internet via broadband infrastructure to shared resources in social projects and community as the interconnection of academic, health institutions and schools, facilities, etc., promote the creation of knowledge communities in the territory, relying in particular on the government infrastructure and public or private initiatives [38].

Senegal also introduced the platform "eVision" that aims to put the citizen and business concerns within the government, to allow all citizens to access information, to meet the performance needs of the state and actionable information officers. The Government of Senegal launched the strategy document to finalize "Senegal Digital." On December 28, 2015, the State of Senegal and the African Development Bank (AfDB) signed a financing agreement of a budget of 40 billion CFA Francs for the construction of Park digital technologies. Built on a pole of 25 ha, it aims to be a regional investment hub in this sector and develop the IT segment of the ICT sector to make Senegal a reference digital country in Africa [39]. Other innovations are on infrastructures and education with: E-infrastructures (Grid Computing project, Brain Gain Initiative, Education and Research Network, Migration from Analogue to Digital Broadcasting project); and E-Education (Virtual University of Senegal enrolled more than 2000 students in 2013–2014).

The Multimedia Community Centres (MCC) Programme implemented by the ICT Ministry with the cooperation of UNESCO aimed to develop a network of 20 MCCs in Senegal over two years, and the main objectives are to: reduce the digital divide; facilitate access and appropriation of ICTs by communities; reduce poverty by enabling people to solve development problems they face; and strengthen the capacity of communities. As at December 2013, 30 community centers are now installed through the country.

Migration from Analogue to Digital Broadcasting Project: A national committee for the migration from analogue to digital broadcasting was established in August 2010. It is under the authority of the Minister of Communications and Telecommunications. The committee's mission is to guide, coordinate and control the actions needed to ensure the passage of the audiovisual sector to digital. It is composed of state representatives, regulatory authorities in the audiovisual and telecommunications companies in the audiovisual sector public and private operators of telecommunications services and ICT, professional organizations, etc. The national committee consists of a coordinating committee and specialized committees that are responsible for providing solutions to legal, technical, commercial and related content and audiovisual programs.

The Research and Trial Center "**Centre de Recherche et d'Essai (CRE)**": Under the Ministry in charge of Scientific Research and Higher Education, units of development of research based on the promotion and the provision of means of applications of scientific and technological innovations for well-being, provide an interface between citizens and the Research and Development sector and use ICT as a main activity. As at October 2014, 17 research centers are already installed and ten more were due to be installed during 2015.

Senegal Virtual University: The Ministry of Higher Education and Research established the Senegal Virtual University to facilitate efficient and accessible Higher Education through a digital open space in each department in the country. Teaching commenced in February 2014, and over 2000 students enrolled for the academic year.

Scan-ICT is an activity carried out by the Research Centre for International Development Research Centre (IDRC) in collaboration with the United Nations

Economic Commission for Africa (ECA). This is an ambitious proposal with long-term aims to mobilize the support needed to create a phased comprehensive African capability to collect and manage key information needed to support investment increasingly important technologies information and communication technologies (ICT) to help African countries become an Information Societies.

Dakar Digital City "Dakar Ville Numerique": Along with the government programs and policies on ICT, the city authorities of Dakar have also introduced initiatives aiming to make Dakar a digital city. The city of Dakar has launched the project "SSID: City Wifi Dakar" [40]. A pilot project to install WiFi in large public places was initiated by the city of Dakar in partenariat with the mobile operator Tigo, a subsidiary of Millicom International Cellular Group, to make so free internet connection to the public. The initiative will be also extended to the public transport buses with the network 3G+. This will contribute to the expansion of internet in a country where the cost of connection to internet is still high and the speed of the network slow. City authorities will need to develop and accurate transit maps and data and train transit agencies in the use of such maps and data. Methodologies and open-source software applications are available allowing the production of transit maps at low cost and in a short period. This will allow city authorities of Dakar to make ambitious planning and investment decisions based on accurate, comprehensive transit data [41]. Development and use of transit maps and data are becoming common in cities of developing countries as in Manila (Philippines). Mobile survey applications with the introduction of the smartphone allow to automatically collect route data in an open-data platform with and open-source software system, transit staff members simply to ride the routes and allow the GPS capability of the phone to generate route coordinates that were simultaneously transmitted to the database [42].

The city of Dakar is also a member of the UNESCO Creative Cities Network in the category of Digital Arts [43]. "Dakara Creative City by UNESCO" is a recognition of the action taken by the municipality to develop, with all the actors, new dynamics of cultural and artistic convergence through innovative projects. The Creative Cities Network aims to develop international cooperation among cities and encourage them to develop agreement on developing partnerships with UNESCO's priorities.

Along with the government programs and policies on ICT, there are several other initiatives by private sectors, NGOs, civil society, academic that invest on the expansion of ICT. An ICT Incubator, launched in 2011, assists ICT companies, information technology and communication, as well as project leaders, in their stages of creation, development and growth. It offers businesses and to project the ICT infrastructure and services necessary to ensure sustained growth and sustainable. CTIC Dakar is an example of public–private partnership led by the ICT Incubators Foundation of Senegal (FICTIS). Partners and sponsors include both public and private international organizations. An other example is the Women and Ecommerce project with the objective to promote greater integration of women in the development of their countries in a more competitive and with greater facility: find real information and useful for their activities; communicate with each other

and develop barter and trade in goods and services, become known internationally and to be in contact with potential partners; establish a circuit solidarity trade; to sell their products in most competitive markets; to share best practices and their constraints; reduce intermediate; and to have more information to facilitate innovation and technological advance.

31.3.3 ICT for All—Dakar Toward a Smart, Digital City

To be an effective smart city, the city of Dakar needs to engage all stakeholders in all sectors. People need to understand what smart cities are their role in the urban life, and how they can participate and shape them. An inclusive ICT training program must support different types of learners to acquire the awareness and skills relevant to the use and development of ICT in the city of Dakar as a digital city [44]. Open online platforms offer learners an introduction to smart cities, providing an insight into the role that ICT can play in addressing city challenges and how citizens can get involved in their creation. There is a couple of available training programs in open platforms that can be used to reach more people, particularly in a city such as Dakar where the literacy rate is relatively high.

Providing training in ICT to people in many non-ICT sectors is more needed than ever. Many firms report difficulties in finding workers with the required ICT skills to fulfill some tasks due to the digitization on most non-ICT jobs. This means that the city of Dakar must pay more attention to providing advanced ICT skills training in her education system as well as in other leaning platform. This will ensure ICT literacy and numeracy of its citizens that can allow them to use ICT apps in their job. The revolution of ICT is irreversible, and for young people to find good jobs, they will need skills in ICTs. The digital financial market makes large financial services available to people, but only ICT educated people can use them, with the level of use depending on the level of education. It is indeed important to put in place an adequate user education in the promotion of financial literacy. However, in any system, mechanisms must be put in place for fraud prevention, dispute resolution and data privacy. The project "social impact of ICT" focused on development of mobile payments, Internet use in the campaign and interconnection of all government infrastructures (fixed telephone, mobile, Internet).

All businesses, from administrative to commercial activities, will involve tasks that require users with basic knowledge of ICT. City can leverage the capability of the ICT technology in analyzing and integrating large data sets for a smart decision on policies and actions relevant to people's well-being. This will require a right understanding and choice of investments on intelligent infrastructure and connectivity to deliver long-term value. Integration of smart technologies into existing urban fabric will drive greater efficiencies in city operations; provide a platform for innovation at a citywide scale; and promote social inclusion through heightened accountability and citizen empowerment. This will also enable governments to view their citizens and firms not just as passive customers of public services, but as key

partners in innovative problem solving. Real-time data bring emerging problems at the planning before they become acute. Open data, social media and cellphones enable governments, firms and citizens to exchange vast amounts of information at virtually no cost—making it far easier to share knowledge and ideas that are distributed throughout society. Various smart analysis and simulations and forecasts are required, such as: automated optimization that translates data from cameras, sensors and anonymized cellphone records into intelligence to, for example, help optimize traffic flows in real time; predictive analytics that uses such data to track and predict everything from rainfall to crime hot spots to possible landslide areas; and evidence-based decision making and planning that can continuously monitor milestones and targets to ensure cities can quickly take corrective actions as needed to achieve their goals.

The government of Senegal launched its own intranet resource center in 2009, which allows it to develop and use an e-government system. All this requires that people be able to familiarize themselves with the ICT infrastructure. The National Program for Good Governance (Programme National de Bonne Gouvernance) identified ICT as a valuable instrument for improving productivity in public service, enhancing performance and promoting modern communication. The State Information Agency "Agence de l'Informatique de l'Etat- ADIE" was launched to implement ICT policies and programs for the government of Senegal. ADIE set up a governmental intranet providing a one-Gbps network linking the different departments through optical fibers. The intranet can also be utilized to train civil servants. For example, they can follow training programs in project management on the intranet [45]. Outside service is connected to this intranet through wireless connection. The telephone lines between departments are free. At the community level, the government is working in partnership with various partners to build community multimedia centers (CMCs) which will provide radio broadcast and ICT services.

The Dakar Digital City initiative, launched by the government in partnership with one of the mobile operators, Tigo, established a free WiFi zone at the capital's independence square, with plans to establish more of them in big public arenas all over the city. This is an encouraging first step toward a digitized city, but building a digital city requires a holistic approach that embraces the urban life itself in all sectors. The city must first promote open data at the local level where municipalities (communes) share local data with the public, promoting transparency, accountability and collaborative problem solving. Data revolution is along with the ICT revolution and use unique opportunities to city leaders to revolution their decision in turning their cities into laboratories, sort of "science of cities," for smart innovations that translate local experiments into global knowledge and global knowledge into local solutions. Pilot municipalities as "living labs" can be used to test new ideas. Local Observatories linking Research to Actions (LORA) can also be used as the platform link policy makers, local universities and research centers, the private sector and other stakeholders to provide to collect and analysis municipal
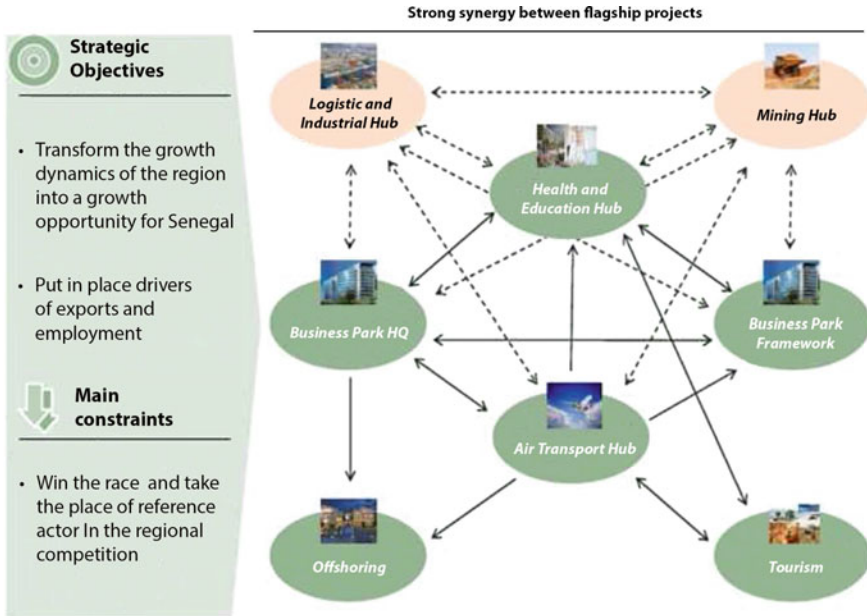
Fig. 31.9 Flagship projects of the PSE "Plan Senegal Emergent." *Source* [46]

data for policies. LORA has four integrated components: a) collect and analysis of data; b) develop policies/actions; c) develop advocacy and communication materials; and d) train and develop capacities. LORA is inclusive and allows to timely take into consideration needs of all citizens. It helps to identify and direct investments to the most vulnerable areas.

Technology Park—In an effort to decongest Dakar, the Senegalese government is creating six new urban centers at the edge of the city. Along the extension of the city, the government is putting in place an ambitious project of a technology park in one of the urban centers, Diamniadio, called "Diamniadio Technology Park." The park is based on the Silicon Valley model and intends to promote data revolution and higher education centers (Fig. 31.9)

Several conferences and forums are organized to assess better ways to extend ICTs development and use in Senegal. The IT Forum Dakar 2015 assessed the national strategy on the digital within the Plan Senegal Emergent (PSE)—Challenges of a digital city (Diamniadio) [47]. The Research and Trial Center "Centre de Recherche et d'Essai (CRE)" under the Ministry in charge of Scientific Research and Higher Education provides an interface between citizens and the Research and Development sector and uses ICT as a main activity. As at October 2014, 17 research centers are already installed and ten more were due to be installed during 2015. There is the Scan-ICT project carried out by the Research Centre for

International Development Research Centre (IDRC) in collaboration with the United Nations Economic Commission for Africa (ECA). This is an ambitious proposal with long-term aims to mobilize the support needed to create a phased comprehensive African capability to collect and manage key information needed to support investment increasingly important technologies information and communication technologies (ICT) to help African countries become an Information Societies.

Across the city of Dakar, CTIC are incubating companies, running an accelerator program and a pre-incubation program with start-ups as well as on a broad range of sectors, primarily but not exclusively commercial. HubSocial works to develop social solutions for Senegal and West Africa, particularly on the just concluded MDGs, particularly on poverty reduction, health and education. A little different is Jjiguene Tech, a female-led organization with a mission to encourage women and girls in ICT and to keep female ICT graduates and others actively involved in the ICT business [48]. Technology hub Bantalabs have established offices in Dakar to provide open-source web development, consulting and training. Facebook also invests in Senegal to launch Internet.org (a project aimed at bringing Internet access to two-thirds of the world that are not connected) as well as more than a dozen free basic services within the country. According to Facebook, the services will be available to Tigo SIM card holders. Senegal is now the sixth country in Africa, and third country worldwide, where Internet.org is available. The free basic services that will be available through Internet.org to consumers with a Tigo SIM card will include: AccuWeather, BabyCenter and MAMA, BBC News, BING, UNICEF, Ebola Info, Facebook, UNICEF Facts for Life, Girl Effect by Nike Foundation, Malaria No More, Messenger, Wattpad, Wikipedia, Wiwsport, Dakaractu.com, Senjob. The E-Riders Senegal project aims to mentor a group of young Senegalese to make it free software developers and providers of ICT services by the organizations of the civil society [49]. Jokkolabs works to support ICT communities by targeting multiple creative sectors, not just techies and open-source geeks. Finally Coders4Africa is a not-for-profit with a mission to create hubs and laboratories across Africa where technologists and others can receive advanced training and develop ICT tools that address community needs [50]. All these projects, though not well coordinated to increase synergy, witness the era of ICT revolution in Senegal, and particularly in Dakar [51].

In order to make ICT accessible, the government should lower taxes on ICT infrastructure, particularly on those for education and research. Liberalization of the ICT, particularly the telecommunication market, can contribute to making internet connectivity affordable. Deploying ICTs will bring equal opportunities and create an environment favorable for smart cities, which are sustainable, inclusive and prosperous. A smart, digital Dakar will be the driver of the "Plan Senegal Emergent."

31.3.4 *Promoting Digital Transport Through the Integration of ICT Infrastructure*

The opportunities for ICT to support the overall transport challenges and opportunities are enormous, and cities in developing countries can integrate and use ICT solutions to facilitate the greater provisioning of transport services. Newly cheap ICT can unlock possibilities for greater transport efficiency. Cities may be able to use real-time data to design and implement policies that increase transit accessibility, decrease travel time, substitute for expensive road construction and abate congestion and pollution. A good starting point is with the most basic foundation of planning: Dakar as most cities in low income countries do not have complete maps of its transit networks. An example can be found in Manila which has developed and applied a mobile phone-based application to survey and map routes, using an open-source data standard. The map powers a consumer trip-planning app and is being used by city planners to reduce redundant routes and plan a new mass transit corridor. For instance, the widening use of smartphones, high urbanization rates and the rapid evolution of technologies are driving the expansion of real-time passenger information (RTPI) systems for urban transport services. RTPI provides accurate information on actual departure and arrival times and service disruptions, enabling passengers to plan more-efficient trips [52]. National and local authorities can also build awareness on "Intelligent Transportation" with the integration of ICT to address transport challenges. The ICT revolution with the rapid development and use of Internet, digital mobile communication and "big data" analysis enable to create a less costly and more powerful "intelligent transport systems" (ITS) [53]. The ITS have a greater potential to more efficiently manage transportation assets, improve road safety, reduce traffic congestion and travel time. This will boost productivity and reduce greenhouse gas (GHG) emissions.

However, optimizing the potential of ICT with its variety of applications such as RTPI and ITS in a city such as Dakar where the internet is still at a high cost and is not yet a common public good will heavily depend on the commitments of national and local authorities to consider ICT has the driving force in all development sectors, including the transport sector. Despite various initiatives, programs and projects, the vision of "Dakar Digital City" is still not materialized in several aspects including governance, commerce and infrastructure. For instance, at the infrastructure level, the comparative advantage of ICT is not yet well integrated in the transport sector. Since the city of Dakar is at the onset of digitalization, it can benefit from various good practices in integrating ICT in making transport sector smart. We are presenting some good practices and experiences around the globe that serve lessons for the integration of the ICT in the transport sector in Dakar and Senegal in general.

In the management side, intelligent transport systems integrate vehicle-locating systems using global positioning system (GPS) information; fare collection and revenue management; and traffic signaling; and improved information for transit travelers. Various other applications are embedded in the ITS such as: E-ticketing to

integrate fare systems and revenue distribution across multiple transport modes; area traffic control to improve vehicle flow; dispatch and vehicle location systems to shorten transit times. Road safety—reduction of the incidence of accidents—can also be increased with the installation of speed cameras and remotely controlled electronic signs to discourage road traffic violations. A 2007 report on studies of speed camera programs worldwide found crash reductions ranging from 9 to 41 % [53]. Tracking, navigation and scheduling software improve capacity utilization for logistics and transport companies. The delivery company UPS famously saves about 1 million gallons of gas each year by using routing technology that minimizes left turns, where vehicles are often held up by oncoming traffic [31]. Supply chains and logistics operations account for 10–20 % of Chinese equipment manufacturers' costs, so companies using real-time data to optimize inventories and transportation routes can achieve substantial efficiency gains. Bus rapid transport systems can automatically monitor vehicle speed and ridership, tracking maintenance, capacity use and responses to weather. Health systems can track use and outcomes if patients and providers use digital ID cards to log services. Remote sensing can track program impacts on agriculture, water use, deforestation reduction or air pollution. Ground sensors can track the sustainability of infrastructure in remote and conflict-affected areas. These systems offer rich, representative, actionable real-time information.

Technological changes are disrupting the employment landscape. Occupations are becoming more technology intensive, and analogue economic jobs are giving way to digital economic jobs. Though this transformation is just starting in many developing countries, its development is irreversible, and we must anticipate leaving in a perfect digital world by 2050 or earlier for countries that are committed to the development and use of ICTs. Changes in education and training take a generation to have an effect, and reforms need to start early so that skills do not become a bottleneck as countries advance in their digital transformation. Digital businesses support a sustainable transport in reducing the demand for both motorized and non-motorized means of mobility. Digital businesses include mobile money, price comparator Web sites and online media. At the higher scale, we are moving to the era of digital goods traded exclusively online, as for e-books, online search and streaming music and videos—making *transport*, storage and distribution obsolete for these transactions. Nowadays, increased newly created businesses operate model entirely on the web but offer traditional services that require traditional means of transport, and existing businesses are operating part their activities through the web (Fig. 31.10).

Illustration of Fig. 31.10: The green panel illustrates a situation of mixed land used or alike where services are walking distance from residence (threshold to be determined). Here we can walk, drive and use ICT, *but walking along with the use of ICT to access services is highly recommended*; the red panel illustrates the situation where services are far away from residence, in a distance making it impossible for people to effectively walk to reach most services, but are in a reasonable distance (threshold to be determined) where people can use motorized means of transport with the possibility to also use ICT, and the third scenario with
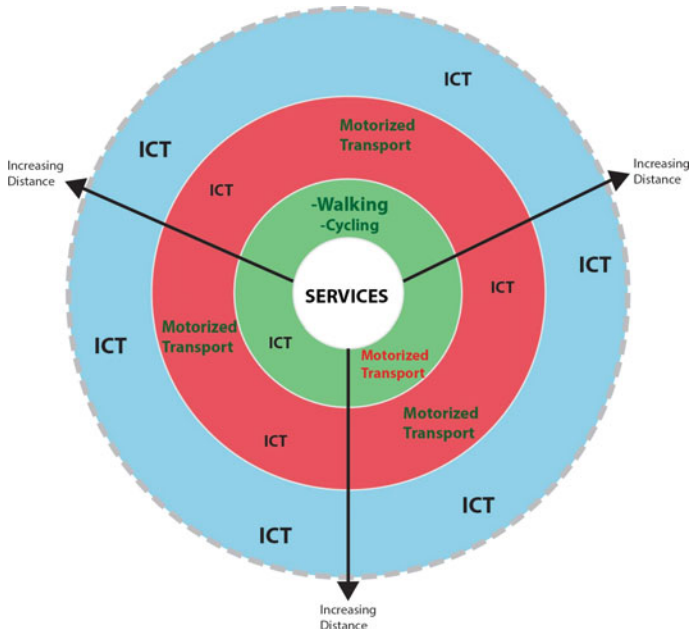
Fig. 31.10 Different means of accessing to services (conceptualized by the author)

the blue panel illustrates a situation where the services are very far (threshold to be determined) from residence making it impossible for people to use motorized means of transport every day to services, and here the only option remaining is the use of ICT to effectively reach services. In all situations, the use of ICT will ease access to services and take city toward smartness.

Location tracking through, for instance, the analysis of mobile call data records (CDRs) is primarily used by emergency services and law enforcement [54], but it is now expanded to other sectors such as transport. Based on data collected from mobile phone traffic, a number of new services are emerging using big data analysis in the transport sector, including fleet management, congestion charging and route optimization. This could further improve monitoring processes in infrastructure projects, identify structural and transport problem areas in marginal communities and strengthen transport facilities in those areas. One example where CDRs were used to analyze and develop large movements of people was a program for optimizing transport networks in Abidjan (Cote d'Ivoire), conducted by IBM's AllAboard project's researchers. "Mobile phone location data are used to infer origin destination flows in the city, which are then converted to ridership on the existing transit network. Sequential travel patterns from individual call location data are used to propose new candidate transit routes. An optimization model evaluates how to improve the existing transit network to increase ridership and user satisfaction, both in terms of travel and wait time (IBM AllAboard 2013)". Based on the CDR analysis and findings, four new bus routes were added to Abidjan's

commuting infrastructure, and one route was extended. This should reduce traveling time by 10 %, illustrating use of CDRs as a useful tool for better urban planning and public transportation [55].

To benefit from all these innovations and good practices, there is need to sustain the liberalization of the ICT in Senegal. Harnessing ICT opportunities requires policies that lower the barriers to competition and market entry, in addition to investments in infrastructure and skills. Only then will firms use new digital technologies more intensively and effectively—and only then will Dakar and the country in general avoid falling behind. This will require investments in skills and infrastructure as well as reform on regulatory barriers by overcoming vested interests to encourage all firms to compete by investing in the ICT. This also involves overhauling regulatory regimes in the digital economy, especially in sectors such as transportation where online and offline firms increasingly compete.[4]

31.3.4.1 Planning the City of Twenty-First Century—A Smart, Digital City

Following the exigency of the city of the twenty-first century that calls for sustainability, inclusion and prosperity, the agglomeration of Dakar must be reconsidered in terms of planning, housing, infrastructure development, economic, environmental sustainability, social development, disaster exposure and resilience and peace and security. The planning of the city of twenty-first century must take into consideration the gain in knowledge on various conditions that make cities smart, green, ecological, livable and healthy; and the progressive emergence of the ICT infrastructures and their correlates such as social media and in general big data.

The data revolution is not only at the technical level, but it reflects the dynamic changes in our living today. It is now recognized that the zoning approach to city planning is no longer on course and must be shifted to planning that promotes mixed neighborhoods at the social as well as at the sectorial level. More importantly, with the development of ICT infrastructures and their correlates, work places are becoming progressively spatially mobile. It has been demonstrated that the zoning planning, where the workplaces are spatially distinct from the residential areas, promotes motorized means of mobility that impacts people's health as well as the environment. Walkability has progressively become a central part of planning of the city of the twenty-first century. This marks the end of the era of arterial streets and calls for a re-consideration of streets which promote public spaces and walkability such as the Lebou settlement in the sixteenth century. Furthermore, with the emergence of ICT infrastructures, the dichotomy between settlements, particularly between rural and urban areas is becoming less relevant than it was traditionally

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[4]For example, regulators around the world seem to be conflicted on whether ride-sharing services should be regulated as transport service companies or as software companies. Is mobile money a banking or a telecom product? And in highly connected markets, could the absence of competition across various digital platforms inhibit future innovation?

perceived. Various comparative advantages associated with urban setting such as diffusion of ideas, innovation and economies of scale can also be achieved in connected sparse settlements. In the twenty-first century, a sustainable, inclusive and prosperous city must be planned in consideration with these emerging parameters and conditions.

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Chapter 32
Smart Social Development Key for Smart Economy

Gora Mboup

Abstract A smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centric approach based on three core components and seven dimensions. The three core components are Smart City Foundation, Smart ICT and Smart Institutions and Laws, which in turn are the pillars of the seven dimensions of a smart city: Infrastructure Development, Environmental Sustainability, *Social Development*, Social Inclusion, Disasters Exposure, Resilience and Peace and Security. The three components together with the seven dimensions make a Smart Economy. This chapter focuses on one of the dimensions of smart cities, the Social Development which is composed of elements of education, health, social inclusion, social capital, population dynamics and other variables. The first section of this chapter is on Education, which is critical to meeting the challenges of smart city, as it connects people to new approaches, solutions and technologies that enable them to identify, clarify and tackle local and global problems. The second section on health considering that healthy population is critical to realizing economic growth through increased productivity. Healthy workers are more productive, bringing greater income to families and higher levels of economic growth for nations, and then enhance. When education and health are combined, they contribute significantly to human development. In both dimensions, the agglomeration has Dakar as the rest of Senegal has made significant progress during these past twenty years. With the decline in fertility and mortality rates, the population of Dakar is marked by a massive youth population (with a median age of 23.2 years) that constitute a potential urban demographic dividend which is the focus of the third section. However, due to high unemployment rates, this demographic dividend has not been fully utilized; most young people are still depend to their parents, thanks to the high social capital in Dakar as in the rest of Senegal. The last section focuses on the social capital in Dakar expressed within the family as well as in the communities through public spaces and social media.

G. Mboup (✉)
Global Observatory linking Research to Action, New York, USA
e-mail: gmboup@gora4people.org

32.1 Education: Building the Human Capital for a Smart Social Development

Smart citizens make smart cities. Smart citizens are literate and well educated in general terms as well as in the digital platform. There can be no smart city without education. Education is critical to meeting the challenges of smart city, as it connects people to new approaches, solutions and technologies that enable them to identify, clarify and tackle local and global problems. Education spans the understanding of natural processes and the human impact thereon, the organization of social systems; the contribution of education to health and well-being and to better subsistence and livelihood is indisputable. It is crucial to reducing poverty, improving health and enabling people to play a full part in their communities and nations. It finally generates powerful poverty-reducing synergies and yields enormous intergenerational gains [1].

32.1.1 Progress in Education and Literacy Drives Dakar Toward a Smart City

Basic education is the foundation of any education system. Basic education is a human right, and most countries around the world today acknowledge the right to education in their constitutions [2]. In countries where primary education is compulsory under law, governments deploy a nationwide education system with free primary school and social assistance toward indirect costs like transport and meals [3]. The international community assembled in Dakar in April 2000 to set an agenda, called the Dakar Framework for Action, for making progress in education to 2015 [4]. In this section, progress in education is assessed from analyzing levels of education and literacy among young people age 15–19 years and 20–24 years old in 2015. These people were aged 0–5 years and 5–9 years in 2000 when the Millennium Development Goals (MDGs), including goals in basic education, and the Dakar Framework on Basic education were adopted. The progress in education is also assessed through the school attendance or enrollment among children and young people at school age. Any change on education must be reflected on these groups when comparing their situation before and during the MDGs and the Dakar Framework. In addition to this technical consideration in terms of assessment, young people of 15–24 years old are those who are leading change of today and in the future along with the younger cohort. Information on highest level of education

of population aged 15 years and above, and on school attendance among children 6–16 years old were collected in a series of Demographic and Health Surveys (DHS) conducted in Senegal from different point of time (1992–93, 1997, 2005, 2011 and 2014) [5]. This information is used to assess trends in education in Dakar in the last 20 years.

Though availability of ICT infrastructure is key to create a digital city, it is equally important to have the human resources capable to use it and further to develop it. The primary education level alone may not provide the required capability to digitize a system, but it represents a good start toward an effective expansion of ICT infrastructure. In the last 20 years, considerable progress had been made in education as witnessed by the increase in the percentage of young people 15–19 years and 20–24 years old with at least a primary level of education. Estimated at 68 % in 1993 and 72 % in 1997, the percentage of women and men 15–19 years with at least a primary education is estimated at 90 and 95 % in 2015, respectively. These figures show that basic education is quasi-universal in Dakar and makes the city of Dakar potentially smart. Education is, indeed, critical to meet the challenges in the ICT era, as it also connects people to new approaches, solutions and technologies that require basic literacy (Fig. 32.1).

It is important to note that similarly the literacy rate has increased from 59 % in 1993 to 80 % in 2014 among the young women of 15–19 years and 84 % in 2005 to 86 % in 2015. However, these literacy rates are 10 points lower than proportion of people in the same age group with a primary education level, indicating that primary education does not necessary provide literacy capabilities. In Senegal, measures have been taken to improve learning quality with the introduction of pedagogical resources, especially textbooks for the core subjects of reading and mathematics with the provision one textbook to every student in a classroom; this has increased literacy scores by 5–20 % [7]. By 2030, literacy will be universal in Dakar as access to education will also be universal. This will impact all sectors of the smartness in many levels in terms of attitudes and behavior.
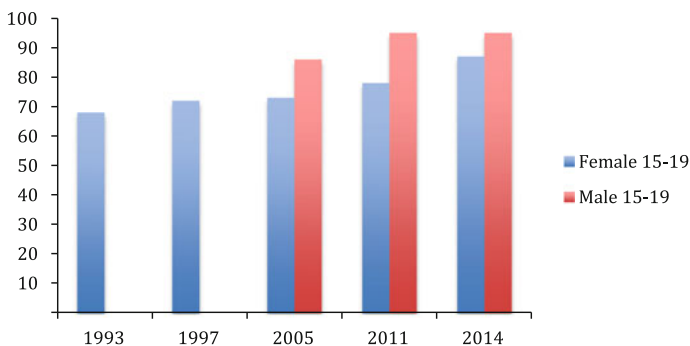
Fig. 32.1 Percentage of men and women aged 15–19 years old with at least a primary education level, Dakar. *Source* [6]

In addition to analyzing the education level, we have also assessed the net primary school attended among children 6–11 years old in Dakar, which is the normal primary school age. Since 2004, the minimum age to enroll to public primary school is reduced to six years from seven years previously. The net primary school attendance rate calculated among children 6–11 years old used the series of Demographic and Health Surveys conducted in Dakar also show progress in school attendance for both boys and girls. Estimated at 60 % in 2000, the net enrollment ratio at the primary education level increased to 78 % for both boys and girls, and to 90 and 91 % in 2015 for boys and girls, respectively. These rates are much higher than those observed in other parts of the country, exception with the Ziguinchor region (in the south of the country), and confirm that the agglomeration of Dakar is a place of opportunities for education. It eases school accessibility and provides the necessary incentives for parents to send their children, both boys and girls, to school. Evidence in developing countries suggests that when schools provide appropriate incentives, boys and girls will equally be enrolled to school [3]. The treatment of early childhood care and education in the Dakar Framework had its roots in the rights-based approach of the Convention on the Rights of the Child. Since 2000, there has been an increasing focus on early childhood, in both poor and rich countries, informed by evidence of its fundamental consequences for future individual well-being, with further research emerging of the importance of the first 1000 days after conception [8]. Literacy skills are best developed in childhood through good quality education. They are sustained by continual practice in literate environments at work or in the community and through adult and continuing education. Developments that may have contributed to a faster decline in illiteracy rates, such as renewed interest in literacy programs, including those that promoted the use of mother tongue. Likewise, more potential opportunities appeared for the use of literacy skills. The quest for an education of good quality cuts across the Dakar Framework and the other five goals. The framework expresses concern over emerging evidence that a sizeable percentage of children were 'acquiring only a fraction of the knowledge and skills they are expected to master [8]. However, the fact that primary school attendance rate is not 100 % seems to indicate that effective attendance and access are not fully enforced in Senegal; the final decision is often left to parents who do not face penalties when they fail to enroll their children to a school [8]. Parental resistance to sending their children, particularly girls to school on the grounds of economic reasons or cultural norms can be overcome only if education is affordable, accessible and, to some extent, flexible, including situating schools within walking distance of residential communities. However, in Dakar mapping the school has shown use geographic disparities where poor areas are less served with school than rich areas.

Though primary education level and its correlate literacy level are important for the use of ICT, further education at the secondary level or higher may be required to develop and use sophisticated applications from mobile phones and computers. Higher education can allow people not only to use the ICT infrastructure, but also to develop sophisticated applications for complex problems and situations with the ICT infrastructure. In several economic and social sectors of Dakar, use of digital technology requires skills and competencies beyond literacy, and people must be equipped with ICT knowledge. Today, Dakar depends heavily on external technical
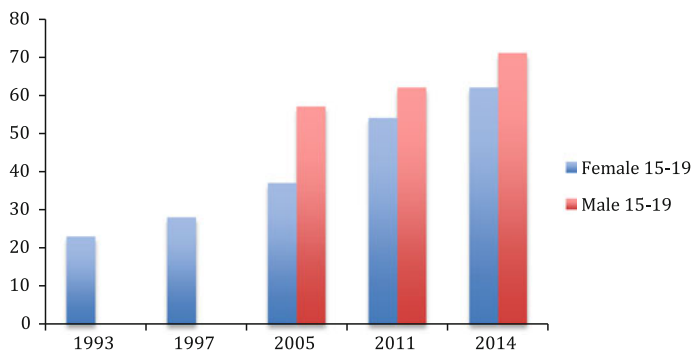
Fig. 32.2 Percentage of men and women aged 15–19 years old with at least a secondary education level, Dakar. *Source* [6]

assistance, but it become clear that the digital city Dakar will be made by the people of Dakar for the people of Dakar. Analysis of series of DHS in Dakar shows that the percentage of young people with secondary education level has also increased during the last 20 years, from 37 to 62 % for women aged 15–19 years old and from 57 to 71 % for men aged 15–19 years old between 2000 and 2015; this is a notable change (Fig. 32.2).

The increase in secondary education in Dakar can be associated with two main aspects. First is the expansion of secondary education facilities in remote and poor areas taken by the government in the early 2000 allowing children to move from primary to secondary level within the same geographic area. Schooling in their neighborhood has also mental and social advantages on children, giving them the opportunity to grow along with their parents. Second is the extension of free and compulsory education to include lower secondary, which has been possible due the political commitment of Senegal as in the MDGs and in the Dakar Framework. Senegal is, indeed, among the few African countries that devote more than 1 % of GDP (1.4 %) to higher education. The Dakar Framework was also influential in encouraging dialogue with traditional religious actors who had been resistant to what they viewed as Western forms of education. Increased dialogue helped generate support for legal reforms in 2004 and facilitate the incorporation of religious schools in the formal education system, thus maximizing the enrollment of lower secondary school-aged children [9]. This was particularly important in Dakar where bilingual schools French–Arabic were introduced with boarding facilities and encouraging parents enroll their children, even girls at the school.

Efforts are still needed to boost enrollment at secondary level where the figures are 46 and 48 % for boys and girls, respectively. Here, there is a slight advantage for the girls. During the progress toward generalization of education, much has been done in favor of gender equity in education over the past 15 years and narrowing of the gender gap. In Senegal, increases in the ratio of girls' enrollment relative to boys' reflect not only a slight advantage in girls' enrollment at entry to primary

school, but also more boys dropping out of school. In Senegal in 1999, 81 boys were leaving primary school for every 100 girls. By 2011, the situation was reversed: 113 boys dropped out for every 100 girls [10, 11]. In Senegal, this progress was possible because national and local authorities clearly recognized the crucial importance of girls' education in development as well as the benefits derived from the "education for all" agenda. Various policy frameworks, including the "women in development," "gender and development," post-structural and rights-based approaches, have contributed to gender equality and quality education in their own way. The "women in development" approach generates clear policy directives on issues such as the hiring of more female teachers, tracking the number of girls and women in and out of school, overcoming barriers to girls' education and reaping the benefits of schooling [10]. Improvements in girls' enrollment have resulted from eight interrelated strategies, some of which may provide some insights into ways to keep boys in school, as well: (1) elimination of user fees; (2) conditional cash transfers; (3) increased focus on gender inequality; (4) recognition of cultural and social constraints to girls' education; (5) improvement in the economic returns to girls' education; (6) promotion of postprimary education for girls; (7) making primary education more gender sensitive; and (8) developing and disseminating gender-sensitive school and pedagogical models [3].

32.1.2 Bridging the Education Divide to Make Dakar a Smart City for All

Averages may hide the invisible; the situation on the ground shows different pictures with persistent social inequalities across settlements that influence and shape the education system. Though cities are hosts to more educational infrastructures than villages and provide young people with opportunities to continue their education and access gainful employment in the formal sector, they can also generate and intensify the kind of social exclusion that denies the benefits of the "urban advantage" to youth and other marginalized groups, particularly in conditions of unprecedented urban growth, increasing poverty and inequality, or inadequate policies [3]. In the same city, some youth are able to succeed and prosper while others drop out of school, fail to find productive employment and sink into poverty. This is the situation of education in Dakar where the differential between children in the suburbs of Pikine and Guediawaye and those living in the center of Dakar remains high, particularly at higher levels of education. Social and cultural barriers continue to deny slum dwellers the opportunity to complete basic education. Children from Yeumbeul Nord in Pikine are less likely to enroll in school, tend to complete fewer years and are less likely to complete primary or attend secondary school than their counterpart living in wealthy families such as the Plateau and Fann of Dakar. The education system in Dakar is more and more privatized; it perpetuates and reproduces social inequalities. Many children in the suburbs though they attend or complete primary school do not attend secondary school and hence miss

the opportunities that higher education offers, which is knowledge and skill development needed to enter the formal labor market and become economically empowered. This is the stage where school enrollment rates are seen to diverge widely across settlements. In urban areas, access to education is often determined by ability to pay fees more than by the physical proximity of schools, or by curricula. School fees, costs of uniforms, materials, exams and other educational expenses have been shown to affect the chances of children from poor families, and girls in particular, going to school, as they add to the already high opportunity costs of letting them leave home to benefit from formal education.

High education remains a luxury for the urban poor—Families in the suburbs of Dakar face constantly an economic dilemma between securing a better future for their children through education, on the one hand, and meeting their own and their children's needs for basic sustenance, housing, water, transportation, on the other. Some parents do not have other choice than to postpone keeping their children at higher education level, especially girls, until they can take care the other expenses. In Dakar, parents spend around 10 % of household income on school costs for every child, but this proportion is twice as high (20 %) for the poorest households. In the meantime, children are expected to assist with domestic work and menial, low-earning jobs. Overall 3 % of children aged 6–14 years were working during the 2013 Senegalese Census [12]. Among those that were not enrolled to school during the census, more than half were working. Another characteristic is the quality of educational services in most poor communities, which remains low, due to lack of up-to-date books and shortage of teachers. For these past years, the country is facing a shortage of teachers at the secondary school level, in particular for subjects such Mathematics, Physics and Philosophy. The suburbs of Dakar are more affected by the shortage of teachers than the center of Dakar where most reference schools are located along the unique university of the region and various professional postsecondary colleges. These reference schools have sometimes surplus of teachers while schools in the suburbs have a shortage of teachers. Better teaching standards are crucial if the performance is to be improved in the suburbs, and equality in educational outcomes to becomes effective. Merely building schools and increasing enrollment without ensuring quality is unlikely to help Dakar meet its human capital objectives as expressed in the Plan Senegal Emergent (PSE). Policymakers must recognize that increasing human capital through education cannot be achieved by only expanding access at the expense of quality; both must be promoted simultaneously.

Bridging the Education Divide Through ICT—Leaving no One Behind in the Journey Toward a Smart City

Making ICT infrastructure economically, socially and environmentally sustainable for learning and knowledge sharing is the key in driving the city of Dakar toward smartness. The DHS data show that, today, a mobile telephone is present in each household of the city of Dakar easing potential access to Internet and multiple applications. With a level of 58 % in 2005, the coverage of mobile phone is quasi-universal in Dakar with a level of 99 % in 2015. This spectacular boom of

mobile phone makes some authors to feature Senegal as the next Silicon Valley [13]. Along with the boom of mobile phones, there is increase in other ICT infrastructure such as computer and accessibility to Internet, but in a lesser extent. With only 5 % of level of possession in 2005, more than one third of people live in a household with at least a computer (37 %). With similar trends, the coverage of computer is estimated at 57, 75 and 92 % in 2020, 2025 and 2030, respectively. The coverage of an Internet connection has also drastically increased since 2005 where the percentage of people living in a household with an Internet connection was less than 5 %. Six years later, the same percentage was multiplied by six with 24 % of people living in a household with Internet in 2011. The trend is irreversible with an absolute increase of 13 points in 3 years; in 2014, more than third (37 %) of people lived in a household with an Internet connection. With similar trends, this percentage of household with Internet connection will reach 62 % in 2030 and 75 % in 2035. However, with the desire to make Dakar a digital city, this trend can be boosted and the availability of an Internet connection at the household level can be generalized way before the year 2030, and this will be in line with the increase in education and literacy observed in Dakar during these past 20 years.

Education has been for a long time obtained in a classroom with a teacher and students. Today, the ICT has transformed the learning environment and methods and calls for a paradigm shift in assessing level of education and knowledge in a country or globally. Lot of things are happening outside the classroom, and knowledge transfer is becoming possible in all corners of the world. ICT offers a unique, historic opportunity for most countries as Senegal where the educational resources in terms of school facilities and human resources have been unable to meet the growing demand in education from sustained increased of children and young population to be enrolled in primary, secondary and higher education levels. With a population growth of 2.5 %, the population of Dakar is still predominant young with more that one and half a million (1,553,000) below age 25 years old, representing more than half of its total population. The population below age 15 years old represents nearly a third of the total population of Dakar [14]. The agglomeration of Dakar has not been able to meet this pressing demand of pupils and students from primary to secondary school and college. Despite efforts for free primary education and lower secondary education, with the shortage of classrooms and teachers, disadvantaged children and young people have been left behind without education or just with some education. The 2014 DHS shows a high proportion of children and young people that had dropped out and had not been able to complete an entire level of education. Despite the huge investments of the government for these past years on educational infrastructures with the opening of more schools in remote areas and the decentralization of secondary schools and colleges, the country still faces shortage in infrastructures as well as in human resources. Exponential growth of private schools has been also noticed making school more accessible, but these are affordable in most cases to only rich families; those available for poor families are in most cases at a substandard performance in terms of infrastructure as well as in terms of human resources. Bridging the gap in terms of social inequalities as well as in terms of supply demand will call for a

paradigm shift with the integration of the digital approach in learning. Investing in the ICT infrastructures will allow to reach the poor in a lower costs and will also allow to fill the deficit supply to demand in lower cost and in a sustainable manner. The city of Dakar is indeed, facing two educational problems; one is associated with quality of education, and other is the shortage of infrastructure and human resources against the pressing demand of massive children and young people.

Improving the quality of education through use of ICT—Digital technologies affect the whole skill formation process by changing both the teaching and the learning processes. It constitutes an effective way of improving the quality of education, particularly in developing countries where the ratio of teacher to students is exceptionally high [15]. Digitization of the education system with the provision of ICT infrastructure such as computer and Internet connection will allow real time access and use of teaching materials and knowledge in general, making teaching more relevant and effective. Teachers can use online portals to connect with each other and to share lesson plans and best practices, while students can use ICT to access online libraries and to master new technologies [16]. In Senegal, the government with its development partners has launched programs aiming to digitize the basic education system. For instance, the FHI 360's Education Base project has reached more 93,000 students and 4,500 teachers nationwide in the use of ICT in middle school. This project won the Innovating Secondary Education Skills Enhancement Prize from the group Results for Development due to its effective use of ICT [17]. The Senegal has also initiated other projects aiming to decentralize teacher preparation process; improve school policy, systems and governance; strengthen students' basic skills in reading and math; and provide life and employability opportunities for middle school youth [18, 19]. The African Network for Distance Education (Résafad) is part of a partnership between the Ministry of Education and Microsoft Program Partners e-learning, particularly on access to ICT, and their use as a support for improved quality training and learning.

Several actors, such as families, school and training systems and other social and religious institutions, also play a key role on children education in building these skills in early age and throughout the life cycle. In the future, all these diverse institutions and groups will use digital technologies in the building of foundational skills. While there are concerns about the impact of digital technologies on cognitive capacities and socialization, especially among young children, increased development and use of these technologies are irreversible. At home, children are exposed to a series of mobile phones and other digital gadgets where their literacy and numeracy initiation starts [20]. In addition to that, online educational games for young children are introduced to children prior to starting school, hence boosting foundational skills [21]. Access to the Internet, laptops, tablets, mobile phones, digital whiteboards and video-based instruction is increasingly common in primary and secondary education. Most countries have also introduced programs like One Laptop per Child (OLPC).

Bridging the education divide with the digitalization of the education systems and methods—The city of Dakar as the country in general has been unable to satisfy the educational demand, particularly at secondary and higher levels. In this regard, ICT revolution can play a significant role. For instance, the Massive Open

Online Courses (MOOCs) is a recent development in distance learning, characterized by three key aspects: open enrollment, online assessment and an interactive forum. They are at a large scale and mostly free, except fees for certification. Platforms such as Coursera.org, Udacity.com and edX.org host these online courses and are also used to assess participants' performances [22]. Training in advanced ICT skills can also be provided less systematically and outside of the formal education system. Coding classes through free specialized online platforms Codecademy are available, and more than 24 million users who have completed over 100 million exercises through such coding classes. Two factors have contributed to the rapid rise of online courses such as MOOCs [23]. Firstly, digital technology has come of age, with widespread use of laptops, tablets and smartphones with growing broadband penetration in many countries. Secondly, the "digital native" generation has now reached university age and is totally at ease with the all-pervasive use of digital social networks for personal communication.[1] The digital revolution is one new and disruptive way for universities to "go global" beyond their single campuses to reach a global audience. Cloud computing and supercomputing as well as the handling of big data, have already transformed research.

Advanced development and use of ICT—The creation and transfer of scientific knowledge are critical to building and sustaining socioeconomic welfare and integration in the global economy. In the long run, no region or nation can remain a simple 'user' of new knowledge but must also become a 'creator' of new knowledge. This also applies in the ICT sector where Senegal must also develop digital products that culturally and socially take into account its identity. Senegal as many African countries are using more ICT infrastructure than developing it. Closing this gap will require investment on research and technology at higher education level in collaboration with the specialized ICT private sector.[2] It is, indeed, important to engage all actors to make full advantage of the ICT revolution. There are various initiatives taken, and innovations made by national individuals that are not rightly recognized at the higher level. In the telecommunication sector, examples are the mobile banking in Africa such as M-Pesa with the mobile provider Safaricom in Kenya and Orange Money in Countries using the Orange network such as Senegal. However, there is need to support research in the ICT sector in order to move from

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[1]The number of world-class universities committed to this digital innovation is steadily growing, as is the number of students—one MOOCs provider, Coursera, has seen the number of students almost double from 7 million in April 2014 to 12 million today. Unlike their online educational predecessors, the costs of MOOCs are borne not by students but by the institution producing the courses, which adds to their attractiveness. MOOCs allow a single university to extend its teaching to a global audience: the Ecole polytechnique fédérale de Lausanne counts 10,000 students on campus but has close to 1 million registrations worldwide for its MOOCs.

[2]Regarding investment in research and innovation in general, according to Bloom [24], responsibility for this relative neglect of higher education lies partly at the door of the international development community, which in the past failed to encourage African governments to prioritize higher education.

simple users to developers then users. In this area, considering the limited public
resource allocated to research in general, Dakar must engage on public–private
partnership on the ICT sector where the demand is growing. In general, Senegal as
most of the African countries is still lagging behind the African Union (AU)'s target
of devoting 1 % of GDP to Gross Domestic Expenditure on Research and
Development (GERD); it is at a level of 0.6 % with 41 % of the funding from
foreign sources. There is also little synergy in Research and Development, which
suffers from a low budget and inadequate equipment, a low status for researchers
and a lack of university–industry linkages. Research results are also insufficiently
applied, owing to weak oversight and relatively low scientific output. Insufficient
availability of funds for higher education calls for the use of ICT to bridge the gap
with the introduction of the MOOC and similar platforms in the education system.

ICT is indeed considered in national policies on research and innovation based
on the vision of the Plan Senegal Emergent (PSE) for the country becoming an
middle-income country by 2035. The PSE considers higher education and research
as a catalyst to socioeconomic development and thus a priority for reform. The
Ministry of Higher Education and Research launched in 2013 an action plan
entitled "Priority Programme Reform and the Development Plan for Higher
Education and Research" (PDESR) with a funding commitment of US$ 600 million
over five years (2013–2017). In its first year of implementation, the PDESR created
three new public universities: the University of Sine Saloum of Kaolack in central
Senegal, specializing in agriculture, the Second University of Dakar, situated 30 km
from the center of Dakar, specializing in basic sciences, and the Virtual University
of Senegal (VUS), enabling efficient and accessible Higher Education through a
digital open space in each region of Senegal. Following the launch of the VUS in
February 2014, over 2000 students had enrolled for the same academic year.
A network of vocational training institutes and upgraded laboratories has also been
developed with the introduction of high bandwidth to connect public universities
with one another. Five Senegalese universities are interconnected with very high
bandwidth that provides them the opportunity to share their teaching resources via
videoconferencing and other distance learning techniques. This type of develop-
ment in ICT has seen Senegal ranked 12th in Africa by the 2014 International
Telecommunication Union (ITU) ICT Development Index. With around 90,000
educated students enrolled in tertiary institutions in Senegal, it trains a large number
of students with excellent ICT skills.

Along the government programs and policies on ICT, there are several other
initiatives by private sectors, NGOs, Civil society, Academic that invest on the
expansion of ICT and education to bridge the digital divide. Among them is the
Senegalese Association of Educational Counselors (ASCP) who, with the support
of Microsoft, held a capacity building workshop in 2009 "ICT for Education
(ICD4Ed)" [25]. The Senegal Global Distance Learning Centre of the World
Bank's Global Development Learning Network (GDLN) is also contributing to the
use of ICT for knowledge sharing [26]. Several research groups and think tanks

have also undertaken studies and analyses on ICT related subjects: the Research and Try Programme Center (Centre de Recherche et d'Essai Programme), the Scan ICT project, the Multimedia Community Center Programme, the Senegal Observatory on Information Systems, the Networks and Info highways, and "Observatoire sur les Systèmes d'Information, les Réseaux et les Inforoutes au Sénégal" (OSIRIS) [27], etc.

32.2 Good Health Fosters Smart Social Development and Smart Economic Growth

A healthy population is critical to realizing economic growth through increased productivity [28]. Healthy workers are more productive, bringing greater income to families and higher levels of economic growth for nations.

32.2.1 Remarkable Progress in Health Care Transforms Dakar Toward a Smart City

The Demographic and Health Surveys (DHS) held in Senegal show a constant progress in access to health services in Dakar during the past 25 years. In the 1990s, access to health services was very limited and infant and child mortality rates were consequently high. With a steady improvement in health coverage, enhanced with the Millennium Development Goals (MDGs) with its Goal 4, 5 and 6, the improvement was accelerated during the 15 years of the MDGs. There is no doubt that improvement in health is significantly contributing to the Dakar smartness. Children born in Dakar have more access to health services such as antenatal (by their mothers), delivery cares and immunization than those born in other cities, town and villages of Senegal. In Dakar, access to antenatal cares is almost universal and 90 % of delivery occurs in health centers compared to less than 50 % in other places of Senegal (49 % at national level). Over 10 % of delivery in Dakar is assisted by physicians or other health care specialists compared to only 1 % at the national level. Most of children in Dakar have also received all required vaccines such as BCG, polio, measles and DTP. When we consider all four types of vaccinations, the percentage children with all vaccinations is 59 % compared to 42 % at the national level. In Dakar, coverage of child immunization is high both in non-slum and slum areas, a situation that shows that living in Dakar provide remarkably the opportunities of access to better health care. Thus, access to health care services in Dakar regardless of the economic status of families, is much better than elsewhere in Senegal [6].

Significant decline of infant and child mortality rates make living in Dakar smart—In the context where access to health services has significantly improved, mortality has also significantly decreased, particularly among children under five years old. Infant and child mortality rates have been more than halved during the past 15 years. In particular, infant mortality has significantly decreased from 59 per 1000 in 2000 to 28 per 1000 in 2015, the child mortality from 35 per 1000 to 13 per 1000 during the same period. The under-five mortality rate, on the other hand, has decreased from 87 per 1000 to 41 per 1000. The decline of mortality rates has also been observed in other parts of Senegal, but to a lesser extent, making the figures of Dakar much better than the national figures. Life expectancy in Dakar is estimated at 69.6 years with an advantage of 2.5 years for female compared to male, 70.9 and 68.4 years, respectively. Overall, people living in Dakar live five years longer than those of others regions; the national life expectancy is estimated at 64.8 years. It is important to note that Senegal has experienced a remarkable improvement on health with the life expectancy of 10 years higher than the level 15 years ago. In 2000, the life expectancy was estimated at 56 years [6].

Significant progress has also been made in the fight against malaria, which had been the first cause of deaths in Senegal. In the past fifteen years, there has been a significant decrease in malaria-related deaths from 40 % in 2000 to less than 5 % in 2015 contributing to the remarkable decline of mortality as observed in the same period. The prevalence of fever, among the symptoms of malaria, has also drastically decreased, estimated at over 40 % to less than 20 % in 2015 during the same period as indicated by Demographic and Health Surveys in Dakar. A hemoglobin level less than 8.0 g/dl is an indication of severe anemia. In Dakar, that level is estimated at 3.2 %. In Senegal, the National Program to fight against Malaria (NMCP) has included in its strategic planning the promotion of the use of Insecticide Treated Nets (ITNs) as a major axis of intervention for reducing morbidity and mortality due to malaria. To achieve this objective, the NMCP and its partners have implemented procurement and distribution activities "Impregnated mosquito nets Insecticide to Long Term Action." This distribution is performed during routine activities through health facilities and community-based organizations. Since 2003, with the spread of chloroquine resistance, Senegal adopted sulfadoxine–pyrimethamine combination plus amodiaquine for the treatment of uncomplicated malaria. Then in 2006 according to WHO recommendations for the management of confirmed cases of uncomplicated malaria, Senegal adopted a Therapeutic Artemisinin-based combination.

32.2.2 Emerging Modern Environment Health Hazards in Dakar

Pollution, Sedentary Life Style and Natural Disasters

For the past 15 years, considerable progress has been made in access to health services as well as in the reduction of deaths associated with traditional

environmental diseases. However, modern environmental diseases appear to impede decline in morbidity and mortality rates. These modern environmental diseases are associated with change on urban life with the increased of motorized means that has enormous negative impacts on people's lives. Modern environmental health hazards include, but are not limited to, water pollution, urban air pollution from automobiles, radiation hazards, land degradation, climate change and emerging and re-emerging infectious diseases [29]. The occurrence of several modern environmental health hazards and their sources has been noted in industrialized and urbanized African communities [30, 31]. It is estimated that indoor air pollution is responsible for between 2.7 and 2.8 million deaths annually [32]. This makes it the second leading environmental health threat in the world, especially in women who cook and their children [33, 34]. Women usually have the added responsibility of caring for children who are then also exposed to high levels of indoor air pollution on a daily basis.[3] Strong associations between bio-fuel exposure and increased incidences of chronic bronchitis in women and acute respiratory infections in children have been documented [35]. Indoor air pollution is a quiet and neglected killer, with lack of global awareness being one of the primary obstacles to the widespread implementation of existing, proven interventions[4] [36].

Due to lack of public transport, Dakar is also haunted by motorized traffic dominated by buses at old age as presented in Chap. 31, leading to high emission of CO_2 and to what is called modern environmental health hazards that may, in certain conditions, supersede traditional hazards [37]. With the increased use of cars, a sedentary lifestyle is becoming more common among the urban middle and upper classes; this contributes to an increase in obesity, in addition to increasing air pollution and greenhouse gas emissions. Cardiovascular diseases have become a serious public health problem. Long neglected, given the magnitude of communicable diseases, they are now the second cause of death in health facilities in Dakar after malaria. These are chronic diseases with expensive heavy burden of morbidity and mortality. Among the risk factors associated with cardiovascular diseases are hypertension (50 %), cholesterol (13 %) and diabetes (12 %) associated with smoking (47 %) and obesity (23 %). Among the cardiovascular diseases, heart failure is a major concern as being the first cause of hospitalization in hospital cardiology services [38]. Another factor affecting health is the occurrences of disasters related to flooding, amplified by climate change. Climate change contributes to the increase of sea levels as recently noted in several coastal cities such as Dakar. Rise of the sea level accelerates coastal erosion and cause the loss of farming land and habitable areas. The impacts of floods on people and communities

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[3]Potential harm is very great for children under one year, since their lungs and immune system are not yet fully formed. Household use of biomass fuels has been found to significantly increase the risk of acute respiratory infections, which annually kill millions of children under age five [33].

[4]Consequently, the United Nations Environment Programme/World Health Organization Global Environment Monitoring System (GEMS) has confirmed that the worst overall air pollution conditions and the largest indoor pollutant concentrations and exposures are found in both rural and urban areas of the developing world.

are enormous ranging from economic, social and health issues to environmental aspects. Flooding affect the few existing social and community facilities such as schools, health centers, markets. Floods are the most common natural disaster and the leading cause of natural disaster fatalities in Dakar and in the world generally[5] [39]. In 2009, the most significant damage related to flowing was on housing (61 %), Transport (11 %) and health (10 %) [40]. Further floods in 2012 resulted in higher numbers of people affected with 26 deaths, 264,000 people affected and 7,737 houses damaged were reported. People are also exposed to shock hazard associated to poorly installed electrical facilities.

Smart urban planning with sufficient walkable streets and public spaces is key in the fight of urban modern environmental health hazards in Dakar. The fight against child diseases should go beyond the traditional environment of diseases which is the household, to the so-called modern environment of diseases— outdoor pollution, climate change, etc. It must be at the city foundation level as well as the infrastructure development. At the city foundation with a better city planning combined with a good coverage of basic infrastructure. At the infrastructure development, this will go with the promotion of public transport in order to reduce emission of CO2, and finally outdoor pollution. Promotion of smart health status requires smart city foundation as well as infrastructure development. Streets that promote walkability and cycling as elements of an active lifestyle contribute to healthy living, as well as reduction in vehicle emissions. Many important quality-of-life benefits also arise when streets promote nonmotorized transport. Increased outdoor activity and reduced air pollution translate into better public health in reducing heart diseases associated with obesity, high blood pressure, diabetes which are now common diseases among the middle class and the richest families in cities. Considering the negative impact of disasters on many aspects of life, the Sendai Framework for Disaster Risk Reduction of the Third UN World Conference on Disaster Risk Reduction held in March 2015, following the Hyogo framework (2005–2015), also recommends that disaster risk management needs to be about managing the risk inherent in social and economic activity.[6, 7]

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[5]The term hazard refers to a severe or extreme event such as a flood, storm, cold spell or heat wave, which occurs naturally anywhere in the world. Hazards only become disasters when human lives are lost and livelihoods damaged or destroyed. Rises in the global population increase the risk of disasters because more people live in harm's way. (Reference: Centre for Research on the Epidemiology od Disasters (CRED) and UNISDR The Human Cost of weather related disasters (1995–2015).

[6]A United Nations Office for Disaster Risk Reduction Perspective A major stocktaking exercise took place on the learning from implementation of the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters (HFA) starting in 2012.

[7]The Sendai Framework's seven targets focus on substantial reductions in (1) disaster mortality, (2) number of affected people, (3) direct economic losses and (4) reducing damage to critical infrastructure and disruption of basic services. The Sendai Framework also seeks a substantial increase in (5) national and local disaster risk reduction strategies by 2020, (6) enhanced cooperation to developing countries, and (7) a substantial increase in multi-hazard early warning systems, disaster risk information and assessments.

32.2.3   Sustained Health Policies and Programs Create a Smart Healthy Environment

Health constitutes a priority in the "Plan Senegal Emergent" where various health development plans are established to make Dakar a healthy smart city.

Health Development Plans—The politics of health and nutrition is to ensure the delivery of quality health care at affordable costs. Actions of fight against HIV/AIDS, malaria and other pandemics must be strengthened. National authorities are putting more emphasis on hygiene and promotion of healthy eating habits. Public–private partnerships in the construction and operation of health infrastructures and pooling of resources and risks will also be encouraged in connection with the "Dakar Medical City" program. Improving the health and nutrition goes through the proper implementation of the National Health Development Plan in order to: reach 80 % of children aged 0–11 months fully vaccinated in 2017; (1) reduce morbidity and maternal and child mortality; (2) maintain the prevalence of HIV/AIDS in the population below 1 %; (3) improve governance; and (4) have at least 62 % of the population registered with a mutual health in 2017 through the Universal Health Coverage. Other initiatives are the improvement of the supply and quality of health services through the development of the Community approach; strengthening health prevention services; construction and rehabilitation of health infrastructure; and recruitment of skilled health personnel and promotion of generic drugs. This will also include improvement of the performance in the prevention of the transmission of HIV and other communicable diseases; the accessibility of Anti Retro Viral drugs to people living with HIV and; prevention and management of chronic diseases. Governance in the health sector will also be of consideration, particularly for the improvement of the efficiency and effectiveness of public spending on health and strengthening of the medical monitoring and evaluation system and policies.

Universal access to health care—Though in Dakar, Senegal has not yet reached the standards recommended by the World Health Organization (WHO), in terms of coverage in health infrastructure and qualified staff, there are many areas where access to health remains luxury, particularly in access to quality care. The accessibility of care is acute, particularly for the poorer segments mostly working in the informal sector without medical coverage and social benefits in general. National authorities are emphasizing the implementation of the Universal Health Coverage program ("Couverture medicale universelle"—CMU) to allow access of the population, particularly the vulnerable groups, to a minimum package of care.

Making Dakar a Medical City—One of the objectives of the Plan Senegal Emergent (PSE) is the establishment of "Dakar Medical City" that offers health services at the international standard. Dakar Medical City will include the establishment of two or three private hospitals by 2018 providing high quality and competitive health services. These hospitals will serve national as well as international demands. This comprehensive ambition will strengthen ongoing initiatives in the health sector and will boost quality of services at the health pyramid and

training of specialized personnel. The platform "Dakar Medical City" in conjunction with the "Dakar Excellence Campus" aims to strengthen health care services along national education systems and contributes to the attractiveness and competitiveness of Dakar and Senegal in general.

32.3 Education, Health and ICT—An Opportunity for Smart Economy

Unlocking the Dakar's Potential Urban Demographic Dividend

A Demographic Dividend is "the potential economic growth that can result from shifts in a population's age structure, mainly when the share of the working-age population (15–64) is larger than the nonworking-age share of the population (14 and younger, and 65 and older)." [41] In other words, it is "a boost in economic productivity that occurs when there are growing numbers of people in the workforce relative to the number of dependents." A country with both increasing numbers of young people and declining fertility has the potential to reap a demographic dividend. In the urban context, the demographic dividend can be obtained before the demographic transition, partly determined by the flux of migrants, particularly active young people, seeking for jobs. Dakar always attracted massive migration from other part of Senegal, for people coming to seek jobs. After Senegal became independent in 1960, Dakar became the country's capital giving it an additional political function. Further rural–urban migration was reported, drastically increasing the population of Pikine. The relocation policy continued postindependence, in which the poor urban residents were relocated to newly developed settlements such as Grand Yoff and Dagoudane Pikine, Pikine-extension (in 1967) and Guédiawaye (1971). Since then, the growth of Dakar is particularly marked by migration, of particularly young people. In addition to that, in recent decades, Dakar has undergone a general decline in both fertility (3.6 children per woman in 2015 vs. 4.7 in 1990) and mortality (41 per 1000 in 2015 vs. 67 in 1990 of under-five mortality) associated with better access to health and family planning services [42]. In 2015, the life expectancy is estimated at 68.7 years in the city of Dakar. With a median age of 23 years, Dakar's population is still predominantly young. In addition to the decline in fertility and mortality, the growth of the agglomeration of Dakar is partly due to the migration, particularly of young people. As illustrated by the figure of the age pyramid, there is an important share of the age group 20–30 years old. These massive active young people constitute a huge economic potential if they are well trained and employed and constitute a demographic dividend in the urban context. However, it is important to note that this urban demographic dividend is different of the national demographic dividend mainly determined by a demographic transition from general decline in fertility and mortality. The urban demographic dividend is partly associated with migration of massive young population that, indeed, may have an effect on the dependent ratio.

In Dakar, the period of the Demographic Dividend is also marked by an increase of age of first marriage allowing young people to stay longer at school and be equipped with knowledge and skills. Young people also enjoy better health and increased access to family planning allowing them to delay they reproduction and or to have fewer children.

Urbanization and population dynamics—The urbanization of Dakar is accompanied with the increase of the age of entry into first marriage, with a median age of 23.2 years against 19.2 years at the national level. In other terms, in general women in Dakar enter into marriage 4 years later compared to the national average, allowing girls to stay longer in school. Indeed, women in Dakar have the highest level of education in Senegal, and a large number of them are literate. In a society where premarital childbearing is not socially welcome, delay of the age at the first marriage implies delay in the onset of reproduction. The median age at first birth is 24.8 years in Dakar compared to 21.2 years at the national level. In Dakar and Senegal in general, the median age of first birth is one year higher than the median age of first marriage indicating clearly that majority of births occur after marriage, and this immediately considering the average of nine months of pregnancy. This also shows at the same time that the marriage is also meant for reproduction as a social institution. People are not married just because by desire to be together, but desire of building a family with children. Total Fertility Rate (TFR) in Dakar is estimated at 3.6 children per woman compared to 5.3 children per woman at the national level. In other terms, woman in Dakar at the end of childbearing will have 2 children fewer than the national level. This can be associated with the delay in childbearing-related late entry into marriage as well as to extended birth interval associated with use of family planning for either delaying the first child or for spacing births, which is higher in Dakar than in other regions of the country [43].

However, the city of Dakar is not benefiting from the Demographic Dividend marked by the increase of age of marriage and the decline in fertility; the majority of young people are struggling to get their fist job and are still depending on their parents. This situation is described as the inverse of the intergenerational flux as observed in the 1990s, period of the structural adjustment in Senegal, marked by an increased youth unemployment. Those that are employed are in the informal sector; nearly 80 % of Dakar residents are employed in the informal sector or are holding an informal job most in sales and services. As indicated by the employment data, only 11 and 20 % of employed women and men hold a professional, clerical or administrative position, respectively. Among the employed women, most of them work in sales and services while the employed men are between sales and services, on the one hand and manual jobs on the other. They earn low salary and do not enjoy any social benefit. In this situation, a massive youth population will not yield benefit from demographic dividend. With an informal sector representing 80 % of the employment sector, Dakar as the engine of the Senegalese economy requires a transformation of its job markets that calls strong labor policies. Despite the impressive economic growth indicated by the national statistics recently (6.4 %), there is a large-scale job creation needed to reduce poverty among others. Recent statistics from the 2015 Human Development Report of UNDP and the 2015 WDR

of the World Bank indicate the Senegal is still among the poorest countries, indicating Dakar as the engine of the national economy was not able to drive the nation to a wealthy stage. Here it is important that national and local authorities give close attention to the conditions of the informal sector and boost it for higher productivity. However, they are constantly harassed, as they are not recognized as the driver of the city economy. Recognizing the informal sector instead of harassing its population will start with creating a legal status that ease access to: (a) space to operate a business served with public services and infrastructure where they can enjoy secure of tenure and prepare a sustainable business plan; and (b) ease access to finance that can boost their economy.
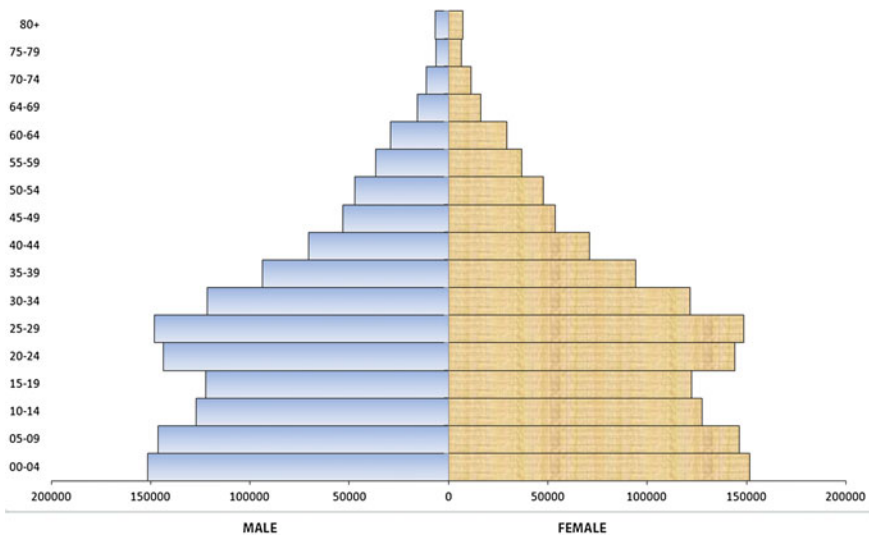
It is urgent that national and local authorities anticipate on the fact that future generations will be well educated and will be composed of native Dakar and many generations of migrants who have a good education and inspire a good formal job. Failing to satisfy this demand may lead to chaos. To change drastically the labor market structure, the Plan Senegal Emergent (PSE) must put employment in the center of its economic policies. The government must create a conceptual framework to assess constraints to higher earnings related to the human capital that workers bring to their jobs, and the business environment that ensures that those jobs are productive. The framework looks not just at the formal wage sector, but also at how to increase productivity in all sectors. In Dakar, it has been challenged to achieve this economic benefit from the demographic dividend. The success of the PSE depends on the conditions created to scale up on the demographic dividend that can last long but not forever. Country that has experienced demographic dividend earlier, with continuous fertility and mortality declines, are now facing

aging with old people leaving much longer beyond the normal retirement age. They can work longer reducing their dependency to retirement or other supports such government, or family in a context where the family is not eroded during all this economic process accompanied with family transformation and change of values associated with social capital. Embracing economic growth while keeping family values is key for a smart city.

With the right empowerment, Dakar's young population can lead the vision for the city of tomorrow and work for it. The ability of the youth to adopt emerging technologies and transfer experiences from other parts of the world must be key drivers of Dakar's smartness in the long term. Various studies show that Africa's young people will be the driving force behind economic prosperity in future decades, but only if policies and programs are in place to enhance their opportunities [44]. These policies and programs include factors such as functioning institutions and laws, efficient bureaucracies, government stability, lack of corruption and a stable business environment that encourages domestic and foreign investors. In order to benefit from its youthful population, the city must embrace smart education driven by the availability of ICT and respond to the requirement of the job market of twenty-first century. It is also important to encourage young people's participation in public life and in policies and programs and services. However, youthful population could also present a significant risk and threat to social cohesion and political stability if Dakar fails to create sufficient economic and employment opportunities to support decent living conditions for them [45]. Empowering young people start in ensuring that youth have solid foundational skills. By addressing these urgent education issues, governments could ensure that youth have the basic skills to build on through further education or on-the-job experience. In Dakar, as presented in the section on education, young people are well educated and are waiting for their integration in the job market. However, additional vocational education and training may be needed to align education and the required skills in the job market. It is important to note that ICT literacy and numeracy are progressively a requirement in all sectors of the economy, and young people must be equipped with knowledge in the use and development of ICT infrastructure.

Using Economy, education and health to build human development in Dakar—Dakar is still the engine of the Senegalese economy. It occupies a pivotal place in the trade sector both nationally and internationally. The autonomous port of Dakar, the international airport, the international trade center, its touristic sites and its commercial centers are assets for the Senegalese economic sector. The city has a concentration of nearly half of Senegalese civil servants. Nine out of ten employees in Senegal's trade, transport, banking and industrial enterprises are in Dakar [46]. Dakar contributes nearly 55 % of the national Gross Domestic Product (GDP) [46],

and its GDP per capita is four times higher than the GDP per capital of the country (US$ 4.476 vs. 1.087 in 2010).
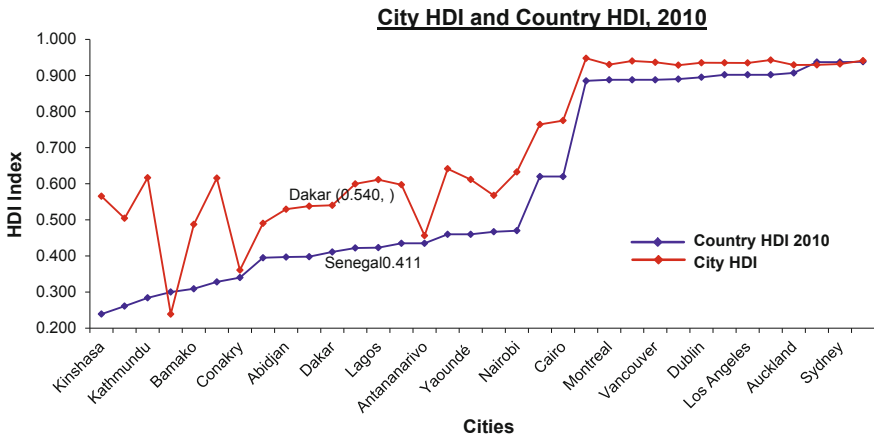
Taking social services to people—**A government initiative**—For a long time, most Senegalese do not enjoy any social benefit; most of them work in the informal sector with its multiple externalities, including lack of medical coverage and retirement pension among others. Considering that the informal sector absorbs the majority of the population and contributes considerably to the national economy, and recognizing that social protection contributes directly to economic growth, the government of Senegal initiated various social programs aiming to provide some sort of social benefits to its vulnerable groups [47]. Those social programs include: (1) National early childhood protection strategy whose implementation will support children in vulnerable situations and overcome the scourges such as child begging, abuse and sexual exploitation, work and child trafficking; (2) Set up of the Family Safety Award Program; and (3) Year quarterly allowances of CFA Francs 25,000 (USD 50) to households living in extreme poverty. The pilot phase of the Allowances program has covered 50,000 families, and a generalization phase from 2014 was supposed to reach 250,000 vulnerable families in 2017 [47]. These allowances will support the enrollment and retention of children in school, immunization vaccine and civil registration. To be more inclusive, all these initiatives will give particular attention to the urgent needs of women, children and vulnerable groups and ensure their equitable access to opportunities. This requires economic, social and political empowerment and strengthening of the mechanisms

of implementation of rules and regulations defining these initiatives. Along these initiatives, the National Framework Plan for the prevention and elimination of child labor will be strengthened with continuous political and social dialogues between the different stakeholders. The Universal Health Coverage (CMU) initiated by national authorities also aims to provide social protection to people working in the informal sector and all vulnerable groups in general. The Social Protection Strategy (SPS) along with the National Social Protection Strategy (SNPS) aims to ensure better access to essential services and social protection for the poorest and most vulnerable groups, including protection of the rights of the disabled (which with equal opportunity card, enjoy free access to care in public institutions). Gender equity at all levels will also be enhanced. Institutional and legal framework reform will extend social security to all workers [47].

32.4 Social Capital as a Supplement of Employment and Social Benefits

In the absence of employment with a formal job where basic social benefits are enjoyed, most people turn to their family and neighborhoods seeking for help. This is made possible due to high social capital values in Senegal.

Family and Social Capital in the making of a smart city—In Senegal, it is quite common to find households comprising several different generations. Most households are in general composed of the nuclear family (the couple and heir children) and other people (related or not to the head of household). The majority of households (51 %) in Dakar are composed of people (extended family) in addition to the head of household and his/her immediate family (spouse and children). The nuclear family represents only 30 % [48]. The average household size is 6 persons. This average is particularly high among extended family with a size of 8 persons per household compared to 4 persons per household among the household with a nuclear family. At the national level, the extended family represents 63 % of household compared to 27 % for the nuclear family. The existence of extended families is particularly pronounced in other regions on the country such as Diourbel, Kaolack, Fatick, Kafrine and Sediou where three quarters of households are composed of extended families. Extended families are still predominant in the context where social capital is very high marked by the presence of cousins, uncles, aunts, grand parents, nieces and nephews all living together. This explains the low level of homelessness in Dakar compared to many other contexts, particularly in developed countries, where without a job most people often become homeless. In Senegal, elderly persons always live with their children or family members. This is reinforced by the high value of social capital in Dakar. There are no institutional homes for elders as it is common in developed countries. Families are still taking care of their elders.

Despite the high-level poverty as illustrated by the weak city foundation with lack of basic infrastructure, high level of the informal sector, homelessness is still

low and security and peace are fairly noticeable in Dakar. One fundamental element that contributes to that is the high presence of social capital in Dakar and in Senegal in general. The social capital is first featured in the formation of households as shown presently with high predominance of extended family. There is strong solidarity between family members helping to live together and also to take care elderly persons. Elderly persons are considered for their wisdom; they chair and facilitate resolution of family internal conflicts. The writer and philosopher Hampate Ba stated that "an elderly person who dies is a library that burns." The social capital is also expressed during family functions such as marriage, baptism, funeral, religious gathering. Solidarities in family are expressed at all levels and are also reflected in the relationship between migrants and their family of origin. In Senegal, remittances from migrants are estimated at CFA Franc 749 billion (USD 1.5 Billion) in 2012, equivalent to 10.4 % of the national GDP. However, these resources are more oriented toward household expenditures (food, education, health and housing) [49] and contribute slightly to investments in productive sectors. For a better coordination, these resources can be directed to productive sectors that generate additional revenues that, in return, will take care household expenditures. Social capital is also enhanced from families to communities, through gathering in public spaces as well as social media. Family and neighborhood interactions occur more often through mobile phone and other social media platforms.

Streets and other public spaces foster social inclusion key for social capital— There is also very strong community interactions initiated outside houses in the streets and outside houses. Indeed, streets and other public spaces promote people interactions and foster social inclusion [50]. Towns and cities have historically been organized around their streets. Streets have traditionally served three main purposes: mobility, commerce and social interaction. There are multiple functions of streets as links or places that have commercial, economic, civic, ceremonial, political, cultural and social value. In Dakar, the first settlement is the Lebou settlements where streets and other public spaces play a crucial role in neighborhood interactions. These interactions determine the heterogeneity of Dakar with several ethnic groups, which are not only living together, but also adopting similar attitudes and behaviors toward various social functions. In Dakar, ethnic belonging plays a minor role in social differentials such as family structure, marriage and reproduction. These depend mainly on social factors such as level of education and economic status [51].

During the flooding that occurred in Yeumbeul Nord in 2012 as in many areas in Dakar, affected households were hosted by neighborhoods with more durable housings, with shelter, food and other basic needs. People and communities are the first to provide rapid responses to flooding in a context where responses from national and local authorities may take a longer time to come, often after technical and political assessment of damages and losses. In this context, only strong social capital can bring urgent responses to acute situations. Some families affected by the flooding are also sheltered in streets and other public spaces. It is therefore urgent that national and local authorities recognize the social function of streets and other public spaces in promoting social inclusion with high quality public spaces that can

promote interaction among communities and improving safety and security. The street is a vital element in the improvement of quality of life in slums, particularly in densely occupied settlements such as in Yeumbeul Nord where the inadequacy of streets is the source of multiple problems faced by slum dwellers. Despite the fact that streets and other public spaces facilitate neighborhood interactions, spaces allocated to streets and public spaces are shrinking along the urbanization of Dakar, with less than 5 % are allocated to streets in the suburbs of Dakar as presented in Chap. 30. In these settlements, due to lack of other public spaces, streets must be strictly redesigned with the primary function of social interaction in an inclusive, well-planned, healthy and supportive environment. No city can claim to be smart when large segments of its population do not have access to streets and other public spaces.

Social Media: Connecting People to People and Enhancing Social Capital— Through social media people, within families and communities, engage on various social issues ranging from family matters to community and political issues. In Dakar, every household has at least a mobile phone, and some are connected to Internet from mobile providers (Orange, Tigo or Expresso) easing the use of Facebook, Whatsapp, Viber and other apps used to communicate. However, the role social media can play in enhancing social capital varies across social groups will depend on variations in access and use of the ICT platform. There are large variations on how people use social media and how they share information. It is now common in Dakar and many parts on Senegal that family arrange meetings through the ICT platform, exchange on social issues, collect funds to build their community, spread news for social functions such as marriage, baptism, funeral and religious ceremonies. People also use the ICT platform to raise concerns about the organization of their communities including connections to basic services such as water, electricity, solid management, flooding. Social media also play a political role in spreading democratic ideals as it is witnessed with the Arab Spring or social demand such as the Wall Street movement. Social media can also spread false information or correct misinformation as it recently happens with various hot topics such as matters related to sexual orientation and changes in the Senegalese constitution and many others.

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Chapter 33
Creating Digital, Smart Cities for Smart Economies: From Big Cities to Digital Urban Centers

Gora Mboup

Abstract This chapter presents the opportunities offered by the ICT revolution in the making of digitally connected cities, which manifests in the rise of urban centers—towns of less than 1 million people. It presents a new form of urbanization, the digital urbanization, where digitally connected towns offer urban advantages traditionally only found in big cities with high densities, such as economies of scale, agglomeration of economies, diffusion of ideas and innovation, and participation in political affairs. The digital urbanization is illustrated through the initiative of the Government of Senegal to create new urban centers to decongest the agglomeration of Dakar which are trapped in frequent flood disasters and continuous traffic congestion among many other urban issues.

Keywords Opportunities · Challenges · Dakar · Urbanization · Urban planning · Infrastructure · ICT · Digital · Urban · Transport · Services

33.1 Introduction

Following the exigency of the city of the twenty-first century that calls for sustainability, inclusion and prosperity, the agglomeration of Dakar must be reconsidered in terms of planning, housing, infrastructure development, economic development, environmental sustainability, social development, disaster exposure and resilience, and peace and security. The planning of the city of twenty-first century must take into consideration the gain in knowledge on various conditions that make cities smart, green, ecological, livable and healthy; and the progressive emergence of the ICT infrastructures and their correlates such as social media and in general big data. It is now recognized that the zoning approach to city planning is no longer on course and must be shifted to planning that promotes mixed land use and socially diverse neighborhoods. More importantly, with the development of

G. Mboup (✉)
Global Observatory Linking Research to Action, New York, USA
e-mail: gmboup@gora4people.org

ICT infrastructures and their correlates, work places are becoming progressively spatially mobile. Walkability has progressively become a central part of planning of the city of the twenty-first st century. Furthermore, with the emergence of ICT infrastructure, the dichotomy between settlements, particularly between cities, towns and villages is becoming less relevant than it was traditionally perceived. Various comparative advantages associated with urban setting such as diffusion of ideas, innovation and economies of scale can also be achieved in connected sparse settlements. In the twenty-firstst century, a sustainable, inclusive, and prosperous city must be planned in consideration with these emerging parameters and conditions.

It is in this context that the Government of Senegal has initiated the creation of several centers in the outskirts of Dakar agglomeration to fight multiple problems the agglomeration is facing associated to its poor urban planning, particularly flood disasters and traffic congestion. Based on previous chapters on city foundation, infrastructure development and social development, this chapter presents the opportunity offered by the ICT revolution in the making of digitally connected cities, the rise of urban centers (less than 1 million people). This chapter presents a new form of urbanization, the digital urbanization where digitally connected towns offer urban advantages traditionally only found in big cities with high densities, such as economy of scale, agglomeration of economies, diffusion of ideas and innovation, and participation in political affairs.

33.2 Dakar: Opportunities and Challenges

33.2.1 *Opportunities of Living in Dakar*

Dakar as a coastal city offers multiple opportunities as a hub of economic activities as well as a link to local, regional and global economies. Today, with its population of 3.4 million, it has an added advantage associated with its high population density (of more than 16,000 inhabitants per km^2) and its youthful population (median age of 23 years), two important drivers of economic productivity and growth. Half of the Senegal's urban population lives in the agglomeration of Dakar. The total population of Senegal is estimated at 14.4 million in 2016 with 45 % living in urban areas [1, 2]. The city's compactness and its associated economies of scale and agglomeration of economies must be viewed as an opportunity to be tapped on as means of promoting economic growth rather than a challenge. Dakar is, indeed, the engine of the Senegalese economy with its autonomous port, its international airport, its international trade center, its touristic sites and its commercial centers being assets for the Senegalese economic sector. Nearly half of Senegalese civil servants are in Dakar, and nine out of ten employees in Senegal's trade, transport, banking and industrial enterprises are also in Dakar [3]. Covering less than 3 % of the national territory, Dakar hosts 75 % of the country's economic activity and

contributes nearly 55 % of the national Gross Domestic Product (GDP) [4], with its GDP per capita four times higher than the national GDP per capita (US$ 4.476 versus 1.087 in 2010). Despite the impressive national economic growth indicated by the national statistics recently (6.4 %), there is a large-scale job creation needed to reduce poverty among others. Recent statistics from the 2015 Human Development Report of UNDP and the 2015 WDR of the World Bank indicate the Senegal are still among the poorest countries, indicating Dakar as the engine of the national economy was not able to drive the nation to a wealthy stage.

Dakar also presents other urban advantages such as better access to ICT infrastructure, education and health services compared with the rest of the country. Over the past 15 years, along the economic power of Dakar, the Senegalese government has taken various initiatives favorable to the development and use of ICT at all levels. It has created a legal institutional framework to support regulatory mechanisms on the development and use of ICT, and introduced ICT platforms such as E-Governance, E-Education, E-infrastructure. Along the government programmes and policies on ICT, there are several other initiatives from private sector, NGOs, Civil society, and Academia who have invested on the expansion of ICT to bridge the digital divide [5]. Today mobile telephone is present in each household of the city of Dakar easing potential access to internet and multiple applications, and by 2030, access to other ICT infrastructures at the household level such as computer and internet will be quasi-universal offering opportunities to live in a digital city. The penetration of ICT is particularly effective in education institutions where they are helping to bridge the gap in a context where national and local authorities have not been able to meet the growing demand from a massive young population. ICT is slowly penetrating the employment sector, but it has been challenged by the fact that over three quarters of the sector are informal. ICT employs less than 1 % of the total labor force, and most sectors have not yet fully integrated the ICT infrastructure in service performance and delivery. However, the informal sector can benefit from the ICT in many ways, particularly to ease financial transactions.

Though availability of ICT infrastructure is key to create a digital city, it is equally important to have the human resources capable to use it and further develop it. Smart citizens are literate and well educated in general terms as well as in the digital platform. Education is critical to meeting the challenges of smart city, as it connects people to new approaches, solutions and technologies that enable them to identify, clarify and tackle local and global problems. In the last 20 years, considerable progress had been made in education as witnessed by the increase in the percentage of young women and 15–19 years with at least a primary level of education, which is estimated at 90 and 95 %, respectively in 2015. However, the government has not been able to meet the pressing education demand for primary to secondary school and college of growing young population (only 62 and 71 % of men have a secondary education level, respectively, in 2015; and less than 20 % in both sexes aged 20–24 years have a college education level); This inaccessibility is particularly pronounced in remote areas and poor urban areas. Bridging this gap calls for a paradigm shift with the integration of the digital approach in learning.

Making ICT infrastructure economically, socially and environmentally sustainable for learning and knowledge sharing is the key in driving the city of Dakar toward smartness. Today, ICT has transformed the learning environment and methods, creating numerous learning and knowledge transfer opportunities outside classrooms [6].

During these past 15 years, the period of the Millennium Development Goals, significant progress has also been made on people's health, a fundamental factor for social wellbeing and economic productivity. There is no doubt that improvement in health is significantly contributing to the Dakar smartness. In the context where access to health services has significantly improved, mortality has also significantly decreased, particularly among children under five years old. Infant and child mortality rates have been more than halved during the past 15 years. In particular, infant mortality has significantly decreased from 59 per 1000 in 2000 to 28 per 1000 in 2015, the child mortality from 35 per 1000 to 13 per 1000 during the same period. The under-five mortality rate, on the other hand, has decreased from 87 per 1000 to 41 per 1000. Life expectancy in Dakar is estimated at 69.6 years with an advantage of 2.5 years for female compared to male, 70.9 and 68.4 years, respectively. Overall, people in Dakar live five years longer than those of others regions in Senegal; the national life expectancy is estimated at 64.8 years.

33.2.2 From Opportunities to Challenges

33.2.2.1 Youth Unemployment

The city of Dakar is not benefiting from the demographic dividend characterized by a massive population in densely population settlements. Majority of young people are struggling to get their first job and are still depending on their parents. Nearly 80 % of Dakar residents are employed in the informal sector or are holding an informal job most in sales and services. They earn a low salary and do not enjoy any or little social benefit. Only 11 and 20 % of employed women and men hold a professional, clerical or administrative position, respectively. With an informal sector representing 80 % of the employment sector, Dakar as the engine of the Senegalese economy requires a transformation of its job markets that calls a transformative economic development. Considering the majority of people are employed in the informal sector, it is important that national and local authorities give close attention to the conditions of the informal sector and boost it for higher productivity. However, people working at the informal sector are constantly harassed, as they are not recognized as the driver of the economy of the agglomeration. Recognizing the informal sector instead of harassing its population will start with creating a legal status that eases access to: (a) space to operate a business served with public services and infrastructure where they can enjoy security of tenure and prepare a sustainable business plan and; (b) ease access to finance that can boost

their economy. ICT can play a significant role in digitizing the informal sector as the digitizing of the formal sector has reached only a minority. The informal sector can benefit from the ICT as the digital finance ease financial transaction in absence of bank accounts. People the informal sector have been able to reach a large number of customers through mobile financial transactions such as Orange Money and Wari. These digital payments reduce transaction coats as well as transaction times. Digital payments increase security compared to traveling with large amounts of cash, as is commonly necessary in the informal sector where bank accounts are not common. Improving internet access and basic literacy and updating skill and training systems are important for a full integration of ICT in the informal sector. With less than 1 % of share in the labor force, ICT has not yet penetrated the employment market.

33.2.3 *Weak City Foundation Hampers City Smartness*

Many of these challenges are partly associated with the Dakar's weak city foundation characterized by three main factors: (a) pour urban planning; (b) insufficient provision of basic services; and (c) inefficient urban policies [7]. The agglomeration of Dakar is poorly served with streets; only 15 % of land is allocated to streets in the central business district of Dakar, and less than 5 % of land is allocated to streets in its suburban areas [8]. More than half of the houses in Dakar are in unplanned settlements, and only 40 % are connected to a drainage system, and less than the third enjoys security of tenure with a title deed or other legal forms of ownership documents. Due to poor land administration and governance, there is no compliance with standards of occupancy of the space leading to high building density and irregularity of the urban fabric. In addition, infrastructure for non-motorized transport (e.g., pavements or sidewalks for walking and bicycle lanes for cycling) is often lacking, poorly developed, or on the decline. This has led to high incidences of traffic fatalities involving pedestrians and cyclists. Streets that provide space only to motorists are, indeed, characterized by congestion and high CO_2 emissions [9].

The impacts of flood disasters on people and communities remain a significant challenge to Dakar sustainable urban development [10]. They are enormous ranging from economic, social and health issues to environmental aspects. They particularly affect social development with inaccessibility to most services; the economic development of the agglomeration is also severely affected with significant decline of productivity of the active population. For instance, in 2009, the Post-Disaster Needs Assessment (PDNA) for Senegal estimated damage and losses to total US$ 90 million (44.5 billion FCFA) nationwide, of which US$72 million (35.5 billion FCFA) was for damage and loss in the Dakar region alone, with the most significant damage being on housing (61 %), Transport (11 %) and health (10 %) [11, 12] (Fig. 33.1).

Fig. 33.1 Urban planning,
urban policies, basic
infrastructure. *Source* [13]

33.2.3.1 Land—The Hidden Asset

In addition of bearing flood disasters, the city of Dakar is not fully benefiting
from its land assets due to the fact that most of this land is considered as
irregularly acquired and lacks legal ownership document such as a title deed.
Land and housing assets constitute more than half of people's wealth. With
functioning institutions and laws providing legal propriety rights, revenues from
land and housing can contribute to the planning, management and provision of
services in settlements. However, in the absence of such institutions and laws,
most of these assets remain dead investments sheltering only people. To tap into
the potential of high densities and the massive active youth population, the city of
Dakar must formalize its land system, which will be the driver of many other
components of its foundation such as streets and public spaces, provision of basic
infrastructures such as water, sanitation and energy, and management of waste.
*Secure tenure goes beyond protection against eviction and offers economic and
financial advantages and opportunities*. Land shall not be seen only as a social
asset providing shelter to people, but as also an economic and financial asset
providing opportunity for investment and saving [14]. Though, it is not always
easy to estimate the land value in a situation where informality is predominant, a
study by the World Bank has estimated the total land value in Dakar at US$44
billion [15]. This means damages and losses associated to hazard will also rep-
resent a high cost. The total land value of the city is 8 times its GDP. This means
that making land work for people, by providing legal ownership documents, will
boost the economy of the city. Most of the land cannot be used in the financial
market due to lack of legal propriety document. The fraction of the level of this
informality varies according to sources. The official figure is 37 % (composed of
irregular settlements and village type settlements), but other estimates provide
figures higher than 50 %. However, if we consider the low figure, we can

consider that US$17.4 billion of land value is not convertible in the financial market to secure marketable financial transactions.

33.3 Managing Flood Disasters, Traffic Congestions and Other Urban Issues

Considering the multiple problems the city of Dakar is facing, raging from development of informal settlements, lack of basic infrastructures, poor management of wastes, frequent traffic congestions among others, national authorities have made progress in the development of policies and programmes to tackle them and then promote sustainable urban growth. The two policy reforms/plans that stand out are the "Act III of Decentralization" in 2013—an administrative reform, and the "Plan Senegal Emergent (PSE)" in 2014—a holistic framework for sustained development and economic growth. The Act III of Decentralization allows local authorities to plan and manage their municipalities, rending possible the creation of sustainable settlements, while the PSE provides roadmap toward sustainable economic growth including sustainable urbanization. The Plan Senegal Emergent (PSE)—The PSE is strategically based on three axes: (1) structural economic growth and transformation; (2) human capital, social protection and sustainable development; and (3) governance, institutions, peace and security. At the sectorial level, the PSE is based on six main sectors: energy, infrastructure, business environment, telecommunication, human capital and finance [16]. The Senegal Government introduced the Urban Master Plan (Plan Directeur d'Urbanisme—PDU 2025) which was approved only nine years later.

The Urban Mobility Plan in the PDU 2025 has been developed to address the critical problems of mobility in the Dakar agglomeration and to reorganize the transport by promoting public transportation in Dakar, but has not been not taken into account in the construction of the major roadwork components in Dakar, implemented and managed by other specialized agencies. The PDU 2025 has been under revision with the preparation of the master plan (PDU 2035) initiated in 2014 for the urban development of the region of Dakar and its surroundings by 2035 [17]. The main objectives of the PDU 2035 are: Sustainable Urban Development; Compact cities connected with a transport network; Robust and Resilient city and; Vibrant city with active interaction between information, goods and people. In addition, there is the National Plan for Territorial Development "PNAT" prepared in 2015 that proposes five development areas: urban areas; areas for economic activities; areas for agriculture activities; areas for touristic activities; and areas for conservation [18]. The PNAT also identifies areas with high risk for habitation and any other activity. This plan also promotes green areas and other protected areas for environmental purposes or spaces with light recreational facilities, which, when well integrated enhance the character or the ecological value of the area. Specific focus areas of the PNAT also aim at: controlling the internal urban growth;

reducing the proliferation of slums; promoting a balanced urban development; and meeting the housing demand. Coordination and integration of these programmes, plans, and reforms which are under different administrative may yield to the building of sustainable, inclusive and prosperous cities.

In addition to the above plans and programmes, national authorities have also introduced specific projects particularly tackling floods. The government responses to disasters related to flooding have been progressive with three major faces. Prior to 2006, the government response consisted of emergency pumping operations in neighborhoods and the temporary resettlement of the victims in public buildings, such as schools. This strategy proved to be very expensive (for fuel and maintenance of pumping equipment, deploying field teams, sheltering flood victims and repairing the buildings where victims had been sheltered). Besides, such a strategy was not sustainable because similar actions were being repeated each year at the same sites with huge losses, unforeseen expenses and reorganization in the state budget. In 2006, the project for construction of social housing and the fight against floods and slums was aimed at implementing the "Jaxaay Plan" and the "One Family, One House" program [19]. From 2006 to 2012, the "Jaxaay plan" built houses for flood victims and installed water drainage systems using emergency pumps [20].

The year 2009 marked the turning point with the government understanding that responses to flooding go beyond managing damages and losses but preventing occurrences of floods. In August 2010, the Government of Senegal decided to prepare an urban development project for rainwater management and climate change adaptation, known as PROGEP, aiming to reduce floods through an integrated and sustainable approach [21]. With a budget of more than US$ 55 million and over a 5 year term (2013–2017), the PROGEP consists of four components: (1) Flood Risk Mainstreaming in the Urban Sector; (2) Drainage Investment and Management; (3) Community Engagement in Urban Flood Risk Reduction and Adaptation to Climate Change; and (4) Project Coordination, Management, Monitoring and Evaluation. The holistic approach of PROGEP to tackling flood disasters is the recognition of the deep roots of the causes embedded in the planning and the management of the city itself, which is poorly planned, poorly served with basic infrastructure and inefficiently managed along inefficient urban policies. When a city has such a weak foundation, it is complex to solve disasters with routine solutions.

Despite all these initiatives and projects with billions of CFA Francs invested, flooding still causes damages and losses among people and communities. In 2015, several settlements were flooded, and roads were deemed impassable, forcing many motorists to rely on alternative means of transport so as to protect their vehicles from being washed away or damaged by water. The fight against flooding in Dakar will be won beyond the current adaptation and management of flood disasters. Even outside the raining season, some settlements of Pikine and Guediwaye are exposed to high risk of flooding due to rise of the sea level associated to climate change and coastal erosion. In Dakar, despite the authorities' commitment to the restoration and rehabilitation of these ecosystems, the deteriorating trend is not reversible due the

fact that people have settled in wetland areas. If they were well managed, watersheds play crucial role in the urban ecosystem in becoming green areas, protected areas for environmental or recreational purposes, which if well integrated, enhance the character of their ecological value [18, 22]. This calls for a paradigm shift, which consists of solving the problem from outside the agglomeration with a creation of urban centers to first decongest the city, and then progressively rebuild it.

33.4   From Big Cities to Digital Urban Centers—The Digital Urbanization

While developing urban policies and projects to tackle flooding and traffic congestion in the agglomeration of Dakar, national authorities have taken bold urban policies with the creation of seven polycentric urban centers in the outskirts. The creation of these urban centers will decongest Dakar and will mark the transition of big cities to digitally connected towns (of less than 1 million people). Fighting the problem of the big city from outside with the formation of small cities: This represents a new form of urbanization, the digital urbanization where digitally connected towns offer urban advantages traditionally only found in big cities with high densities, such as economies of scale, agglomeration of economies, diffusion of ideas, innovation, and participation to political affairs.

33.4.1   Toward a Digital Environment

For these past 15 years, along the economic power of Dakar, the Senegalese government has taken various initiatives favorable to the development and ICT at all levels. It has created legal institutional framework to support regulatory mechanisms on the development and use of ICT. It has also introduced ICT platforms such as E-Governance, E-Education, E-infrastructure and supports education and training on ICT. The city of Dakar in partnership with the mobile operator Tigo (a subsidiary of Millicom International Cellular Group) has also launched the Dakar Digital City initiative, a pilot project "SSID: City Wifi Dakar" [23] to make free internet connection available in large public places. The initiative will also be extended to the public transport buses with the network 3G+. This will also allow local authorities to make ambitious planning and investment decisions based on accurate, comprehensive transit data [24]. The city of Dakar is also a member of the UNESCO Creative Cities Network in the category of Digital Arts [25, 26]. Along the government programmes and policies on ICT, there are several other initiatives by private sectors, NGOs, Civil society, Academic that invest on the expansion of ICT and education to bridge the digital divide.

Across the city of Dakar, incubating companies such as CTIC Dakar are running accelerator and pre-incubation programmes with start-ups as well as on a broad range of sectors. Other initiatives are: HubSocial which works to develop social solutions for Senegal and West Africa, particularly on poverty reduction, health and education; Jjiguene Tech, a female-led organization with a mission to encourage women and girls in ICT and to keep female ICT graduates and others actively involved in the ICT business [27]; and Technology hub Bantalabs that have established offices in Dakar to provide open source web development, consulting and training. Facebook also invests in Senegal to launch Internet.org (a project aimed at bringing Internet access to two-thirds of the world that are not connected) as well as more than a dozen free basic services within the country. According to Facebook, the services will be available to Tigo SIM card holders. Senegal is now the sixth country in Africa, and third country worldwide, where Internet.org is available. The free basic services that will be available through Internet.org to consumers with a Tigo SIM card will include: AccuWeather, BabyCenter and MAMA, BBC News, BING, UNICEF, Ebola Info, Facebook, UNICED Facts for Life, Girl Effect by Nike Foundation, Malaria No More, Messenger, Wattpad, Wikipedia, Wiwisport, Dakaractu.com, Senjob. The E-Riders Senegal project aims to mentor a group of young Senegalese to make it free software developers and providers of ICT services by the organizations of the civil society [28]. Jokkolabs works to support ICT communities by targeting multiple creative sectors, not just techies and open source geeks. Finally Coders4Africa is a not-for-profit with a mission to create hubs and labs across Africa where technologists and others can receive advanced training and develop ICT tools that address community needs [29]. All these projects, though not well coordinated to increase synergy, witness the era of ICT revolution in Senegal, and particularly in Dakar [30].

Several conferences and forums are organized to assess better ways to extend ICTs development and use in Senegal. The IT Forum Dakar 2015 assessed the national strategy on the digital within the Plan Senegal Emergent (PSE)— Challenges of a digital city (Diamniadio) [31]. The Research and Trial Center "Centre de Recherche et d'Essai (CRE)" under the Ministry in charge of Scientific Research & Higher Education provides an interface between citizens and the Research & Development sector and use ICT as a main activity. As at October 2014, 17 research centers are already installed and ten more were due to be installed during 2015. There is the Scan-ICT project carried out by the Research Centre for International Development Research Centre (IDRC) in collaboration with the United Nations Economic Commission for Africa (ECA). This is an ambitious proposal with long-term aims to mobilize the support needed to create a phased comprehensive African capability to collect and manage key information needed to support investment increasingly important technologies information and communication technologies (ICT) to help African countries become an Information Societies.

33.4.2   The Rise of Digital Urban Centers

It is in the ICT revolution momentum that the Government of Senegal has initiated the creation of urban centers in the outskirts of Dakar in order to decongest the city. The National Territorial Development Planning classifies these urban centers in three categories: *Urban centers of the "Massif"* structured around national sport centers and an international exposition center; *Coastal urban centers* structured around coastal touristic areas and; *Eco urban centers at the "Lac Rose"* characterized by the presence of microorganisms and mineral elements [32]. Among these urban centers, features the Urban Pole of Diamniadio, which is already under implementation as part of the Plan Senegal Emergent (PSE), representing the first sustainable city model with the integration of climate risk resilience. The government is also putting in place an ambitious project of a technology park in Urban Pole of Diamniadio, called "Diamniadio Technology Park". The park is based on the Silicon Valley model and intends to promote data revolution and higher education centers. The Urban Pole of Diamniadio is also among the pilot cities of the National Sustainable Cities Initiative (SCI) that supports integrated climate resilient urban planning and management at national and local level. The SCI is part of the Sustainable Cities Programme launched by the Global Environmental Facility (GEF) in 2015 (Fig. 33.2).

These urban centers are not created to depend on Dakar, but to be the engine of the development of Dakar, and to the rest of country [34]. Unlike Pikine, whose creation and growth during the colonial and post-independence periods where the poor were politically forced to move to the suburbs without adequate planning,
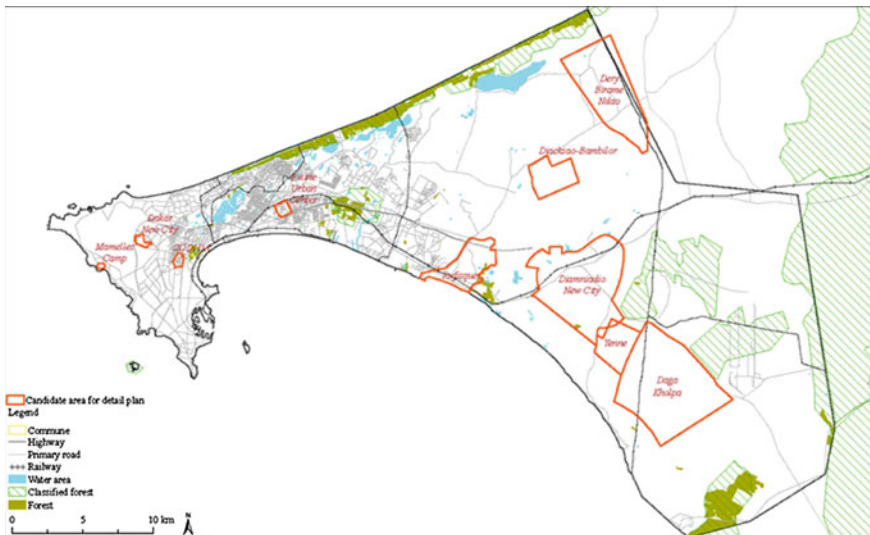
Fig. 33.2 map of the region of Dakar with the new urban centers. *Source* [33]
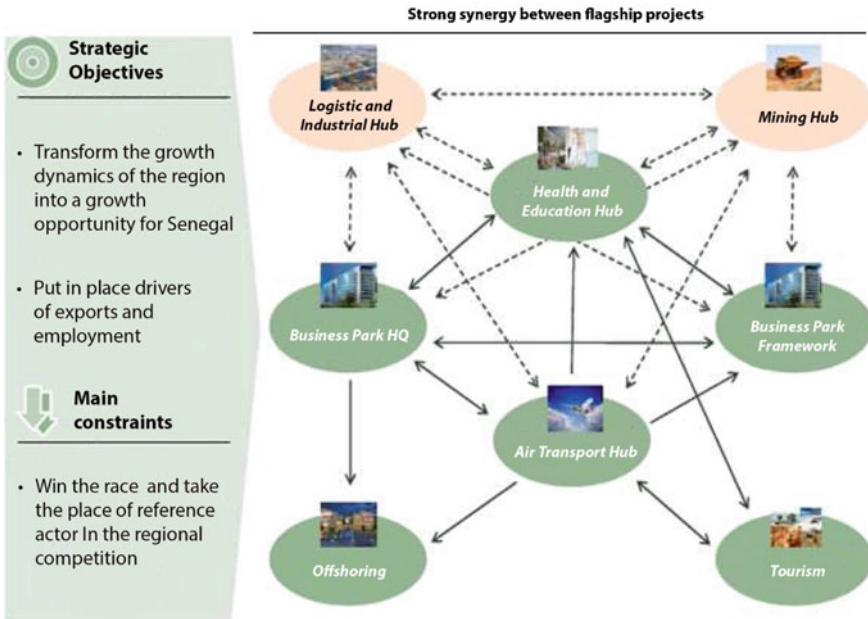
Fig. 33.3 Flagship projects of the PSE "Plan Senegal Emergent". *Source* [35]

provision of basic infrastructures and secure land tenure in the new urban centers will offer all basic human settlement prerequisites, and will host socially diverse groups of people (Fig. 33.3).

The creation of these urban centers promotes mixed land use approach in the sectorial as well as social aspects. Mixed land use approach has proven efficient with high economic, social, and environmental returns. It has various social benefits by improving accessibility to services and urban amenities for a broader segment of the population, and increasing housing options for diverse household types. It also promotes walkability to access services; this has, in turn, social and health benefits. In addition to promoting mixed land use, the creation of the new urban centers also promotes public transport in the combination of spatial planning and transport policies. This would reduce people's need to travel; improve travel conditions with affordable and efficient public transport options; and manage supply and demand traffic to curb congestion, which is a major barrier to productivity and a headache for residents [36].

When these urban centers integrate the sustainable, inclusive and prosperous city model (Fig. 33.4), they will represent the first generation of smart cities in Senegal. Smart city foundation and Smart institutions and laws with the integration of Information and Communication Technologies, are the key pillar to the various other dimensions of a smart city. Infrastructure development includes transport, energy, school, and health in addition to the basic infrastructure elements of the city
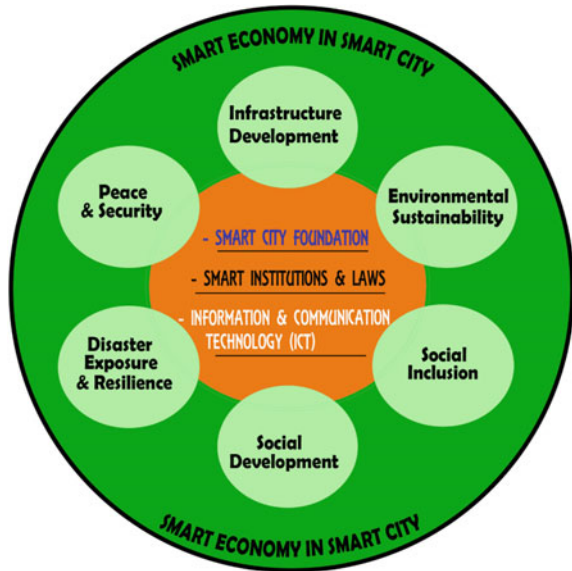
foundation: water facilities, household energy sources, sanitation systems, and solid waste and water waste management. Environment sustainability is composed of elements of energy, transport, building, and pollution. Social inclusion includes aspects of participation in decision making as well as according all city residents equal opportunities for smartness. Social development is composed of elements of education, health, public spaces, and social capital. Disaster exposure and resilience incorporates elements of exposure, mitigation, and adaptation to various disasters such as flooding, droughts, storms, and earthquakes. Peace and security incorporates all forms of violence and conflicts, including domestic violence, violence in public places, crime, armed conflicts, terrorism, and policing. An insecure city limits opportunities for investment and economic growth and cannot be a smart city. Digital urban centers reinforce Senegal's commitment to the sustainable development goals (SDGs) and the Conference Of Parties (COP1) in 2015 [37].

With the creation of digital urban socially, economically, and environmentally integrated urban centers, the urban landscape is featuring the digital urbanization with the end of big cities and the rise of digitally served towns and villages. Dakar may remain the only Senegalese agglomeration with a population of more than 1 million. With the development of ICT, all the advantages associated to large cities with high densities, such as economy of scale, agglomeration of economies, diffusion of ideas, and innovation will be obtained through digital towns and villages interconnected through the Internet. In this situation the planning of settlements may take into consideration the planning of other settlements; this calls for territorial planning which goes in tandem with inter-city cooperation. Occupations are also becoming more technology intensive, and analog economic jobs are giving way to digital economic jobs [39]. Though, this transformation is just starting in

Dakar as in many developing countries, its development is irreversible, and we must anticipate living in a perfect digital world by 2050 as Senegal is committed to the development and use of ICTs. The PSE that has the ambition to create six urban centers must anticipate in strengthening the smartness of Dakar through the development and use of the ICT in the metropolitan. Many villages and towns in Senegal are already in the digital age, starting with the use of mobile telephone with its financial transaction feature.[1]

ICT alone cannot make a city smart; it is the way it is integrated in the city fabric that will determine the city smartness. Today, it is possible, with the ICT revolution, that settlements be connected and form virtual dense settlements offering economy of scale and agglomeration of economies. To create urban centers and decongest Dakar, it is important to promote inter-municipality cooperation. Cooperation between settlements is essential in order to create synergy between them and boost their economy and the economy of the entire Dakar agglomeration. ICT will be crucial to enhance this cooperation between cities and create digital urban centers as illustrated in Fig. 33.5. These digital urban centers will be connected via the Internet for their commercial, financial, administrative, and social activities. Indeed, digital towns and villages will be the future of human settlements development. Making people to buy and sell products beyond geographical boundaries, ICT reduces the cost of transactions by a large margin and opens remote areas to new opportunities. In terms of job density these urban centers can be denser than analog cities that are not able to expand their service outside their geographical boundaries. Through ICT, it is expected that these urban centers have access to innovations and participate in democratic debates. Finally, the creation of these digital urban centers will foster economic development without damaging the environment; there will be less consumption of land for private proprieties, less use of motorized means to access and to deliver service.

The green panel of Fig. 33.5 illustrates a situation of mixed land used or alike where services are walking distance from residence (threshold to be determined). Here people can walk, drive and use ICT, *but walking along with the use of ICT to access services is highly recommended*; the red panel illustrates the situation where services are far away from residence, in a distance making it impossible for people to effectively walk to reach most services, but are in a reasonable distance (threshold to be determined) where people can use motorized means of transport with the possibility to also use ICT; and the third scenario with the blue panel illustrates a situation where the services are very far (threshold to be determined) from residence making it impossible for people to use motorized means of transport

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[1]From June to August 2015, the Programme of GORA Corp was able to visit 17 municipalities of the Department of Louga in Senegal, where the communication in meeting arrangement between the GORA Corp's New York Office and the municipalities were facilitated through the use of mobile telephone. GORA Corp is presently working with these municipalities with the creation of open online information system. This shows the digital urbanization will go beyond the government initiative and will make Senegal digitally urbanized much earlier before the predicted figures by national and international agencies.
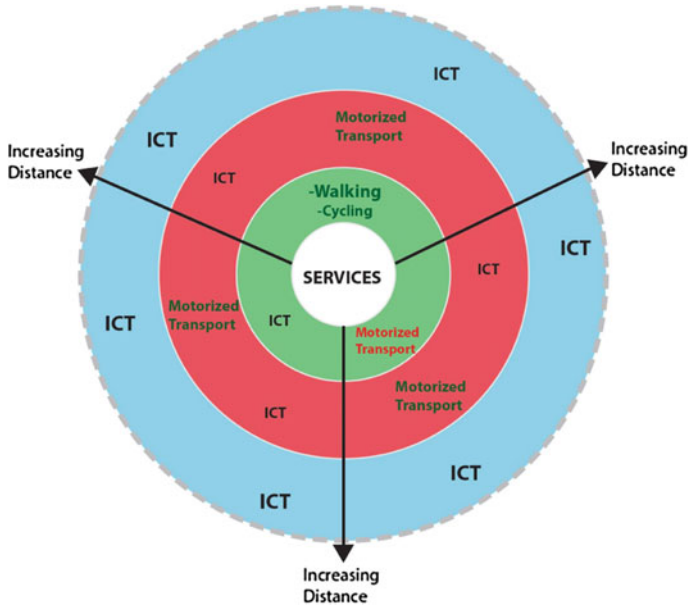
Fig. 33.5 Planning and managing the urban pole to decongest Dakar and to be a sustainable city model connected to Dakar and the rest of the country through walking, non-motorized, ICT means. *Source* [40]

every day to services, here the only option remaining is the use of ICT to effectively reach services. In all situations, the use of ICT will ease access to services and take city toward smartness.

The opportunities for ICT to support the overall transport challenges and opportunities are enormous. Rapid evolution of ICT technologies is driving the expansion of real time passenger information (RTPI) systems for urban transport services. RTPI provides accurate information on actual departure and arrival times and service disruptions, enabling passengers to plan more-efficient trips [41]. National and local authorities can also build awareness on "Intelligent Transportation" with the integration of ICT to address transport challenges. The ICT revolution with the rapid development and use of Internet, digital mobile communication, and "big data" analysis enable to create a less costly and more powerful "intelligent transport systems" (ITS) [42]. The ITS have a greater potential to more efficiently manage transportation assets, improve road safety, reduce traffic congestion and travel time. This will boost economic productivity and reduce greenhouse gas (GHG) emissions.

The creation of these smart, digital cities will give consideration to the protection of watersheds and public spaces, and the development streets that are people friendly and that do not promote motorized means of transport. With increased digital mobility, streets can be given back to people as public spaces. With an extensive use of ICT to access to services, there will be few cars than before in the

road making streets friendly and healthy for walking and cycling. Streets can be planned and designed as public spaces [43] to serve communities for their social interactions as well as mobility. Hence, they can promote infrastructure development, enhance environmental sustainability, support high socioeconomic development, and promote social development, equity, and social inclusion [44]. In a long term, it will reduce emissions of CO_2 and promote the creation of low carbon city, reduce land degradation, and promote biodiversity. The planning of the new urban centers also implies that people will enjoy secure tenure, that help to make their investment work for them as a shelter as well as the financial asset, boosting the economy scale. ICT will also play a significant role in digitizing the land tenure system and make it transparent. This will reduce transaction costs and time and will increase trust. With an open platform, buyers and sellers are linked; they can negotiate and settle with trusted financial institutions. In this way, a smart land tenure system is created and being part of the economic and financial market.

To benefit from all these innovations and good practices, there is need to sustain the liberalization of ICT in Senegal. Harnessing ICT opportunities requires policies that lower the barriers to competition and market entry, in addition to investments in infrastructure and skills. Only then will firms use new digital technologies more intensively and effectively—and only then will Dakar and the country in general avoid falling behind. This will require investments in skills and infrastructure as well as reform on regulatory barriers by overcoming vested interests to encourage all firms to compete by investing in the ICT. This also involves overhauling regulatory regimes in the digital economy, especially in sectors such as transportation where online and offline firms increasingly compete [39]. All this will require a strong rule of law, efficient bureaucracies, government stability, lack of corruption, and a stable business environment that encourages domestic and foreign investors. With functioning financial institutions, land/housing and employment form the driving triangle of economic growth and prosperity. In cities where the housing, employment and financial market are formal in a transparent, administration and governance, the relationship between employment and housing have been straight with the former being a driver. Creating conditions of this triangle will move Dakar toward a smart city, a driver of the "Plan Senegal Emergent".

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Part XIII
South Africa-Cape Town

Chapter 34
Transforming the City of Cape Town from an Apartheid City to an Inclusive Smart City

The Long March to a Sustainable, Inclusive and Prosperous City

Paida Mhangara, Naledzani Mudau, Gora Mboup and Dennis Mwaniki

Abstract A smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centric approach based on three core components and seven dimensions. The three core components are Smart City Foundation, Smart ICT and Smart Institutions and Laws, which in turn are the pillars of the seven dimensions of a smart city: infrastructure development, environmental sustainability, social development, social inclusion, disasters exposure, resilience, and peace and security. The three components together with the seven dimensions make a smart economy. Infrastructure development has several elements across various social, economic and environmental dimensions. Cape Town's historical apartheid growth has been characteristic of social, income and city foundation inequalities which have created uniquely distinct human settlements—rich suburbs with adequate services and opportunities, and poor and informal neighbourhoods with acute shortages in core urban services. Since the end of apartheid, Cape Town has however made deliberate and directed efforts to promote social inclusion through policy incentives, physical public and social space development, and promoting equitable access to basic services. The city has also invested heavily in smart

P. Mhangara (✉) · N. Mudau
South African National Space Agency, Pretoria, South Africa
e-mail: pmangara@sansa.org.za

N. Mudau
e-mail: nmudau@sansa.org.za

G. Mboup
Global Observatory Linking Research to Action, New York, USA
e-mail: gmboup@gora4people.org

D. Mwaniki
Global Observatory Linking Research to Action, Nairobi, Kenya
e-mail: dmwaniki@gora4people.org

growth alternatives which began with the formulation of a smart city strategy in 2000, and which has over the years entrenched smart growth aspects into most sectors of growth, and greatly enhanced efficiency and productivity of the urban system. Today, Cape Town is reaping on its massive investment in information and communication technologies, which have made it Africa's premier international city supplying goods to many cities in the west and offering global business process outsourcing services. The city's deliberate progression towards smart growth has opened huge economic activities for its residents, which will continue to reinforce its position as the Western Cape region's economic powerhouse. This chapter discusses Cape Town's growth as an apartheid city, its city foundation during and post-apartheid and the various targeted smart growth approaches adopted in the city over the last two decades as well as their outcome in creating an equitable and productive urban system.

Keywords Cape Town · Smart city · Smart economy · Smart city foundation · Urban planning · Streets · Public spaces · Basic infrastructure · Infrastructure development · Transport · Information · Communication · Technology · Government

34.1 Introduction

The city of Cape Town is the oldest city in South Africa with recorded continuous settlement dating as far back as 1652. With a population of 3.7 million people in an area of 2461 km^2 [1], Cape Town is South Africa's second most populous city after Johannesburg (4.4 Million) and the tenth most populous city in Africa [2]. Cape Town is the provincial capital of the Western Cape region and the legislative capital (seat of the nation's parliament) of South Africa along with Pretoria, the administrative capital, and Bloemfontein, the judicial capital. Cape Town is home to about 64 per cent of the Western Cape region's 5.8 million population and represents about 80 % of its GDP [1–3].

The city of Cape Town metropolitan economy contributes more than three-quarters of the Western Cape province GDP and therefore dictates the economic growth in the region. The metropolitan region has specifically developed a strong financial and business services sector and has a large retail, wholesale, catering and accommodation sector linked to a vibrant tourism industry, and a rich cultural history—all of which heavily rely on the growth of ICT infrastructure. With an increase in a diversity of "global" opportunities present for Cape Town residents, the level of human development in the city, measured through the Human Development Index (HDI), is highest in the city of Cape Town metropolitan municipality (*measured at 0.74 in 2010*) as compared to the other districts of the Western Cape region [4]. This reflects to the fact that the city residents are able to live long and to have healthy lives, to communicate, to participate in the life of the community, and to have sufficient resources to obtain a decent living. This in turn

increases the city residents' spending power and improves opportunities for economic growth.

However, having been the centre of the apartheid regime in South Africa that lasted from 1948 to 1990, the city of Cape Town has been among the most unequal cities in the world. Although the city's Gini coefficient consistently improved between 2001 and 2010, it increased to 0.67 in 2011/2012 [2], a level higher than all other African cities and only comparable to South African cities such as Durban, Johannesburg and Pretoria.

Since the end of apartheid, different models have however been adopted to make the city more inclusive post-apartheid, the key ones being on participatory planning and design; development of inclusive public spaces; improvement in basic infrastructure provision and public transport particularly to the poor neighbourhoods; and development of policies that encourage inclusive human settlement and trade. As a result, the city was named the World Design Capital for 2014 by the International Council of Societies of Industrial Design [5]; and also named the best place in the world to visit by both The New York Times and The Telegraph [6, 7]. Although Cape Town has made commendable progress since the end of apartheid in 1990, efforts are still needed to create an inclusive smart city, a city which is sustainable, inclusive and prosperous.

The study on Cape Town brings a unique city setting: (1) one where segregationist development (apartheid) has been legally rooted in the city foundation and manifested through urban planning and design, institutions and laws and access to basic services; and (2) followed by an inclusive post-apartheid development through urban planning, housing, social development and economic development. This chapter discusses Cape Town's growth as an apartheid city, its city foundation during and post-apartheid and the various targeted smart growth approaches adopted in the city over the last two decades as well as their outcome in creating an equitable and productive urban system. The analysis will be based on the concept of smart economy in smart city developed for the four African cities covered in this book which are Cape Town, Nairobi, Dakar and Senegal.

34.2   The Concept of Smart City Economy in Smart City in the African Context

As noted in Chap. 1, The Smart City concept is built on a combination of ideas associating ICTs with improvements in the functioning of cities in terms of competitiveness, efficiency and innovation in the fight against poverty, social deprivation and poor environmental management. In this regard, the notion of smart cities and its implementation can be associated with sustainable urban development, including economic development. Furthermore, Chap. 1 defined a smart city as being more instrumented, inter-connected and intelligent. It is "a knowledge-based city that develops extraordinary capabilities to be self-aware; functions 24 h and

7 days a week; communicates, selectively, knowledge in real time to citizen end-users for a satisfactory way of life with easy public delivery of services, comfortable mobility, conservation of energy, environment and other natural resources; and creates energetic face-to-face communities and a vibrant urban economy even at a time of national economic downturns".

Referring to Batty et al. [8], Kumar and Dahila [9] presented six interrelated, essential elements that contribute to the "smart city system": (i) smart economy (competitiveness), (ii) smart people (social and human capital), (iii) smart living (quality of life), (iv) smart mobility (transport and ICT), (v) smart environment (natural resources) and (vi) smart governance (participation). Considering that a smart economy is characterized by use of ICT in all economic activities, Kumar and Dahila [9] identified seven characteristics of smart economy, which are as follows:

1. Innovative spirit that finds newer approach to economic activities.
2. Entrepreneurship generated out of individual effort independent of family wealth and inheritance.
3. The ability of the city to create economic imaging, branding and trademark.
4. High productivity of labour and capital.
5. Flexibility of labour market which includes acceptance of labour from outside and devoid of conflicts, and avoiding loss to urban economy by periodic labour unrest.
6. Smart city economy acts as force that creates international embeddedness.
7. Smart economy shows high ability to transform the smart city.

Furthermore, Kumar and Dahiya [9] associated smart economy with other elements of a smart city such as a smart city structure, smart ICT, smart spatial planning and urban design, and smart institutional processes.

A comparative analysis of the concept of smart city presented in Kumar and Dahiya [9] shows that most of the elements of a smart city diversely developed in several studies are also part of the conceptual framework of a sustainable, inclusive and prosperous city developed by Mboup in 2015 [10]. Mboup [10] considers that a smart city is a sustainable, inclusive and prosperous city that promotes a people-centric approach based on two core components: smart city foundation and smart institutions and laws. These two components are the pillars of the other seven dimensions of a smart city: infrastructure development, environmental sustainability, social development, social inclusion, disasters exposure, resilience, peace and security, which in turn make city economy smart. Points of difference are the aspects of social and human capital developed in Kumar and Dahiya [9] concept paper which is lacking in the conceptual framework of a sustainable inclusive and prosperous city of [10]. In addition for Mboup [10], there are two core components for a smart city: a smart city foundation and smart institutions and laws. These two elements are presented in the Kumar and Dahiya [9] as spatial planning and urban design futures, and governance, respectively, but are presented at the same level of the other components of smart city. Mboup [10] also introduces other important elements for a city to be smart: disaster exposure and resilience as well as peace and

security. In the study of smart city economy in Africa, while we will consider the concept of smart city presented by Kumar and Dahiya [9] as the starting point, we will reconceptualize the smart city based on the conceptual framework of a sustainable, inclusive and prosperous city developed by Mboup [10].

For the African cities covered in this book, a smart city is viewed as a sustainable, inclusive and prosperous city that promotes a people-centric approach based on three core components—*smart city foundation, information and communication technology (ICT) and smart institutions and laws*. These three core components are the pillars of the seven dimensions of a smart city: infrastructure development, environmental sustainability, social development, social inclusion, disasters exposure, resilience, and peace and security. The collective of these components and dimensions constitute a smart city economy (Fig. 34.1).
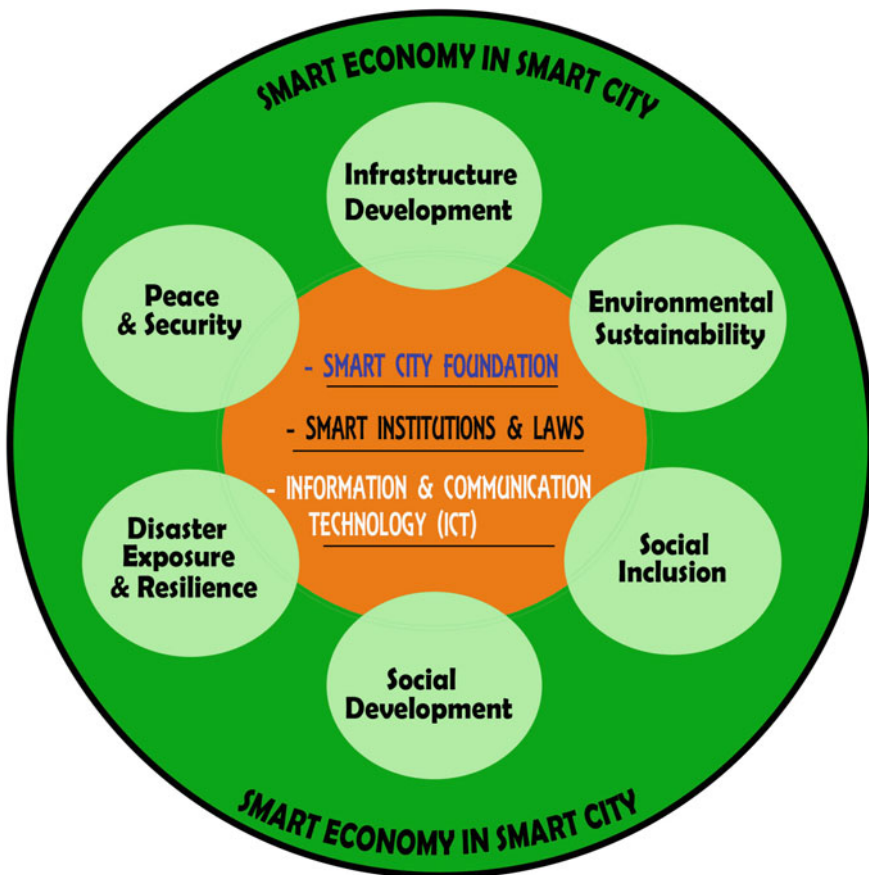
Fig. 34.1 Conceptual framework—smart economy in smart cities in the African context. *Source* [10]

Infrastructure development complements the basic infrastructure services under smart city foundation and extends to actual investment and advancement of services such as transport, ICT, industrial energy, education and health. **Environment sustainability** is comprised of elements of energy, transport, building and pollution. **Social inclusion** includes aspects of participation in decision-making as well as according to all city residents equal opportunities for growth and prosperity. **Social development** encompasses elements of education, health, public space, social inclusion and social capital. **Disaster exposure** incorporates elements of mitigation and adaptation to various disasters such as flooding, droughts, storms and earthquakes. **City resilience** is composed of elements of city foundation, environment, social capital and social development. **Peace and security** deals with all forms of violence and conflicts, including domestic violence, violence in public places, crime, armed conflicts and terrorism. An insecure city limits opportunities for investment and economic growth and cannot be a smart city.

A smart city foundation is composed of three elements: urban planning and design, land policies and basic infrastructure, all of which integrate ICT into their developmental and operational architecture. For a city foundation to be smart, it must be inclusive at the onset of the urban planning and promote mixed neighbourhoods where social clustering is discouraged. Having all the poor living together creates slums and fuels instability and insecurity. Inclusive urban planning eases access to basic services (water, sanitation, housing, education and health) and to decent employment for all. A key element of smart urban planning is a smart street network that reduces travel time and encourages walking and social interactions. Smart urban planning enhances infrastructure development, environmental sustainability, economic and social development; makes cities resilient and prepared to overcome natural disasters; and promotes mixed neighbourhoods where services are walking distances from people's residences. ICT plays a crucial role in promoting a smart city foundation, by enabling inclusiveness in planning, policy and infrastructure provision processes such as through public participation, as well as creating enormous non-physically-limiting opportunities to all city residents. Basic infrastructure constitutes access to urban basic services such as water, sanitation, housing and energy (Fig. 34.2).

34.3   Cape Town's Historical Apartheid City Foundation

The City foundation of Cape Town has historically been guided by a segregationist ideology manifested through institutions and laws, urban planning and design, and access to basic services and amenities. The history of segregation across race in the city dates as far back as the mid-seventeenth century when Jan van Riebeeck, leader of the first Europeans to settle in South Africa, proposed the typically Dutch
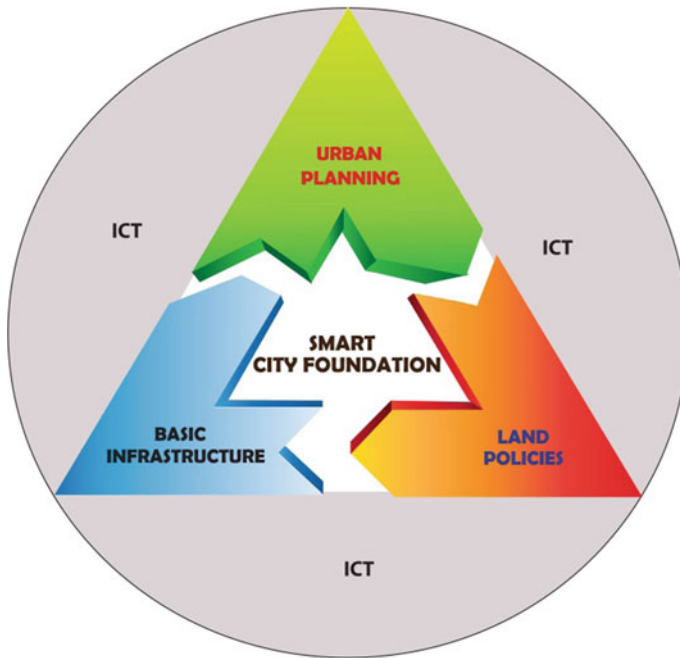
Fig. 34.2 Smart city foundation. *Source* [11]

solution of digging a canal across the Cape Peninsular to separate the white paradise as a self-contained island, cut-off from the rest of "darkest Africa". Unable to realize this ambitious project, he instead opted to plant a bitter almond hedge to keep the blacks out of his settlement [12, 13]. Systematic segregation would continue into the late-nineteenth and early-twentieth centuries, effected through manipulation of urban planning and design principles, and sustained through a diversity of institutional set-ups and various laws and policies [12].

Legislation aimed at preventing land acquisition by "natives" and limiting their movement within the city of Cape Town existed as much as 25 years before the official commencement of the apartheid era in 1948 [12]. The 1922 Stallard Commission, tasked with bringing black workers and consumers into cities while still keeping them separate from whites, and the subsequent Urban Areas Act of 1923 which ordered the removal of Africans from desirable city centres to less desirable "locations" are perhaps the oldest reflections of separationist development in Cape Town [12, 14].

34.3.1 Progressive Institutionalization of a Racial, Social Exclusion: An Apartheid City Foundation

Progressive institutionalization of a racial, social exclusion gave birth to the grand apartheid (separate development) in 1948, a system that was as much an economic and spatial dispensation as it was a political and legal one [15]. This new system enshrined in law the systematic categorization and segregation of the population based on race, with the white group accorded the highest privileges and powers [16]. Laws, policies and planning guidelines were put in place to create clearly demarcated and minimal-interaction white and non-white areas throughout the city. The first key legislation, effected as the Population Registration Act of 1950, officially divided South Africa into four racial groupings—"White", "Coloured", "Asian" or "Native" (African) and requiring all residents to register their race to ease official segregation. In this categorization, the natives had the least rights to the city, and from 1951 a permit system was established to control property transfers and changes of occupancy from members of one race to another. This had serious effects on the businesses of many African and coloured shop owners and artisans, who were suddenly prevented from operating in "white" areas [16–18].

34.3.2 Use of Urban Planning and Design to Mainstream an Apartheid City Foundation

The Group Areas Act of 1950 brought forth strict zoning principles based on a misrepresentation of both Ebenezer Howard's garden city movement and Le Corbusier's Ville Radieuse planning approaches [12]. The adopted zoning models twisted the core principles of functional segregation put forward by the two visionaries to achieve racial segregation, in which the whites would be situated in the most advantageous spaces and the non-whites settled in the least desirable areas [12, 16, 17, 19] (Fig. 34.3)

To achieve the "desired" racial zones, massive forced evictions and relocations were carried out in which Africans were relocated to peripheral "orderly" townships designed along the lines of military barracks, in which grim "matchbox houses" were laid out in strict grids of wide streets and surrounded by a fence, with only two or three points of entry. This, it was believed would mould the black labour force into an orderly class, would be easily contained if need be by sealing off the neighbourhoods with minimal effort [20, 21]. Cape Town's District Six, an informal settlement located near the city's harbour and downtown is the most infamous case of such forced removal. When the district was declared a "whites only area" in 1966, all its 60,000 multi-racial population was forcefully removed and relocated to racially homogenous Cape flatlands 25 km from downtown [16].
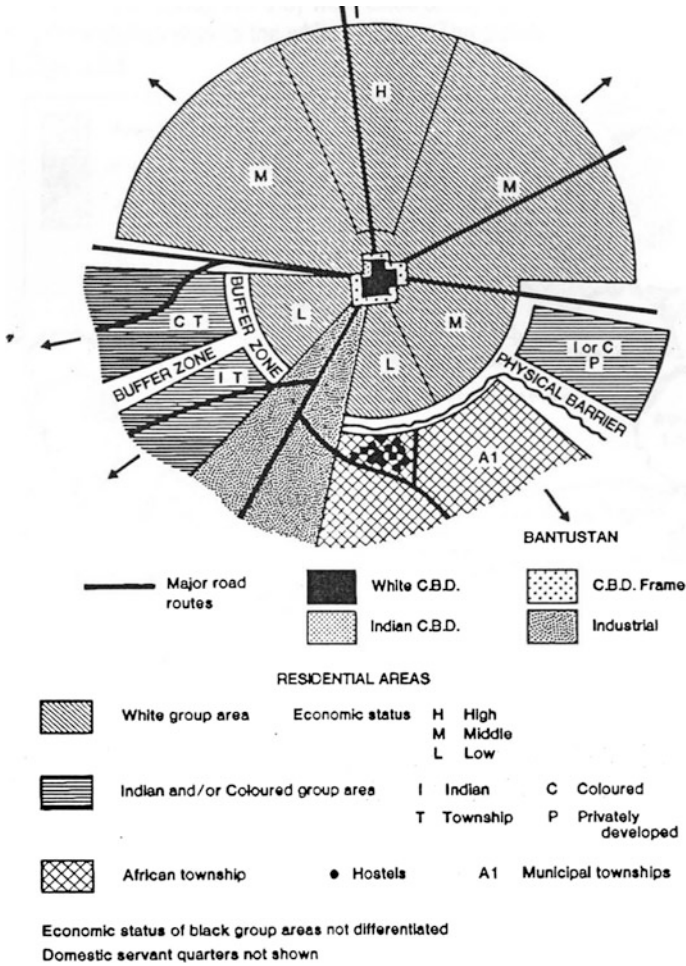
Fig. 34.3 Apartheid segregationist urban planning using strict zoning principles. *Source* [19]

The resultant "zones" from this policy directive and its planning translations gave rise to residential neighbourhoods that prevailed throughout the apartheid period, and that have shaped Cape Town's urban form to date.

34.3.3 An Apartheid Access to Basic Infrastructure and Services

The separate Amenities Act of 1953 included a clause stating that separate facilities no longer had to be "substantially equal", allowing the government to provide better

facilities to whites. Every amenity imaginable was subject to racial categorization, from taxis and ambulances to parks, walkways and parking spaces. Beaches were strictly segregated with those offering more facilities dedicated to the whites, and the blacks only allowed into the unattractive coastal areas. Cape Town's central train terminal is perhaps the most explicit concretization of apartheid ideology by the central government through this act. The terminal was built in 1966 as two trains—one for white and one for non-white commuters; and reverse engineered to bring the different races to the city from segregated suburbs without ever crossing paths [16].

34.3.4 Apartheid Social and Economic Development Through Exclusion to Education, to Decent Employment and Other Social Services

Other significant laws that promoted segregation in the mid- to late-1950s were the Native Laws Amendment Act (1957) which prohibited Africans from going to social places such as churches in white areas, and laws on higher education that designated some universities as mostly whites campuses, with very minimal admission of non-whites. Section 10 of the Natives Act required Africans to work continuously in the Cape if they were to retain their right to live there. Between 1954 and 1962, more than 18,000 men and 6000 women were endorsed out of the city for not continuously working there [15]. Subsequent policies adopted in the 1960s promoted "grand apartheid", by establishing "independent tribal homelands" and making it possible to exclude blacks from a right to live in South Africa. A rule was imposed in 1965 by which African workers had to return to their "homeland" at the end of an employment contract, then reapply to work in the Cape Town area. This was supposed to prevent any growth in the numbers of black "permanent residents" in the city.

34.4 The Long March to Freedom and Social Inclusion: Transforming Cape Town to an Inclusive, Smart City

With an apartheid city foundation characterized by apartheid institutions and laws, apartheid urban planning and design, and apartheid access to basic infrastructure and services, the excluded people of Cape Town had to fight for their social freedom. Both peaceful and violent protests were held in the city between 1950 and 1990 when apartheid was officially abolished, each with varied outcomes.

Protests held during the 1950s to push for social inclusion in aspects such as voting were generally unsuccessful both as a result of non-unified campaigns and also as a result of draconian laws aimed at suppressing any opposition to the

government. Large-scale anti-pass demonstrations held in the 1960s were countered with suppressive measures such as declaration of a state of emergency, banning of social movements, imprisonment and exiling of leaders, and empowerment of the police, which made it impossible to legally protest against the system.

With mounting economic hardships, international pressure and increased local protests throughout the 1980s, the government secretly began negotiations with Nelson Mandela, who had been jailed since 1964. Although police still used violence against peaceful protests, the momentum of the protests was unrelenting and would culminate in mass voting against the government by white Capetonians in the 1989 elections, the release of Nelson Mandela in 1990 and the subsequent repealing of segregationist laws. The first multi-racial democratic elections in 1994 won by the African National Congress and the enactment of South Africa's new constitution, which enfranchised blacks and other racial groups, marked the official end of the apartheid system [15].

The dismantling of apartheid in the early 1990s came with calls for inclusive development in South Africa, mostly guided by Nelson Mandela's ideal of a democratic and free society carried in his 1964 speech:

> "During my lifetime I have dedicated myself to this struggle of the African people. I have fought against white domination, and I have fought against black domination. I have cherished the ideal of a democratic and free society in which all persons live together in harmony and with equal opportunities. It is an ideal which I hope to live for and to achieve. But if needs be, it is an ideal for which I am prepared to die. Let there be justice for all. Let there be peace for all. Let there be work, bread, water and salt for all. Let each know that for each the body, the mind and the soul have been freed to fulfill themselves". [22, 23]

Major strides have been made especially in the areas of policy and opening up of the physical space to promote social integration in the living and public settings in the city as will be discussed in the subsequent suctions. For example, Cape Town is among the first African cities to initiate smart growth through policy directives, as evidenced by the 2000 Cape Town smart city strategy and its subsequent projects which have greatly shaped its transition towards inclusivity and enhanced productivity.

In the effort to be a liveable city, the city of Cape Town has already developed Integrated Transport Plan that accommodated pedestrian and cycling lanes as well as parks and other public spaces. Furthermore, the city promotes car-free zones to create safe public spaces where people of all races interact.

The Cape Town Densification Strategy is another policy the city has adopted in the recent past to promote sustainable, inclusive and smart growth. The strategy, whose aim is to promote higher densities in areas well served with public transport and other social amenities and facilities, has already put in place densification guidelines for the achievement of a more productive city. Once fully implemented, the policy will make the city more compact and easy to layout infrastructure services; more economically productive owing to the creation of threshold populations for businesses to grow and thrive; create more social and spatial spaces where different races can interact; improve housing and tenure options; promote urban place making and improved security; and promote environmental protection; all of

which are central components of a smart city. Other policies that are promoting the growth of a smart Cape Town include, among others, strategies on public transport, provisions for public participation in all urban planning processes, infrastructure service provision and housing upgrading in the poor neighbourhoods, creation of public and open spaces in all city areas, clean energy policies and creation of economic opportunities in which the informal economy can thrive and improve the lives of a majority of the city residents with little investment.

The various city policies, plans and development projects have collaboratively and continuously worked to make Cape Town sustainable, equitable and economically vibrant, particularly by promoting improved access to economic opportunities, integration and inclusivity, resilience, adaptiveness, interconnectedness, land-use intensification, environmental protection and development control, all of which are core components of smart city economy. As a show of the city's progress with inclusive planning, the city received the 2014 World Design Capital award for its innovative use of design as a tool for social, cultural and economic development. The award particularly applauded the city's innovation in public transport and other projects such as the Green Point Urban Park and the Buitengracht Pedestrian Bridge; community development projects, such as the Violence Prevention through Urban Upgrading initiative as well as urban gardening projects; and the revolutionary ICT systems being used to help run the city more effectively. There is however still a huge need to align the various policies and processes into a collective system, which could greatly benefit from smart governance approaches.

34.5   Development and Use of ICT to Transform Cape Town to a Sustainable, Inclusive and Prosperous City

34.5.1   Milestones in the Creation of a Smart City Through ICT

Cape Town has historically experienced major setbacks in the aspect of social segregation, but the city has over the past two decades made major strides towards promoting inclusive and smart growth. The efforts towards smart and intelligent growth have been noticed and honoured in awards such as the World Design Capital for 2014, the Earth Hour City Challenge (EHCC) title of Global Earth Hour Capital in 2014[1] from the World Wildlife Fund (WWF); the SERI special achievement in GIS award in 2013, the computer honours twenty-first century achievement award in 2003, the Bill and Melinda Gates Access to Learning Award for Smart Cape in 2003, and the ICT achiever's award for e-government in 2002 [5, 24].

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[1]Over 160 cities from 14 countries were among the competitors.
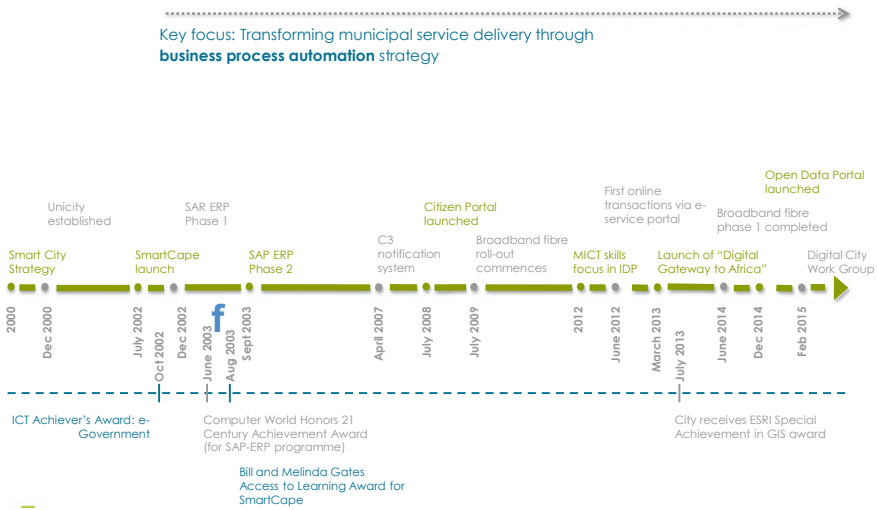
Fig. 34.4 City of Cape Town's steps towards becoming a smart city. *Source* [24]

The transition towards smart growth for Cape Town has however not been haphazard and uncoordinated like in many other African cities where ICT adoption and penetration, and evolution in various smart city systems go side by side with informal growth. In Cape Town, there has been a deliberate approach and efforts (both investment and policy) dedicated towards smart growth. The city has made major strides towards smart growth, through key interventions such as development of a smart city strategy in early 2000, launch of the SAP-ERP programme in 2002, introduction of the C3 notification system in 2007, roll out of the city's broadband fibre in 2009, launch of the city's open data portal in 2014, creation of the digital city working group in 2015 and launch of projects such as MICT skills focus on IDP, online transactions and the digital gateway to Africa project (Fig. 34.4). Through these initiatives, the city's transition has greatly evolved and expanded to incorporate many aspects of the urban system as discussed in the following paragraphs.

34.5.2   Cape Town's Smart City Strategy

The Cape Town smart city strategy introduced in 2000 aimed to reposition Cape Town as a leading player in the new global knowledge economy. The strategy, which was designed to transform local governments into smart growth leader, has not only transformed the way that local government works and delivers its services, but also transformed the way that the entire city operates. Instead of being a technical tool just for IT experts and developers, the ICT was embedded across all city departments and strategies [25].

The smart city strategy and its projects aim to reduce poverty and inequality in the city by empowering social policies and programmes and reducing social and gender gaps in education and employment. It has helped to address key questions pertinent to attainment of inclusive smart growth, which included [25] the following:

– What leadership is necessary to establish competitive advantage in a digital economy and society (smart city leadership)?
– What must be done to ensure that our policy and regulatory environment supports the development of a smart city?
– How will information technology lay the foundation for the building of a new flexible and responsive organization and enable the organisation to continually improve in its efficiency and effectiveness in delivering its programmes and services (administrative/e-government strategy)?
– How do we use IT as an instrument to foster the economic and social development of the city (development strategy)? and
– How can IT be used to ensure/enhance good governance (digital democracy)?

The strategy considers high customer service as prerequisite along with ICT solutions supporting government to be a more "self-service" model in an efficient and less costly operational environment. It focuses on transforming the way the local government delivers its services through five pillars: leadership, development strategy, policy and regulatory environment digital democracy, and administrative/ e-government (Fig. 34.5).

Fig. 34.5 Cape Town smart city strategy framework. *Source* [25]

The five focus areas of the strategy as presented in the Fig. 34.5 are as follows:

- **Leadership**—in technology policy and strategy should be located at the most senior levels in the organisation, both politically and administratively. Other leadership areas are in business, in interaction with citizens, in non-profit organisations and in other collaborative initiatives.
- **Development strategy**—ICTs should be used to foster the city's economic and social development, through the growth and retention of the ICT industry, creation of employment potential through the use of ICT as a skill and the use of ICT for social development.
- **Policy and regulatory environment**—the entire city's legislation needs to be reviewed, and all new legislation passed by the city needs to be designed to ensure digital age appropriateness.
- **Digital democracy**—the city should make a concerted effort to ensure more equitable access to, and spread the benefits offered by ICTs to all. For local government, communities and business to take full advantage of the benefits offered by ICTs, there is an overall need for infrastructure, skills development and planning.
- **Administrative/e-government**—ICTs should be used as strategic tools to transform local government to create a highly efficient and effective organisation, reduce transaction costs, allow service to citizens anywhere and anytime and to allow citizens to deal with local government services in an integrated manner, via one-stop shops.

Within this framework, the "**Smart City**" **Strategy of the City of Cape Town** represents an example not only of successful implementation of an ICTs-driven reengineering of the city government, but a way to address the twin challenges of poverty alleviation and globalisation of the overall provincial government, by identifying the way that ICTs can enable economic and social development and enhance good governance, in the city and in the province, but also in consistency with the national and regional objectives [25].

In order to realize these objectives, the city of Cape Town elected to implement an ERP system, using the proprietary solution SAP. The SAP-ERP has enabled the city to manage its resources more efficiently and help create a citizen-focused environment. The city's ERP programme aimed to capitalise on the output of the organisation by optimising the way it deploys its resources, aligning business processes and by exploiting appropriate ICTs. The overall impact of the new system has been felt across three areas, organizations, human resource and the citizen levels [25].

34.5.3   The Digital City Working Group

In 2015, the city of Cape Town has introduced the Digital Working Group to identify broad focus areas for the city's approach to digital competitiveness,

identify the city's objectives in relation to each focus area, identify the short- and long-term initiatives that could support those objectives, develop an implementation framework that identifies primary and supporting role players who will be responsible for implementation, identify indicators to assess the impact of the strategy, ensure integration and avoid duplication. The working group focuses on the aspects of digital government, digital inclusion, digital economy and digital infrastructure as follows [24]:

– The **digital government** component aims to drive transparency, enhance service delivery, promote citizen engagement through ICT and enable the city to be a caring and responsive government;
– The **digital inclusion** component aims at closing the digital divide by promoting digital access, improving digital skills and driving digital initiatives that enhance quality of life;
– The **digital economy** component aims at creating an enabling environment for the growth of tech-enabled enterprises and maximizing its job creation potential and, in the long term, to make the city of Cape Town a regional tech-hub and growth in the digital economy;
– The **digital infrastructure** component, as a foundational enabler of the other three pillars of the strategy, aims at developing and using digital solutions to enhance the effectiveness of critical city infrastructure and make Cape Town the most connected city in Africa with the lowest telecommunication service tariffs.

34.5.4   State of ICT in the City of Cape Town

The smart city strategy is supported by a robust, well-run and up-to-date ICT infrastructure based on a wide area network (WAN) that provides connectivity to city-wide workstations in several administrative buildings linking officials through several custom-developed applications in conjunction with commercial software packages. In order to better coordinate the Cape Online Programme implementation, the information technology (IT) and e-government units of the Provincial Government of the Western Cape joined in 2004 to form the Centre for e-Innovation (Ce-I). To improve the region's "ICTs backbone", the Ce-I is anticipating the incorporation of "next-generation" technologies aiming to realise an ambitious programme of integration of the current local area networks (LAN) and the WAN, provided by the State IT Agency (SITA), and to prepare to be a "model" for future IT governance planning. The centre for e-innovation has also established partnerships with various government entities to ensure smooth flow of its operations and to promote service infiltration to all government levels [25]. Furthermore, the development and use of ICT has also been noticeable at many sectors from private and individual initiatives. In 1998, the **Cape IT Initiative (CITI)** was launched as a not-for-profit networking and cluster development organisation that brings together people, ideas and capital in the Western Cape ICTs' sector. CITI's

goal is to promote Cape Town as a global IT hub and gateway into Africa, and enhance the creation of jobs and prosperity. Its aims are to enhance the development and collaboration in the ICTs cluster, promote the ICTs industry and make CITI the pre-eminent industry information source [25]. The objectives of CITI are to identify, facilitate and assist entrepreneurial ICTs business in the province through research, networking, collaboration, promotion and marketing activities. Since its founding, the number of IT companies in the province has increased from 248 to over 1200. With a total employment of about 27,000 people, IT companies are the second largest employer next to tourism in the province [25].

Based on numerous ICT initiatives, Cape Town is a base for IT and manufacturing companies in the Western Cape region. The share of the city's population with access to internet increased from only 14 % in 2002 to 49.3 % in 2011 [1, 26]. With this growth, continued investment in the ICT sector by the local authority and the subsequent progress in ICT, media and call centre industries, Cape Town became the first African city to enter the Intelligent Community Forum's "Smart21 Communities" in 2008. At a provincial level, internet access in the Western Cape is higher than the national average with 38 % computer with ADSL internet access in 2015 compared to the national average of 22 and 93.8 % accessing internet via a mobile phone, compared to a national average of 70.8 % [27]. The percentage of people with access to internet using ADSL increased from 20.3 % in 2012 [28].

In its commitment to build an opportunity city, the city is heavily investing in the broadband infrastructure programme. The programme was the single biggest capital expenditure item in the corporate services budget for the 2012/2013 financial year with an allocation of R61 million, and an additional R152 million for the 2013/14 and 2014/15 financial years. The 7- to 10-year broadband project is greatly expected to reduce telecommunication costs, improve connectivity speeds, link different sectors of the city via high-speed networks and improve the city's competitiveness both locally and internationally. The network is further anticipated to create and establish 250,000 jobs throughout the Cape Town metropolitan area, improve business communication, facilitate high-speed data communications to municipal facilities and ultimately help drive economic growth, development and inclusion—especially in previously marginalized areas [29]. The project's plan to avail the network's spare capacity to the private sector, internet service providers and telecommunication companies will further promote outsourcing and stimulate competiveness among businesses and in the telecommunications market, and in turn help reduce costs to end-users. After initial investment in the project, the city's corporate network is already one of the fastest municipal networks in Africa and subsequent expansion into previously unserved areas will directly and meaningfully stimulate economic growth by supporting entrepreneurial activities.

As the core of smart cities, Cape Town's continued investment in ICT infrastructure and its plans to link both the public and public sectors with high-speed broadband network will not only create a "digitally inclusive and equal opportunity" society in which economic growth is possible, but will also cement the city's place as the first smart city in Africa [26].

34.6 Investment in Smart Transport Enhances Cape Town's Efficiency and Productivity

34.6.1 Cape Town Has Invested in Public Transport, Is Promoting Social Inclusion and Enhancing Commuter Convenience

Transport is the other major area where Cape Town has heavily been investing in, in a bid to create an equal opportunity city. Recent development plans and public policies have emphasized the need to promote the development and expansion of a sustainable public transport system, and improvement of public transport is one of eight key strategic focus areas for the city of Cape Town Integrated Development Plan. The current public transport system measures 0.11 km per square kilometre [30] and consists mainly of rail, buses, the integrated rapid transit (IRT), taxis and minibuses.

Efforts on the provision of reliable public transport in Cape Town started as far back as 1861 when an act was passed that allowed for a company to be formed for the purpose of providing horse-drawn tram services between Sea Point and Cape Town. Over the years, new and emerging alternatives have been incorporated into the city's public transport network to help move the ever-growing population. For example, the Golden Arrows Bus Services (GABS) company, which has been operating the city's bus transport service for more than 150 years today, has a fleet of buses that covers 59.4 million kilometres, conveying 51.8 million passengers annually from the townships and suburbs to the city and major economic centres, at a rate of approximately 220,000 per week day [31]. Information on ticket purchase, routes and bus schedules is available online offering great commuter convenience. Equally, the Cape Town passenger rail system—Metrorail—which started operating in the city in 1863 currently covers 610 km and operates 671 scheduled trains per weekday on 23 routes and 118 stations [32, 33]. The Metrorail has the most comprehensive routes in South Africa.

The Integrated Rapid Transport (IRT) system is perhaps the fastest growing public transport system in Cape Town. This bus service, operated under the "MyCiti" brand, was launched in 2010, shortly before 2010 FIFA World Cup. Myciti currently has a network of 32 km of dedicated road within Cape Town, operates on 36 routes and has more than 600 bus stops [33]. The service, which initially only served the wealthy white neighbourhoods, has steadily expanded to the poor neighbourhoods and informal settlements, bringing scheduled, subsidized, state-of-the-art transit to parts of the city that have never had a formal bus route. When the network is finally completed, it is expected to offer a reliable, safe and cost-effective transport network within 500 m of 75 % of the homes in the city [34]. The IRT integrates modern ICT technologies to monitor the fleet and promote security.

Social integration has also been a key target in the expansion of the city's transport as evidenced by the extension network for the IRT system. Likewise, the

city's rail system has over the last decade experienced a major transformation aimed at promoting social integration. In the build-up to the 2010 FIFA World Cup, Cape Town's central train station, a grant representation of segregationist infrastructure of the apartheid regime, was transformed into one of the city's most inclusive spaces. With an intention to open up and democratize the station and promote freedom of movement, the terminal was designed in a way to create democratic public spaces linked to other public transport networks, and to create commercial space specifically for the informal economy where the poor could trade and sell produce to the thousands of daily commuters. The station has not only granted the poor residents' ownership of one of the apartheid regime's most prized segregating infrastructure, but because its centralized location has also become the central square for the city's sprawling informal settlements.

As the public transport system continues to expand into previously unserved areas, and with the continued development of policies to promote public transport and to encourage more commuters to use the same, the result will reduce transport costs for more city residents and in turn improve productivity, which will undoubtedly contribute to the economic growth of the city. The creation of trading spaces within the mass movement corridors near areas such as the train station will also create income generation opportunities for the urban poor and further result in economic growth within this social group (Fig. 34.6).

Fig. 34.6 Cape Town's MyCiti public transport. *Source* Flickr/Steven M Guess

34.6.2 Informal Public Transport in Cape Town

Even though public transportation system in Cape Town is comparable to the cities in the developed countries, the current capacity of the formal public transport cannot meet the demand of the commuters, which creates an opportunity for informal transport system. The informal transport sector in Cape Town comprises of minibus taxis, buses and metered taxis which are owned by private individuals and/or companies. The minibus taxi service in most areas operates on dedicated routes and is frequently available, inexpensive and convenient since loading and offloading happen on demand pretty much anywhere en route [35]. The services have however also been identified as being dangerous, chaotic, unreliable and uncomfortable, with regular commuter complains initiated against the rude and violent behaviour of the taxi drivers.

Despite the challenges associated with the minibus taxi service, the service, which was introduced more than half a century ago provides transport services to 15 % of the population, who are mostly low income earners living the townships and informal settlements [33]. There are 102 registered minibus taxi route associations in the Cape Town metro area [36], which are currently managed by South African National Taxi Association (SANTACO) (Fig. 34.7).

The minibus taxi industry is a critical pillar of the South African public transport sector, operating and competing with the heavily subsidised bus industry for more than five decades without receiving a cent from the government in the form of grants or subsidies. In 2015, the City of Cape Town's Mayoral Committee proposed

Fig. 34.7 Cape Town's minibus taxis. *Source* [37]

a policy to transform minibus taxi services into a formal transportation system. This move, which is in line with the national goal of formalizing the entire public transport system, will make the industry more economically sustainable while improving service delivery. A new national law, the National Land Transport Bill, spells out a plan for publicly controlled integrated transport systems and for cities to take greater control of planning, regulating, implementing and monitoring public transport services [38]. In 2006, The South African National Department of Transport launched a policy to revitalize passenger transport system. The Integrated Rapid Public Transport Network (IRPTN) programme envisaged that the cities in South Africa would implement integrated networks reliant on the Bus Rapid Transit (BRT). The minibus taxis operators in the BRT routes would be given an opportunity to be incorporated in the IRPTN.

34.6.3 Increased Use of Private Car Hampers Efforts to Make Cape Town a Smart City

The absence of reliable public transport leads to middle-to-upper class income group to resolve into buying their own cars or use metered taxis. About 19.1 % of city of Cape Town population used their own cars, as drivers and 14.7 %, as passengers to go to work or school in 2001 [39]. In 2011, number of people using cars to go to work increased to 42.9 % and further to 48 % in 2015 [1, 33, 40], generally translating to an increasing traffic congestion challenge. Western Cape has the highest number of private cars compared to other provinces in South Africa. According to the TomTom Traffic Index Report, Cape Town remains the most congested city in South Africa and is ranked 47th in the world. Cape Town has a Traffic Index of 30 %, which means that drivers experience an average increase of 30 % in trip length of throughout the day. During the morning peak period, Capetonians can expect to add an additional 71 % to free-flowing travel time [41]. If the city of Cape Town does not improve its public transportation system, this number will continue to rise as the number of middle class people and urban growth increase.

Increased use of cars in urban areas results in increased demand of land required for road infrastructure and parking facilities. While owning a car represents a revolution of mobility and convenience, increased use of private cars results in increased use of non-renewable energy, obesity, accidents, social isolation, urban decay, urban sprawl and pollution. The second largest contributor to greenhouse emission is transportation sector. Air pollution data from World Health Organization show a moderate PM10 Pollution Level in the city of Cape Town. Main sources of air pollution in Cape Town are industrial and vehicle emissions. Improvement on public transportation is vital for environmental sustainability of the city as it can reduce CO_2 emissions.

Like other South African cities, Cape Town is a monocentric city where the wealthy communities are situated next to the economic opportunities whereas the poor and overcrowded communities are located in the periphery of the city [42]. This leads to congestion and long trips from the periphery to the centre. Traffic congestion is a major indication of the disjuncture between land-use planning and transport systems. It not only exposes the limitation of a transport-oriented bias to mobility, but also reveals the inefficiency of land-use systems in a given city. Limited road capacity, in the face of growing demand for motorized mobility, partly explains deteriorating traffic conditions. Congestion has widespread impacts on the urban quality of life, consumption of fossil fuels, air pollution and economic growth and prosperity. In addition to economic costs, congestion causes significant numbers of early deaths from respiratory illnesses, stress and physical and mental fatigue. It also degrades green areas, which, in turn, diminishes their carbon sequestration properties.

To alleviate traffic congestion in Cape Town CBD, Transport for Cape Town (TCT) is undertaking a R6.5bm project to review and improve traffic signal timing at the 110 intersections in the CBD [43]. The city also plans to extend Myciti routes and to use electric buses as IRT. This will make Cape Town the first city in Africa to use electric buses for public transport [40]. These initiatives directly support the city's commitment to the Paris Pledge for Action at COP21 and as member of the C40 cities to take progressive action and lead the way in reducing energy consumption and emissions. To reduce the disjoint of economic and residential locations, in 2016, the city has adopted new approach to integrated spatial and transport planning called Transit-Oriented Development (TOD) Strategic Framework [44] which is aimed at ensuring that new developments are strategically located around public transport where residents will have easy access to either rail or MyCiTi trunk routes.

34.6.4 Integrating Public Transport, Walking and Cycling in the City of Cape Town: Creating Streets for All

Cape Town has formulated and adopted several policies with an aim of making the city more sustainable, inclusive, livable, prosperous and smart. In 2012, the city joined the livable streets movement in a bid to promote streets for all, and to make the city more livable and more pedestrian and cyclist friendly by reducing motorized transport. Over 21 % of population of the City of Cape Town population walks as a mode of transport [38]. As part of this movement, the city has already put in place policies within the Integrated Transport Plan and invested in the construction of pedestrian and cycling lanes as well as parks and other public spaces.

In addition, the city organizes "open streets-type events" for which car-free zones are temporarily set up to create safe public spaces in which citizens can experience and appreciate their city in a new way. Four of such events have already

been set up between 2013 and 2015 and have greatly been received by the city dwellers and applauded for creating social spaces where people of all races interact.

Photo of Cape Town—streets for all. *Source* © www.andrewboraine.com

34.6.5 Smart Streets Contribute to Provision of Basic Infrastructure and Safeguard Environmental Sustainability

Connectivity includes prioritizing streets as the basic element of mobility and accessibility accompanied by the progressive provision of services (connections to water, sewerage facilities, energy, drainage, etc.). As connectivity increases, travel distances decrease and route options and travel modes increase (e.g., more use of non-motorized and public transport), allowing more direct travel between destinations, thereby creating a more accessible and resilient system. A smart street network expands multimodal transport systems with sidewalks and bicycle paths, ensures eco-efficiency of infrastructural systems and supports density through integrated infrastructure development, thereby enhancing efficiency and access. Streets that provide space only to motorists are characterized by congestion and high CO_2 emissions.

Besides easing mobility, streets provide pathways for pipes, power lines and drainage systems, among other amenities. Evidence from most cities across the world shows that areas of the city endowed with adequate streets are also areas with laid down pipes for water supply, drainage and sewerage networks. Cape Town's high street share area also provides infrastructure for basic services such as water, sanitation and electivity. According to census 2001 and 2011, there has been an increase in the number of dwellings with access to basic service in the City of Cape Town, with 94 % of household having access to electricity and 75 % having access to piped water inside dwelling in 2011 [1].

Environmental sustainability is another dimension of city smartness. Smart streets contribute to safeguarding environmental sustainability. The natural assets of

cities should be preserved for the sake of future generations and create sustainable environment. Research shows that street design patterns greatly influence level of pm10 air pollution. In Africa, studies measuring air pollution emissions on the street indicate that poor roads, fuel quality, vehicle maintenance and roadway dust are the most common sources of pm10 and pm2.5 emissions. The South African National Environmental Management: Air Quality Act 39 of 2004 stipulates that three main criteria pollutants need to be measured and reported. In 2010, the city adopted the City of Cape Town Air Quality Management Bylaw. Among other provisions, this bylaw regulates emissions of atmospheric pollutants within Cape Town and puts in place licensing and penalty systems. Since 2011, no station failed to comply with the limit of no more than four exceedances of the 120 $\mu g/m^3$ daily standard [45].

To promote the city's coordinated growth, efficiency in the transport and movement systems and to enhance environmental sustainability, the City of Cape Town has compiled 8 district plans for each of its planning districts. The plans, which have been approved by the city authority, are aimed at assisting in providing a guide to land use and environmental decision-making processes within the districts. Four local spatial planning and design projects have already been informed by the city's spatial development framework and the district plans. These projects are Lavistown Development, urban fringe development, Langa Local Area Planning Initiative and Du Noon Northern Sport Precinct Plan. Opportunities that existed in these areas were identified, and the plans are aimed utilizing these opportunities to empower the communities and reduce the negative impact of human activity on the environment. The projects promote improved access to public transport (both BRT, non-motorised and rail), basic services, economic opportunities, recreational facilities, housing and ICT infrastructures among others using existing spaces. Walking ways are part of each development to promote walking and cycling in these areas.

Some of these projects involve development of mixed land uses and high-density housing opportunities. Mixed-use developments can reduce the distance between residential and employment areas, which lessens dependency on cars and travel demand altogether. Density and mixed-use around public transport stops will increase use and, hence, system viability. Linking job location and transport needs increases land efficiency. A compact pattern adjacent to a public transport node has many benefits. The Comprehensive Integrated Transport Plan 2013-2018 guides the development of efficient and viable relationship between land use, supporting infrastructure and transport for the sustainable development and improvement of public transport system within the city region.

34.6.6 *Intelligent Transport Systems Are Key for Cape Town's Smart Mobility*

Intelligent transport systems (ITSs) apply computer and communication technology to assist in solving transport problems. The development of an integrated ITS strategy for the City of Cape Town has been ongoing since 2002. The aim of the strategy has been to develop and implement systems that will improve service for travellers in the city through an increase in the capability of existing infrastructure and resources; a reduction of the environmental impact of transport; a reduction in the effects of congestion; a reduction in the number and severity of collisions; a reduction in user costs; and an improvement in public transport service [46].

Some of the intelligent transport system projects that have been proposed and/or being implemented by the City of Cape Town include the metropolitan area traffic control system, advance transport monitoring system, metro-trans-info call centre, CCTV public area surveillance systems on the road network, automated incident detection (in combination with the CCTV systems), improved public transport safety in combination with the CCTV systems, automated speed enforcement system for freeways, advanced public transport system for the CBD, red-light and speed violation monitoring systems for local roads, and expansion of existing CCTV and area traffic control systems.

The Metropolitan Area Traffic Control System is an investment of more than 50 million rand (R 50 million) and replacement costs of about R 80 million commissioned in 1998. The system has about 700 sites connected to two central computers which integrate features such as detailed fault and event monitoring, traffic counting, lamp and detector monitoring, remote clock setting, 50 timing plans and remote downloading of signal plans [46]. The system has resulted in among others, time and operating cost savings among road users estimated at about rand 5 million per month; coordinated operation; better utilization of existing traffic corridors, effective use of road space resulting to an increase in usable capacity; fewer and shorter disruptions due to faulty signals; improved safety; and enhanced traffic management [46].

As part of the larger ITS system, and in order to improve efficiency in the utilization of transportation resources among government entities, Cape Town has introduced various innovations such as e-fuel, which is a fuel management component that brings together bank, fuel supply and vehicle tracking systems to ensure that government fuel purchases are tightly controlled; and FleetMan, a web-enabled tool, to help fleet managers track and take care of this investment. The asset management system, for example, supports automatic logging of vehicle use, enabling departments to be billed promptly and accurately. This improves cash flow and financial accountability, as well as eliminating many disputes.

34.7 Social Infrastructure Development Attracts Investment and Enhances Cape Town's Productivity

34.7.1 Health and Education Infrastructure for Enhanced Human Capital

The contribution of education to health and well-being and to better subsistence and livelihood is indisputable. It is crucial to reducing poverty, improving health and enabling people to play a full part in their communities and nations. It finally generates powerful poverty-reducing synergies and yields enormous intergenerational gains

The city boasts of the highest literacy rates within the larger Western Cape region, recorded at 90.5 % in 2011 [1]. Although Cape Town's literacy rate is slightly lower than the national level's total literacy rate of 94.3 % [47], the city has heavily invested in the education sector, so much that it enjoys relatively good net enrolment and pupil–teacher ratio, and has the highest manpower potential in South Africa [48].

Cape Town also has the highest number of health facilities within the larger Western Cape region, with a total of 160 facilities, comprising of 149 primary healthcare facilities (community health centres, clinics, satellite clinics, etc.), 9 district hospitals and 2 regional hospitals in 2013 [49]. This has been translated into high level of health service provision within the city, as witnessed by high levels of immunization (*population of under 1 year fully immunized was 89.5 % in 2011/2012*) and low levels of severe underweight children under five years (*number of severely underweight children under 5 years in 2011/2012 was 3.2 per 1000 population*) [39]. The implication in turn is a healthy city population that will be able to achieve and maintain a high quality of life, and access opportunities to boost economic growth.

With an increase in a diversity of "global" opportunities present for Cape Town residents, the level of human development in the city, measured through the HDI, is highest in the city of Cape Town metropolitan municipality (*measured at 0.74 in 2010*) as compared to the other districts of the Western Cape region [4]. This reflects to the fact that the city residents are able to live long and to have healthy lives, to communicate, to participate in the life of the community and to have sufficient resources to obtain a decent living. This in turn increases the city residents' spending power and improves opportunities for economic growth.

34.7.1.1 Cape Town: A Knowledge-Based City Through ICT Innovations

At the beginning of the new millennium, considering that economic growth will be driven more by people and knowledge than capital and natural resources, the city Cape Town introduced the "The Cape Online e-government Programme" to boost

"the transition to a society based on the availability and leverage of knowledge, it is necessary to change and adjust to the imperatives of the knowledge society". The Cape Online Programme was introduced "to develop an innovative environment that facilitates a competitive, knowledge-based economy that promotes economic growth and enhances the quality of life of the people". This is to be realized through "Enabling government to harness the capabilities of the Internet to grow the appropriate use of ICTs, increase internal efficiencies and provide better service to its citizens as a pathway to e-government" [50]. The Cape Online Programme was later strengthened in 2004 with the information technology (IT) and e-government units of the Provincial Government of the Western Cape to form the Centre for e-Innovation (Ce-I). The Centre's purpose is to provide ICT services to the PGWC, including driving its e-government strategy; its roles are: (1) to provide and support the basic ICTs infrastructure upon which most of the government's activities depend; (2) to provide and support applications that improve the efficiency of government administration, lower costs and reduce the scope for corruption; (3) to provide and support applications that enable the government to deliver better services; and (4) to build an inclusive Information Society [25].

Under the Ce-I, various educational projects have been implemented, including Education projects—The Khanya Project is a joint venture between the Ce-I and the Western Cape Education Department that uses ICTs to support the educational curriculum throughout the Western Cape by providing content for teachers and learners an integrated learning platform; the Schools Administration Management System Project (SAMS) has been developed with an aim to provide a way for even the most remote and isolated schools to upload administrative information to a central server automatically and quickly; and e-Literacy was reinforced with Ce-I developing a series of community training and e-literacy projects, including training modules that will be free for anyone to adapt and use for themselves [25].

34.7.1.2 Use of ICT to Strengthen Health Sector and Services

Various healthcare systems such as maternity system (CRADLE) and networking community health centres (CHCs) have been developed to improve efficiency in the healthcare system. It is linked with the health information system, which provides consolidated electronic health records for patients across the provincial health system. The use of CRADLE has allowed access to accurate, timely and comprehensive information on maternal and child health and has enabled officials to track problems and intervene in a timely manner when problems arise [25].

The development and the use of the Social Service Electronic Document Management System (EDMS) has also strengthened the Department of Social Services and Poverty Alleviation to reduce significantly the management and administration time of grants and pensions, and also prevented the loss of paper-based applications, fraud and corruption. The city of Cape Town has also introduced two innovative ICT infrastructure systems: the Cape Gateway that provides government information to Western Cape citizens via a web portal, a call

centre and a walk-in centre in Cape Town's Long Street; and the Cape Access, which complements Cape Gateway by providing computer access and skills in rural communities [25].

34.7.2 Peace and Security for Sustained Investment and Economic Growth

A city that does not promote peace and security is not attractive to investors and cannot enjoy smart economic growth. Despite the fact that Cape Town has the highest police—civilian ratio (*1:6754*) among the major South African cities (*Johannesburg, 1:1272; Tshwane, 1:3072; Ekurhuleni, 1:5252 and Durban, 1:2452*) [51]—the city has capitalized on smart policing technologies such as smart monitoring systems including use of CCTV, development of digital criminal database and fingerprint technologies and incorporation of community policing to reduce the crime prevalence in the city, making it among the most secure cities to live and invest in. These ICT-based surveillance and response systems have resulted in reduction of crime rates and increased arrests across the city.

With the continued adoption and investment in modern ICT-based security monitoring systems, Cape Town is strategically placed for attracting investments and in turn promoting smart economic growth.

34.8 Innovation in Promoting Access to Basic Infrastructure

South Africa has made significant strides since 1994 to reduce extreme poverty by providing basic services—such as water, electricity, sanitation and housing—to large segments of its population. Cape Town has some of the best rates of infrastructure provision throughout the country. Although not at 100 % service delivery, statistics from the South African Census of 2011 portray Cape Town as a city that has not only invested, but has also innovated and developed "smart" approaches to basic infrastructure service delivery for its residents.

In a bid to promote access to water to all its residents, the city of Cape Town has invested in smart approaches and technologies to the entire water supply chain—catchment, storage, treatment and distribution system. As a factor of investment in this chain, up to 97 % of the city's water demand is collected from surface water, and only an average of 4.3 % of the total bulk water is unaccounted for [52]. To ensure equitable water distribution among all its residents, the city further created a system through which informal settlement residents are serviced from standpipes within a walking distance of 100 m. To reduce water wastage at the household level, the city has installed more than 45,000 water meters since 2010 in houses to

alert owners when water consumption has reached unaffordable levels, and provides hands on training on aspects such as fixing water leaks among the poor households [1]. The various projects are enabled and supported by policies related to water quality, public participation in water governance and community information on the importance of attaining maximum utility for the water service. As an outcome of these initiatives, 87.3 % of the city residents had access to piped water either inside their dwelling or inside their yard, 12 % had access to piped water from a communal tap and only 0.7 % did not have access to piped water in 2011 [1].

A similar trend of heavy investment has been observed in the city's attempts to provide sanitation facilities to its residents, resulting in 90 % of households having access to flush toilets. Increased connections to the city's sewer network over the past decade increased the need for more efficient wastewater management technologies. In 2010, eight out of the city's 23 wastewater facilities were awarded with the Department of Water and Forestry's "Green Drop" award for high standards and adoption of modern technologies in wastewater management [30].

Cape Town has over the years not only invested heavily in municipal waste collection systems but has also shown leadership and innovation in fostering public private partnerships for waste collection, management and recycling. The city has been lauded for its efforts to promote reduction in waste generation, encourage recycling and for its schemes to promote waste reduction, reuse, recycling and separation at the household level. Recycling, on-site and central community collection and drop-off facilities are also widely available across the city. The use of ICT in managing solid waste has been adopted in the city through the integrated waste exchange website, which allows businesses and the public to exchange potentially useful waste materials. The city has put in place smart policies, such as Cape Town's extended producer responsibility policy in which the city procurement guidelines favour companies that operate take-back programmes for items they sell, and also has policies to monitor and enforce waste generation and disposal standards by industries. With a waste generation rate of 573 kg per capita [30], and the city's continued growth, a lot of pressure is being exerted on the waste management systems and the Cape Town is rapidly running out of landfill space at its three main sites. More "smart" waste management approaches are urgently needed to reverse this trend.

34.9 Conclusion

The study on Cape Town brings a unique city setting where segregationist development (apartheid) has been legally rooted in the city foundation and manifested through urban planning and design, institutions and laws and access to basic services; and also where deliberate inclusive development has been promoted post-apartheid through both policies and investment. Although Cape Town has made commendable progress since the end of apartheid in 1990, efforts are still needed to create a smart city, a city which is sustainable, inclusive and prosperous.

Since the end of apartheid, different models have however been adopted to make the city more inclusive, the key ones being on participatory planning and design; development of inclusive public spaces; improvement in basic infrastructure provision and public transport particularly to the poor neighbourhoods; and development of policies that encourage inclusive human settlement and trade. The transition towards smart growth for Cape Town has however not been haphazard and uncoordinated like in many other African cities where ICT adoption and penetration, and evolution in various smart city systems go side by side with informal growth. In Cape Town, there has been a deliberate approach and efforts (both investment and policy) dedicated towards smart growth. The Cape Town's smart city strategy has transformed the way the local government delivers its services through five pillars: leadership, development strategy, policy and regulatory environment digital democracy, administrative/e-government. In 2015, the city of Cape Town has also introduced the Digital Working Group to focus on the aspects of digital government, digital inclusion, digital economy and digital infrastructure.

Implementation of various smart growth-targeted policies, plans and development projects has collaboratively and continuously worked to make Cape Town sustainable, equitable and economically vibrant, particularly by promoting improved access to economic opportunities, integration and inclusivity, resilience, adaptiveness, interconnectedness, land-use intensification, environmental protection and development control. All these are core components of smart city economy. As a result of the various interventions, the city has received several awards, such as the 2014 World Design Capital award; the Global Earth Hour Capital in 2014 from the WWF; the SERI special achievement in GIS award in 2013; the computer honours twenty-first century achievement award in 2003; the Bill and Melinda Gates Access to Learning Award for Smart Cape in 2003; and the ICT achiever's award for e-government in 2002.

The 2014 World Design Capital was awarded to the city for its innovative use of design as a tool for social, cultural and economic development. It particularly applauded the city's innovation in public transport and other projects such as the Green Point Urban Park and the Buitengracht Pedestrian Bridge; community development projects, such as the Violence Prevention through Urban Upgrading initiative as well as urban gardening projects; and the revolutionary IT systems being used to help run the city more effectively.

Transport is the other major area where Cape Town has heavily been investing in, in a bid to create an equal opportunity city. The development of an integrated intelligent transport system strategy for the city in 2002 has, among other things, greatly contributed towards efficiency in the public transport network through an increase in the capability of existing infrastructure and resources; improved commuter convenience; reduced the environmental impact of transport; reduced congestion in the city; lowered the number and severity of collisions; and reduced the transport system user costs. Social integration has also been a key target in the expansion of the city's transport as evidenced by the extension network for the IRT system. Likewise, the city's rail system has over the last decade experienced a major transformation aimed at promoting social integration. As the public transport system continues to expand into

previously unserved areas, and with the continued development of policies to promote public transport and to encourage more commuters to use the same, the result will reduce transport costs for more city residents and in turn improve productivity, which will undoubtedly contribute to the economic growth of the city.

Upon realization that economic growth will be driven more by people and knowledge than capital and natural resources, the city Cape Town introduced the "The Cape Online e-government Programme" to boost "the transition to a society based on the availability and leverage of knowledge, it is necessary to change and adjust to the imperatives of the knowledge society". The Cape Online Programme was introduced "to develop an innovative environment that facilitates a competitive, knowledge-based economy that promotes economic growth and enhances the quality of life of the people".

Today, the city of Cape Town metropolitan economy contributes more than three-quarters of the Western Cape province GDP. The metropolitan region has specifically developed a strong financial and business services sector and has a large retail, wholesale, catering and accommodation sector linked to a vibrant tourism industry, and a rich cultural history—all of which heavily rely on the growth of ICT infrastructure. The city residents are able to live long and to have healthy lives, to communicate, to participate in the life of the community and to have sufficient resources to obtain a decent living. This in turn increases the city residents' spending power and improves opportunities for economic growth. Although Cape Town has made commendable progress since the end of apartheid in 1990 that led to numerous award of recognition, the city is called to reduce inequalities and create smart solutions for all citizens.

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Part XIV
USA-St. Louis

Chapter 35
Profile of St. Louis as an Urban Entrepreneurial City

Jim Brasunas and Francis Chmelir

Abstract St. Louis has had a deep history of being a city of industry and entrepreneurial promise. As the "Gateway to the West," St. Louis' geographic location in the center of the USA made it a city of vital importance to trade and commerce for many decades of its history. However, due to a large exodus of corporate headquarters, starting in the 1980s and continuing to present day, St. Louis has struggled to retain talented young people, grow new, innovative business ventures, and deal with less than effective government policy. In addition, the region's strained racial and socio-economic tensions have been ripped open in very public ways. It is in this backdrop that an emerging startup community has worked its way into existence and is beginning to thrive. Given St. Louis' economic history and abundance of talent, a collaborative Smart City initiative that cuts across socio-economic boundaries could be truly transformative.

Keywords St. Louis · Cortex · Technology innovation · Downtown · Corporate headquarters · Anheuser-Busch · St. Louis county · St. Louis economic development partnership · Millennials

35.1 Overview of City of St. Louis, Missouri

St. Louis is a city and port in the U.S. state of Missouri. The city developed along the western bank of the Mississippi river, which forms Missouri's border with Illinois. In 2010, St. Louis had a population of 319,294; a 2013 estimate put the population at 318,416, making it the 58th-most populous U.S. city and the second-largest city in the state in terms of city proper population. The St. Louis metropolitan area includes the city as well as nearby areas in Missouri and Illinois; with a population of 2,905,893, it is the largest in Missouri and one of the largest in the USA.

J. Brasunas · F. Chmelir (✉)
ITEN, 911 Washington Ave, Suite 722, Saint Louis, MO 63101, USA
e-mail: fchmelir@itenstl.org

The economy of St. Louis relies on service, manufacturing, trade, transportation of goods, and tourism. The city is home to several major corporations including Express Scripts, Peabody Energy, Ameren, Ralcorp, and Sigma-Aldrich, as well as a large medical and research community. St. Louis has two professional sports teams: the St. Louis Cardinals of Major League Baseball, and the St. Louis Blues of the National Hockey League. The city is commonly identified with the 630-foot (192 m) tall Gateway Arch in Downtown St. Louis.

With over 30 four-year colleges and universities enrolling more than 125,000, the St. Louis area produces more than 25,000 graduates with bachelor's, post-bachelor's or professional degrees each year (NCES). The area also has an extensive network of community colleges, which enroll an additional 75,000 plus students, as well as vocational and technical training facilities and some of the most highly rated elementary schools and high schools in the country. As a result, Greater St. Louis is a great learning environment in which to grow up, as well as a sought-after destination for thousands of people from around the country—and the globe—who are attracted to its top-tier education resources every year.

Many of the best and brightest who study in St. Louis enjoy the community so much they decide to plant their roots here after earning their degrees. In fact, the Nobel Prize has been awarded to St. Louisans in nearly every Nobel category—physiology, medicine, chemistry, physics, and literature. Among those benefiting from this situation, of course, is the St. Louis business community. A smart, hard-working work force fuels the growth of companies throughout the region.

35.2 The Changing Economy

St. Louis is still reverberating with the echoes of the significant economic downturn that began in the late 2000s. Thought the Great Recession technically ended more than five years ago, healing here has been much slower and more uneven than it has been in the rest of the country.

The evidence shows up in the region's job statistics, among other places. Over the past year, the number of jobs increased by 2.3 % across the nation. In the St. Louis area, the number of jobs increased by 1.3 %. Since 2009, the year the recession ended, the number of jobs in the nation has increased by 8 %. In metro St. Louis, it is 3.6 %. By last May, the nation had caught up on all the jobs lost in the recession and added more. As of December, St. Louis was still 35,000 jobs short of its peak in early 2008.

In fact, St. Louis ranks 45th out of 50 large metro areas in job growth from 2010 to 2013, according to an analysis from the East–West Gateway Council of Governments, the region's planning arm [1].

Economic production is growing more slowly here as well. The value of all things produced in St. Louis grew 10 % from the recession's depth in 2009–2013, the last estimate available from the U.S. Bureau of Economic Analysis. Production in all metro areas in the U.S. grew 16 %.

The region's economy is seeing signs of recovery, particularly in the central corridor around the CORTEX Innovation District, but it trails the rest of America. St. Louis ranked near the bottom in economic growth among 515 cities nationwide, according to a new WalletHub study [2].

To identify the cities that have grown most rapidly in socio-economic terms from 2008 to 2014, WalletHub compared 515 cities based on 10 metrics, from population growth to unemployment rate decrease. A score between zero and 100 was assigned to the weighted metrics, and the cities were ranked by their overall score. In addition to separate large-city rankings, WalletHub also ranked small cities (populations of fewer than 100,000) and midsize cities (populations from 100,000 to 300,000).

St. Louis ranked 490th among 515 cities of various sizes, and 61st among 64 large cities with populations of over 300,000 in the study, "2015s Cities with the Fastest-Growing Economies." "City" refers to the city proper and excludes surrounding metro areas, according to WalletHub. Among only large American cities, St. Louis ranked 64th in population growth, 25th in median household income growth, 61st in job growth, 43rd for poverty rate decrease, 35th in regional GDP growth, 47th in unemployment rate decrease, 43rd for growth in number of businesses, 64th in full-time jobs increase, 63rd for working-age population growth and 47th in growth of median house prices.

35.3 The Evolution of Entrepreneurship in St. Louis

St. Louis began as the "gateway to the west," a pioneering, entrepreneurial city where anything seemed possible. Indeed for much of the twentieth century, companies thrived in St. Louis with headquarters for Anheuser-Busch, May Department Stores and Emerson Electric all located in the region. A thriving advertising and public relations sector—the firm Fleishman-Hillard started in St. Louis in 1946—joined financial services as industry strengths for the city, with a great deal of business transacted between all of these innovative organizations. St. Louis' central location in the USA also allowed for some of the best airline connectivity in the nation. But the mid-century time period began to see a steady stream of corporations leaving the area for a variety of reasons, bringing the St. Louis economy to an all time low late in the second half of the century. As the county and suburbs grew and borders expanded and shifted, St. Louis became an economically depressed, socio-economically segregated community. The region began to turn around in the middle of the first decade of the 2000s, however, when community organized entrepreneurship and infrastructure development started to take hold. Progress was slow at first, until a national uptick around 2011, which led to cross-market communication, accelerators, funding sources, education, and the emergence of new community champions and leaders coming together to organically develop the entrepreneurial ecosystem.

For all of its striving, St. Louis today is still far from being a Smart City. It is just beginning to be recognized as a viable startup location, but the population continues to decline as people move further into the suburbs or to more vibrant regions of the country. The startup community has struggled against this downward trend for a very long time and has managed to make great strides since 2003. At that time, companies were not attracted to downtown St. Louis. For a multitude of reasons, which will be elaborated on in this section, the downtown area had become something of a hollow core to the city—there was a lot of crime and it lacked the vibrancy and forward thinking that companies and young talent seek in a downtown location. At the time St. Louis lacked the two important aspects needed to develop a Smart City; on the one hand, you need people with the vision and resources to develop the infrastructure and physical attributes of the Smart City, such as fiber optic connectivity and density of business and industry, but you also need civic/governmental policies that reward innovation and opportunity and that seek to create a more entrepreneurial environment. We look here at the effect civic conditions in St. Louis have had on the development of IT infrastructure in the city.

While a city that is not proactively creating infrastructure around technology innovation isn't exactly acting antagonistically to entrepreneurship, it creates an atmosphere of lethargy around innovative development, as can be seen in St. Louis. Much of this lethargy stems from St. Louis's long history of complicated boundaries, particularly the fact that St. Louis City and St. Louis County have been separate entities since 1876. The split first took place because residents of the affluent city didn't want to pay taxes and spend resources on the county residents. As urban sprawl began and more people started moving to the county, however, they took much of the wealth of the city with them and the city became more and more destitute. While in other cities the affluent make up part of the community and pay taxes that go to support that community, the wealth in the St. Louis region moved to the county suburbs, leaving the city with a woefully underfunded government and much of the population living below the poverty line. The city government lacked the resources, energy, and forward thinking necessary to improve. Our governmental structure almost mandates that the city of St. Louis is going to be a low class population. As regional leaders begin to address some of these policy deficiencies, there is hope that the framework moving forward will foster more Smart City development. St. Louis has recently combined its economic development agencies from the City and County into one organization—the St. Louis Economic Development Partnership. In addition, a new position in the City is to be filled soon—a Chief Resiliency Officer, funded by the Rockefeller Foundation [3].

Part of the exodus of wealth to the county was fueled by St. Louis's long history of racial tensions, which we see effects of in conflicts like the 2014 social unrest in nearby Ferguson sparked by the police shooting of an unarmed black teenager [4]. Racial attitudes and prejudices are deeply engrained in the structure and policies of the region, and the impact of inequality on the African American population in the region has been significant. In terms of the effects this has on entrepreneurship in St. Louis, while St. Louis loses a lot of young people coming out of college to more exciting cities, among African American youths that loss is much more dramatic

Fig. 35.1 North side—City of St. Louis. *Source* STL Today 2014

because of the better conditions elsewhere. Civic leaders have yet to make significant steps in consciously addressing the racial issues in our city in the way that more historically segregated cities in the south have (Fig. 35.1).

The racial issues in St. Louis are just one part of the larger issues that divide us. The Missouri/Illinois divide, the city/county divide, the numerous municipalities in the county: all of these things seem puzzling to people from outside the region, and yet, there is nobody making changes, so we've been losing our young creative minds and diversity of perspectives to more forward-thinking cities. While these setbacks seem obviously avoidable to those outside the region, regional leaders and citizens must first concentrate focus and resources on tackling all of these underlying issues of poverty and crime.

Alongside these governmental issues and the loss of young talent, the 1990s and early 2000s saw a large number of our established business corporations either leaving St. Louis or being acquired by other companies who moved the forward-thinking aspects of those organizations outside of the region [5]. Many of these companies moved to Chesterfield (an affluent suburb), elsewhere in the county, or out of the region altogether. There was no mandate coming from these established business communities, big taxpayers who have a strong influence on the political base and provide a large number of jobs, to make local improvements in innovative city design and Internet capabilities. They had no incentive to develop new software or launch and test new products in the region because many of these companies merely left behind call centers or customer service offices, for which there was already existing support infrastructure. Take, for instance, our history with Southwestern Bell, a large telecommunications company originally headquartered in St. Louis. Eventually AT&T absorbed the company and the headquarters was moved to Texas [6]. There are now two AT&T high-rise buildings downtown, one of which is vacant. Of primary concern is the lack of innovative

decision making at the City level that could work more closely with startups or launch new initiatives to spur growth.

The biggest example of the harm done to the St. Louis region from the departure of large corporations can be seen in its transportation history [7]. At one point St. Louis was a main hub for two competing airlines: TWA and Ozark. In 1986, TWA bought Ozark and the two merged to become one of the major airlines in the USA—most people who flew on TWA flew through St. Louis. American Airlines then bought TWA in 2001 and promised that St. Louis would remain a major hub for the airline, but they ended up terminating their St. Louis hub a mere two years later. This had a significant negative impact on the region as suddenly people in sales or on business for a national company wanting to get to St. Louis from anywhere in the country would have to fly somewhere else first. Despite the central location of St. Louis, it took people a full day of travel to get here, which was a deterrent to them coming at all. This took the wind out of the sails of corporate growth in St. Louis, and still today it is having a huge effect on the startup community in terms of our ability to get investors from the west or east coasts to come here to look at potential investments.

Another prime example of the complacency of the region is when the Belgian company InBev bought Anheuser-Busch in 2008 [8]. Anheuser-Busch is one of the largest breweries in the world, but since its beginnings in St. Louis in 1852, it has been an important regional brewer and local corporate partner. The brewery not only hired a lot of people directly, it also employed architects, advertisement and marketing firms, and other small businesses in the region—a significant amount of local revenue was tied to the brewery. When the brewery was bought, the main decision-making core of the company was moved out of the region and the local brewery became just another location where beer is made, ending all of that crucial partnership with local businesses.

This has further negative ramifications for the startup community in terms of its ability to find skilled and experienced decision makers in the region. When it comes to developing Smart Cities, before you can install gigabit fiber and other infrastructure, you first need smart people making the decisions. The established leaders in St. Louis who are currently making decisions (or choosing not to make decisions) are influenced by old ingrained interests. For example, in the early years of the tech industry in St. Louis, there was a Missouri tax credit that supported the infrastructure large businesses needed to run their physical locations—warehouses, factories, heavy machinery, etc. This was written from a very nineteenth/twentieth century old-economy viewpoint. While local policy leaders lacked the incentive or vision to change these tax laws, they were open to changing them only so long as those changes didn't threaten the core of what they thought of as necessary to the business environment in the city. Two local attorneys eventually took the opportunity to change this tax law to allow tech innovation—they realized the engines of economy for tech companies were servers, data centers, and IT infrastructure, and they were able to add a sentence or two to this existing policy to allow startups to use that tax policy to offset some of the costs of launching [9]. We do have visionaries like this bubbling up in our history to take advantage of gaps and

opportunities in civic law to advocate for innovation, but in terms of general leadership, echoes of the severing we had with the entrepreneurial spirit that fueled the early part of the twentieth century in St. Louis are felt strongly today. The descendants of people who made their fortunes doing those entrepreneurial things control a great amount of the resources of the area—they have become quite comfortable with those resources and, having no ties with the city community, see no incentive to share those resources for the good of that community, and see no need for innovative thinking.

The region now has to fight against that lethargy and complacency to reset the communal mindset on what it means to be entrepreneurial and how to think globally and embrace change and the lessons of failure. These setbacks to down-town and the city negatively affected the local economy, but had an even greater impact on the region's self-esteem. The city was founded and thrived on the notion that its citizens could do anything they set their minds to. Now most of the inno-vative activity is happening elsewhere. Rather than being on the forefront of technological innovation, the communal attitude in St. Louis is merely about the city holding its place so that it doesn't fall further behind.

The thing that is possibly the most discouraging is that even deeper than the fact that some of the issues of disunity we've mentioned are not being addressed, there's no entity that can address them. Bi-State Development is one organization that has sought to tackle our regional fragmentation issues, but their projects are limited to transportation. Likewise, the St. Louis Regional Chamber seeks economic solu-tions, but their mandate is somewhat limited to big companies. 2013 saw a glimmer of hope that the city and county would unite to spur economic development when the St. Louis Development Corporation merged with the St. Louis County Economic Council to form the St. Louis Economic Development Partnership. There was a lot of hope that this would combine city and county for economic devel-opment and would begin to address some of these issues, but progress has been slow and there is a lack of strong leadership. The city and the county together represent close to half of the population of the whole metro area—as the core of the region one would hope to see them united through an overarching regional gov-ernment with a vision and implementation plan, but right now St. Louis lacks the visionary leadership to set the goal and identify the means to make the region stronger. Building more metro link lines to improve public transportation, for example, would take a tremendous amount of money and time. There is no leader thinking 25 years in advance and setting long-term plans. If you have no plan, then nothing is going to happen.

One thing the region needs to focus on much more is fostering improvements to attract more people of the millennial generation. St. Louis lacks the obvious geo-graphical draws of oceans and mountains, so it must focus on building the cultural, lifestyle, and entrepreneurial ecosystem attractions: pedestrian-friendly streets, Smart City foundation, an urban community that caters to younger people, infrastructure that supports quick business starts, policies that help grow those businesses here, and favorable viewpoints on investment in these early opportu-nities. St. Louis has wonderful architecture and neighborhoods that are already

trendy and attractive, but there are many more aspects that make a city vibrant and exciting which we can be better at: strong public transportation so you don't need a car to live here, a larger and more diverse immigrant population, and of course jobs and a large population of young singles living in town. St. Louis currently has a lot more of those things than it did five or ten years ago but nowhere near enough. Part of the hindrance to this forward movement is, again, the more traditional ideas of our regional identity: what does it mean to be St. Louis? A lot of people who live here really love it, but they love it for various and conflicting reasons. The greater St. Louis area is primarily more of a family region than a young person single scene. Families living in the county love it because it's safe—the crime is largely limited to the city, which families in the county don't have to worry about and don't have to pay taxes to prevent. It's a highly segregated city, but if you're on the good side of the tracks St. Louis is a good place to live. Those living in the county have been able to keep at bay the negative effects of change seen in the city, but this barrier around their lifestyles and their environments is increasingly being knocked down.

While that strong sense of community in St. Louis has had negative consequences in terms of who exactly belongs to that community and the distribution of resources within that community, one positive is that the young visionaries we lose to more vibrant cities have incentive to return with new resources and new perspectives that seek to address the community's problems. Take, for example, Square [10], a company started by a native St. Louisan who had trouble finding the talent to grow their base here. The company was founded, instead, in Silicon Valley, where there is more talent and more opportunities for funding. They scaled the company up to a sustainable position and have now moved back to St. Louis, bringing hundreds of jobs with them [11]. The biotech community has also been effective at drawing back St. Louis expatriates who had moved to Boston or other places to start their companies and find success. These founders are happy to come back and contribute that success to the St. Louis startup community. While this activity is a small trend, we need to consider how we can encourage more of this. Can we send young entrepreneurs to Silicon Valley or other parts of the country to get funding and startup traction and commit to coming back at some point or build a portion of their company in St. Louis where there are advantages from a cost standpoint to help us build our talent incrementally?

Local entrepreneurs, leaders, and citizens must think realistically about what St. Louis can accomplish over the next two to five years, and what else that work can eventually lead to. The best time to work on a problem is before you're in absolute crisis mode, and we're nearing crisis mode from a standpoint of retention of the creative class and our ability to turn the tide. St. Louis's lethargy that tends to perpetuate mediocrity, however, is strong. Our situation is not bad enough to be compared to Detroit or the rust belt cities that have hit rock bottom, but we are not able to get out of our own way and elevate our status to the level of Boston or even Nashville. The latter is seeing tremendous growth despite not having the mountains and oceans that draw millennials. They have a cool factor that we just do not. While we must focus on putting the environment in place to make that happen, progress

will still take a great deal of time and we need a dynamic leadership with vision for what they want St. Louis to be in fifty years, a plan for how it will happen, and the patience to see it through. There needs to be a fundamental shift in the region to start looking at what else we need to do to make St. Louis a millennial-friendly Smart City—increasing metro link lines to improve transportation, streamlining some way out of our regional/governmental problems, etc.

Recently, the startup community has tapped into the remnants of the city's entrepreneurial foundations as the lack of other opportunities has made startup entrepreneurship something of a necessity. We are about four or five years into seeing some renewal of the startup mentality, and for our community to get to the point where our efforts are producing meaningful results could take ten to twenty more years [12]. What we are concerned with right now is whether or not the community has the patience to see that through. As mentioned earlier, the issue of failure in our region is a big one—failure here is an absolute negative that people tend to want to avoid completely. Startup communities, on the other hand, value the concept of using failures to learn and grow to thrive and move forward. As a region, are we going to commit to struggling and figuring it out, making hard decisions, and learning from wrong decisions? We are on tenuous ground when figuring out how to build our tech community; it will take many years, people may lose money, and companies may go out of business, but hopefully along the way a couple of companies hit it big and we release more talent and wealth and other assets back into the community. If and when that occurs, amazing things could happen around this region and to this community. We can't predict, however, when that will be and whether we as a region have the wherewithal to see it through. This is where a Smart Cities initiative could help spur even more life for the startup community by luring in large corporate partners that care about innovation and see those gaps or opportunities in our policies and our region. We are now at a critical point with tech entrepreneurship in St. Louis. In just the last two years, the old leadership that was so lethargic has begun to recognize the value of startups. But while there is energy and excitement around the big picture, individual small companies that are trying to raise money and gain traction with larger companies still struggle to find crucial support. Unless the region can start delivering on a deeper level of backing and support for the entrepreneurial community, we are in danger of this new energy going flat.

35.4   Conclusion

Startup innovation energy is like a living, breathing organism that requires the right tending, especially in these important early stages. The city needs talent, capital to nourish the growing environment to help it become sustainable in the long term. There is a concern that this energy is picking up pace too quickly. Even the good press and the good attention that has come out of St. Louis's current entrepreneurial activity

causes worry that maybe the growth of the ecosystem is being rushed too much. There are still some fundamental issues that need to be addressed that are foundational to attracting young people to the area, and these involve changing things are fundamental to how St. Louis has subsisted for a hundred years. The younger millennials focus on what technology and an urban environment can do, but entrenched traditional values in St. Louis interpret this as a threat to the regular way of life. The fight over whether or not to allow Uber to operate in the city is emblematic of this changing economy [13]. From a Smart City standpoint, those kinds of tools should be readily available to anyone through their mobile phone because we have the technology to make that possible, but what is an obvious point of development for most cities is still a painful birthing process here. Supporting entrepreneurism in St. Louis is challenging because other American cities are ahead. Given St. Louis' challenging economic history and unique abundance of talent, a collaborative Smart City initiative that cuts across socio-economic boundaries could be truly transformative.

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Chapter 36
Challenges and Lessons Learned in Developing Smart Cities

Jim Brasunas and Francis Chmelir

Abstract This chapter explores the growth of the start-up tech entrepreneurial sector in the St. Louis region from the early 2000s to present day, highlighting its success in spite of a great deal of adversity. This sector of business development effectively leveraged very little resources in terms of intentional funding and support to create a bright spot for the St. Louis economy today. The burgeoning asset of entrepreneurial start-up growth in St. Louis creates a valuable resource upon which to build a Smart Cities initiative for the region that would greatly benefit the start-up community.

Keywords Start-ups · Technology entrepreneur center · Incubators · Accelerators · Missouri technology corporation (MTC) · Missed opportunities · Cortex · T-REX · Capital innovators · ITEN

36.1 Introduction

The tech start-up scene has arisen in St. Louis almost in spite of the challenges articulated in the previous section. It is difficult to pinpoint the exact causes or conditions responsible for the recent flurry of activity, but there is currently a great sense of momentum and excitement.

The tech start-up scene really took root in the early 2000s, with incubators like the Technology Entrepreneur Center (TEC), the Center for Emerging Technologies (CET), and the monthly networking at the Missouri Venture Forum's breakfasts [1, 2]. Tech activity was pretty sparse, still, and many companies in those early years faced challenges in location and funding. TEC, for instance, was founded in downtown St. Louis in 2003, at a time when few companies sought to locate

J. Brasunas (✉) · F. Chmelir (✉)
ITEN, 911 Washington Ave, Suite 722, Saint Louis, MO 63101, USA
e-mail: jbrasunas@itenstl.org

F. Chmelir
e-mail: fchmelir@itenstl.org

downtown and fewer people lived, worked, or visited there. Given the newness of the venture at that time and the lethargy among the civic and institutional leaders discussed above, it was very difficult for TEC to procure funding. The constant necessity of raising money hand to mouth to remain operational detracted attention from the goal of supporting new tech companies and improving the environment.

One of the most important activities between 2001 and 2005 in St. Louis was the implementation of a more robust and ubiquitous IT infrastructure [3]. While civic leadership was only marginally engaged, this growth happened in fits and starts by people who recognized opportunities and leveraged their own business assets and interests to put data centers, fiber optic networks, and other important elements of technology infrastructure in place.

However, while improvements were made, the city, collectively and in terms of policy, failed to take full advantage of the possibilities of the existing infrastructure downtown in those early years—redundant power opportunities such as dark fiber and utilities already in place beneath the streets—to really position St. Louis as a great location for a tech infrastructure to develop. For example, Google took a hard look at establishing a major data center in downtown St. Louis, but ultimately went elsewhere because the City of St. Louis and St. Louis County could not agree on who would own the contract. When the streets were repaved, very few people, and certainly not policy makers, proposed putting fiber down to provide high-speed Internet in all of the buildings. There were many unused resources, such as fiber optic infrastructure and real estate, and missed opportunities because the city did not yet have any leaders thinking ahead in terms of what could be done with the existing infrastructure.

36.2 Early Growth in Data Centers and Entrepreneurship

The early growth of the St. Louis IT industry was in data centers. The companies that gained traction at that time (Cybercon, Contegix, Xiolink, Connectria, and others) grew up as data centers for mid-tier companies to house and protect their data resources [4–7]. Established St. Louis leadership could see the value in these start-ups because data centers require real estate, lots of power, and expensive machinery—familiar infrastructure to traditional business. These data centers found an easy home in downtown St. Louis because of the existing, largely unused buildings with useful architectural elements: old manufacturing buildings with high ceilings and very heavy loading capability at the ground level, so they could hold a lot of weight. These were the physical attributes that data centers needed—all one had to do was install a few other necessary attributes, such as cooling and redundant power sources. It was cheap. Around the same time, there was an attempt by some real estate-holding individuals to make St. Louis a data center hub because power was also very cheap. The local energy companies (AmerenUE) saw how they would benefit from this and were eager to help make it a reality [8].

As this tech-friendly environment was being put into place, tech incubators such as the Center for Emerging Technologies and IT Enterprises took advantage of the

burgeoning infrastructure [9]. While the physical downtown location was difficult to financially maintain for TEC in those early years, the location-agnostic ITEN was much easier to sustain. ITEN, a regional initiative to help start-up tech companies anywhere in the St. Louis area—Missouri or Illinois—began in 2008 with an initial office at a small incubator owned by the University of Missouri, St. Louis [10]. A few years later in 2011, TEC itself was "reborn" as a co-working space for tech start-ups and was called T-Rex [11]. It was founded in the old Railway Exchange building in the urban core and was supported by a public–private partnership. It seems that the environment downtown had changed sufficiently by that point and T-Rex was able to actually get a foothold there, thanks to early support of ITEN and Capital Innovators, a St. Louis-based accelerator that was founded at the same time that T-Rex opened its doors [12].

As T-Rex began to fill up with Capital Innovator and ITEN start-ups, these organizations and other well-wishers began to look for ways to boost the momentum of tech-focused entrepreneurship in the area by providing resources and making connections for start-ups with mentors and other serial entrepreneurs. Additional support organizations began to spring up to further this mission. One such organization, Arch Grants, was created in 2011 and provides $50,000 non-dilutive grants to innovative start-up companies that locate their business in St. Louis [13]. The organization continues to drive early-stage growth in multiple sectors into the city. Recent industry-specific accelerators in St. Louis like YieldLab, focusing on Ag Tech, and Six-Thirty, a financial tech accelerator, are attracting ventures from all over the world to St. Louis while leveraging some core regional industry strengths. Together, these initiatives are furthering the development of the ecosystem that allowed more and better tech start-ups to arise. Because of those early champions, a lot of great stuff has happened in the time since [14].

For St. Louis to cement its renewed entrepreneurial identity, it must continue to connect entrepreneurs to the resources they most need: capital, talent, and customers. Investment opportunities need to be broadened to seek out multiple models of financially supporting entrepreneurs and their ventures. The Missouri Technology Corporation (MTC), a statewide entity focused on innovation and entrepreneurship, must continue to receive funding from the state legislature to invest in start-ups and in the support organizations that develop those start-ups [15].

36.3   University Collaboration Accelerates Entrepreneurial Opportunity

Universities must be brought into the conversation on talent, to plug their students into entrepreneurial opportunities on a more real-time basis, not just during semester schedules. Incubators in this region cannot be just about the physical space but must have activity and programming within their four walls to foster interaction, value, and growth for the start-ups they house. Finally, corporate innovation teams must interact more closely with start-up companies, collaborating on mutually

beneficial solutions to real market issues. Start-up companies in St. Louis need more local adoption from established firms to generate business activity within the City, as was the case decades ago.

In recent years, the ecosystem has attracted many creative minds. It has grown to the point where young entrepreneurs see opportunity in St. Louis [16], but there is still work to be done to get the greater community to find value in this and to find ways to reduce interference and to increase and fund the underpinnings that will allow the ecosystem to grow to the next level.

One corporation that has made great strides in making this happen is the Cortex Innovation Community, a leading non-profit organization in biotech innovation [17]. By bringing together bioscience and technology research with commercial development, they have been able to get a lot of the more imbedded older real estate leaders interested in their development projects, which people take notice of because of these traditional values the community has in physical real estate infrastructure. By thinking geographically and regionally, Cortex has been able to expand and form more crucial partnerships and gain the critical mass needed for growing momentum.

That forward thinking on the part of growth organizations, however, must be tempered by continuing attention to the fundamental nourishment of the entrepreneurial ecosystem; for an ecosystem to thrive, there are some things you start that you need to continue to do. While ITEN's mission has evolved over time, for example, its core functionality over 8 years remains the same: connecting entrepreneurs to experienced talent, validating their business models, and putting them in touch with investors and large corporations that will value their innovations.

While the St. Louis start-up scene today exhibits many of the different aspects that make up a thriving ecosystem, and while the entrepreneurial community has created a lot with a small amount of resources, what could we be doing with a better-funded ecosystem? There is a lot of money in St. Louis, but it is yet to be seen whether or not that money is being bet on the future of St. Louis, and if it is being bet on our future, is the entrepreneurial ecosystem part of that future?

One notable example of misplaced bets was seen a few years ago when Boeing put out a request for proposal (RFP) to find a location to undertake a new project for the United States Department of Defense [18]. They had been contracted to build an aircraft, so one of the RFP requirements was that the location has a seaport for shipping and logistics. Being landlocked, St. Louis failed to meet that requirement, but civic and economic development leaders still spent a great deal of time and energy putting an application together with incentives totaling over several hundreds of millions of dollars to put in front of this corporation and win the contract. This is the old smokestack-chasing economic model that is still prevalent not just in St. Louis, but in many American cities—leaders seek to persuade big corporate entities to either come to their town or stay in their town to gain the immediate impact of new jobs. But what happens when the contract ends and those jobs go away, what will we have done to fortify our community against future economic hardships? Boeing's contract would have potentially hired a good number of people, but wouldn't have been the foundational, sustainable, long-term

development we need. The amount of political will and energy expended was tremendous, at the local level, at the city and county level, at the state level, and even somewhat at the federal level. If a tenth of that budget were allocated toward something in the innovative entrepreneurial Smart City or other initiatives, you could make the argument that the multiplier in terms of wealth creation, jobs, and impact in the local region would dwarf whatever Boeing could have done, and of course Boeing ended up not choosing St. Louis. If that kind of coalition could come together around the entrepreneurial community our growth as a region would be exponential.

36.4   Conclusion

In St. Louis, we have a history of working against our mutual benefit. However, recent developments have led to great advancements in our entrepreneurial ecosystem. To continue this growth, we need regional leadership to look forward and allocate resources to sustain the growth of the growing entrepreneurial ecosystem. Leaders will need to plan for the city to become a more attractive place to young creative innovators: a city with great public transportation and opportunities for all regardless of race, gender, sexual orientation, or ancestral legacy and a city that welcomes people of all types, from all over the world, to live and work together. Solving these issues will be an essential component of St. Louis community revitalization and building the foundation for our Smart City.

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Chapter 37
Smart City Leaders, Champions, and Entrepreneurs—The People Part of Vibrant Smart Cities

Ken Harrington

Abstract This chapter will provide definitions for four Smart City elements: (1) leaders, (2) champions, (3) entrepreneurs, and (4) ecosystem development activities. It will then offer thoughts on the evolution of Chattanooga, Tennessee, and Kansas City, Missouri/Kansas, two Central US Smart Cities. The relationship between the four elements is important to discovering the economic and social innovations that are possible with Smart Cities. The key to this innovation cycle is ecosystems that cause high-velocity, collaborative relationships between leaders, champions, and entrepreneurs.

Keywords Kansas City · Chattanooga · Innovation · Ecosystem · Entrepreneur · Smart City · Economic development · Venture development · Entrepreneur development · Entrepreneur champion

37.1 Definitions

37.1.1 Leaders

What is a *leader*? Leaders are the people or organizations that control the resources and rules for a region, community, or organization. They are critical to Smart City initiatives since they choose priorities for how resources are used. The USA has leaders in governments, companies, universities, healthcare providers, not-for-profits, and philanthropic, religious, social, and other entities. All can benefit from Smart Cities, but the leaders must first decide how to muster the funding and effort to build the digital infrastructure that is needed. One challenge is convincing these various leaders and leadership groups to collaborate to commit the resources for Smart City assets. How to build the infrastructure is often decided with a top-down, leader-led, economic development plan. Leaders also work

K. Harrington (✉)
The Bayberry Group, 4 Bon Hills, St Louis, MO 63132, USA
e-mail: ken@bayberrygroup.net

together to create public/private partnerships, legal entities, and incentives that support investments.

A second function of leaders is to make strategic decisions on allocating resources to support entrepreneur development programming activities. An important choice is to decide whether these will be centralized or decentralized programs. Decentralized activities are powerful for creating bottom-up engagement by entrepreneurs. Centralized activity may lack passion and miss some high-potential areas of entrepreneurial activity that are not seen as strategic. Also, the measures of success for centralized activities are often economic outcomes like jobs, funding, new ventures, revenue, and the like. This is important but will not be realized unless there is high connectivity between entrepreneurs that in turn leads to new entrepreneur relationships. These relationships cause prospective founders to choose to start ventures more frequently. The experiences of those entrepreneurs increase the community's collective entrepreneurial IQ and that strengthens a region's entrepreneurial culture. Later parts of the chapter will expand on the importance of bottom-up entrepreneur development.

37.1.2   Champions

Who are the *champions*? Champions are the individuals that want to stimulate how particular areas of interest will change, evolve, and improve through the use of high-speed connectivity and more ubiquitous information. Their programs develop and stimulate entrepreneur founders who imagine and pursue ideas that use the network and information of a Smart City. Their role is to create an environment that causes large amounts of entrepreneurial action. Champions create this environment by forming organizations that are the catalyst for a region's entrepreneurial culture and innovation pace. Champion organizations need intentional investment by leaders. Entrepreneur development organizations are usually bottom-up and champion-founded. Often they are marginally funded, collaborative, and autonomous (not centrally coordinated and controlled) and focus on a specific area of interest. Champion-led organizations are the important multiplier that delivers the desired economic outcomes (new companies, jobs, lower costs, tax revenues, wealth, etc.) and social outcomes (public safety, improved health, reduced poverty, equitable opportunities, better education, etc.).

37.1.3   Entrepreneurs

Entrepreneurs are the ones who cause commercial, social, and mature organization innovation in Smart Cities. Without them, Smart City initiatives stall. Entrepreneurs have the vision to see how Smart City infrastructure and information will change what we do and how we work. Some of this change is disruptive, and some is

incremental. The motivation for change varies from wealth seeking, to creative accomplishments, to the greater public good, and others. All types of entrepreneurial action are needed and possible within Smart Cities. Regions that create champion-led ecosystem environments that are inviting to entrepreneurs will get the highest economic and social returns from their Smart City infrastructure investments.

37.1.4 Ecosystem Development Activities

Entrepreneur ecosystems are increasingly cited as the foundation for innovation. Vibrant ecosystems are a mix of economic and cultural assets that leaders, champions, and entrepreneurs put in place over years. There are three types of development where Smart City actors need to collaborate.

37.1.4.1 Economic Development

The first is *Economic Development*. The primary focus here is on putting into place the assets and infrastructure needed to cultivate, support, and mature ventures. Economic development is generally rooted in public policy and is supported by top-down strategies that are often led by economic development agencies. In most cities, this activity is undertaken by leaders who organize creative public, private, and philanthropic partnerships to support economic development. These partnerships developed strategies, generate incentives, and make considerable investments in digital networks as well as facilities, research initiatives, capital formation, workforce development, and similar areas, all of which are key parts of an innovation ecosystem.

37.1.4.2 Venture Development

The second type of ecosystem development is *Venture Development*, whose primary role is to provide the funding and incentives for commercial, social, mature organization, and other types of ventures. The startups can be new for-profit or not-for-profit companies that have been founded and are now trying to grow and scale. Mature organizations may offer funding to the new companies but also may invest in internal projects that are important to their business. Funding is given to ventures that have shown the most promise. Not all are funded. Investors want winners; thus, the funding selection process is competitive, the goal being to pick not just good deals but the best deals.

   In the commercial areas of venture development, entrepreneurs and investors share wealth, and the legal structures they establish support wealth seeking and wealth sharing. Venture development investors include self-funding, friends and

family, service provider discounts, angel investors, accelerators, venture capital funds, government co-investment funds, strategic partners, and private equity. In Smart Cities, the digital infrastructure makes it possible to found and grow innovative companies that would not be possible without high-speed connectivity and ubiquitous information.

In the social area of venture development, the motivation is less about wealth and more about improving society. These entrepreneurs are creating returns that are shared by society or a particular constituency. Funding comes from socially conscious customers and public, philanthropic, religious, and similar organizations. One example might be public health initiatives that were not possible without high-speed networks and the new information that feeds innovative applications and tools.

Mature organization (public and private sector) entrepreneurship is also possible. In this type of venture development, the funding comes from the established entity. The motivation may be innovation or efficiencies and cost reduction. An example might be innovation in government that reduces the time and cost of administration or improves constituency communication.

37.1.4.3 Entrepreneur Development

A third and critical component of a vibrant ecosystem is ***Entrepreneur Development***. Entrepreneur development focuses on supporting entrepreneurs who are thinking about or have decided to pursue an idea. Smart Cities need to have this type of programming and activity to increase the number of startups. The programming for developing entrepreneurs is typically offered free or for a nominal fee. No equity or compensation is exchanged, and the legal structure of the program entity is normally a not-for-profit. University education and co-curricular programs can play a large role in this part of the ecosystem. Entrepreneur development includes idea exchange sessions, mentoring services, grant funding, competitions, internships, education events, speaker events, startup weekends, hack-a-thons, and similar activities. Smart Cities need to intentionally design these champion-led entrepreneur development programs so there is a large pool of new entrepreneurs being created. In the parlance of baseball, entrepreneur development is the farm team system that is grooming the talent that advances to venture development.

37.2 Two Central US Examples

Some cities have already benefited from leaders who have collaborated and made economic development Smart City infrastructure investments. This section talks about two US examples that used different funding approaches. They are also at different maturity stages. Chattanooga, Tennessee, is a smaller metro area (528,100), and Kansas City is midsize (population 2,035,000). They are good

examples because both are working on digital infrastructure, as well as regional entrepreneurial ecosystems. This mixture of top-down economic development and bottom-up entrepreneur development will help them uncover the economic and social returns that are hoped for with Smart Cities.

37.2.1   Chattanooga, Tennessee

Chattanooga, Tennessee's city-owned agency the Electric Power Board (EPB) funded their digital infrastructure effort starting in 2008. They did this with a mixture of new bonds ($220 million) and federal grants ($112 million). Their gigabit Internet offering, Chattanooga Gig, drastically increased access to high-speed connectivity. The leaders in this case were the utility, civic, and other leaders who saw potential payback from a more attractive technology environment, lower utility operating costs, and new subscriber revenue. They created a network that reduced the costs of operating their power grid and infrastructure, especially cutting the time and cost of electric outages and repairs. In addition, the infrastructure provided greater connectivity for citizens and serves as an alternative to the slower Internet speed cable company.

The Chattanooga network is fully in place and offers service to EPB's 170,000 customers. The network is upgrading to 10-gigabit speeds in its second generation. Customers can choose from different Internet speeds, telephone service, and digital cable TV. Comcast is the main competitor.

Chattanooga's ecosystem appears to have a number of not-for-profit champion-led entrepreneur support organizations that are working on different entrepreneur development environments. One is the Company Lab, an entrepreneurial accelerator that supports entrepreneurial growth [1]. There is also the Lamp Post Group, a venture incubator that provides capital and mentorship to growing startups [2]. Another is the Chattanooga Market, which provides a low-cost environment to start, grow, or expand businesses for entrepreneurs who are hand-making, growing, or otherwise creating their own goods [3]. A fourth is Launch Chattanooga, which seeks to empower underserved communities and individuals through entrepreneurship [4]. Chattanooga also has publicly funded efforts like the Enterprise Center and Innovation District, a designated area for innovation and entrepreneurship as well as the INCubator at the Hamilton County Business Development Center [5, 6]. INCubator houses the Tennessee Small Business Development Corporation, a network of certified business counselors that support small businesses. In addition, Chattanooga is investing to expand connectivity to other cities while increasing network speed to 10 Gb.

Some issues that Chattanooga may consider are:

1. Are there enough champion-led entrepreneur development programs to create the high level of entrepreneur participation that is needed to scale venture and economic development?

2. Will the Chattanooga ecosystem create companies that uncover the many new Smart City commercial and social innovations that are possible?

37.2.2   *Kansas City, Kansas/Missouri*

Kansas City, which straddles the Missouri/Kansas border, is a second US Smart City putting in place the infrastructure while concurrently building a diverse entrepreneur ecosystem. Google Fiber chose Kansas City as their first gigabit city. The decision to build and fund the digital infrastructure was top-down and financed by Google. In turn, local municipalities within the Kansas City metropolitan area paved the way for a rapid Google Fiber infrastructure deployment by reducing or eliminating franchise fees, adopting favorable right of way ordinances and fast-tracking community broadband agreements. Google agreed to build networks and provide access in neighborhoods where enough subscribers committed to the service and where the local municipality took proactive steps to reduce regulatory hurdles. The network is being built in a series of 14 fiberhood geographic footprints and is still a work in progress with some fiberhoods more complete than others.

Prior to and since the 2011 Google Fiber announcement, a number of top-down economic development and bottom-up entrepreneur development efforts have been put in place. In 2011, Mayors Sly James (Missouri) and Joe Reardon (Kansas) appointed the Mayors' Bi-state Innovation Team and charged it with developing a playbook of creative ways the community could use Google Fiber to spark economic development, advance opportunities, and improve daily life in Kansas City [7]. KC Digital Drive, a champion-led not-for-profit, was formed and funded with $1.25 million to implement and refine the KC Digital playbook following the Bi-state Innovation Team effort [8]. KC Digital Drive has spurred and is tracking what appears to be 200 innovation efforts across a diverse set of impact areas, including gigabit applications, digital inclusion, economic development, government, health care, and education. This specific Smart City thinking and work is complimented by and benefits from a regional entrepreneurial ecosystem that has evolved over several years. The regional goal is to make Kansas City America's most entrepreneurial city.

Kansas City has also put in place an impressive number of entrepreneur development efforts in diverse areas. The KCSource Link Web site lists over 200 not-for-profit, economic development, and entrepreneur-related support groups that underpin the region's ecosystem(s) [9]. These are creating innovation momentum across a broad front, including animal science, bioscience, technology, food, education, female entrepreneurship, not-for-profits, and others. Some examples follow.

One Kansas City, grass roots effort is Startup Village, an entrepreneur-led community with physical space and programming that helps grow and support entrepreneurs [10]. A second is UP Kansas City, which supports new ventures with volunteers who provide resources for entrepreneurs and connects the community

[11]. They are a chapter of Global UP and have events including startup weekends where entrepreneurs launch new companies. The Kauffman Foundation's one Million Cups is a weekly volunteer-organized community meet-up where entrepreneurs present and support one another [12]. The Center for Entrepreneurial Ecosystem Development is a startup ecosystem incubator that is building a pipeline of engaged, entrepreneurial talent [13]. Digital Sandbox KC provides proof-of-concept resources including market validation, prototyping and beta testing support for development of digital technologies within new and existing businesses [14]. It started with an I6 grant from the US Department of Commerce Economic Development Agency. The Farm to Table Kitchen is a shared-use incubator for small businesses such as farmers' market vendors, food trucks, caterers, and others to make their products [15]. Each of these groups and many more will uncover how Smart City infrastructure might be used for innovation in their area. These are just a few, and the KCSource Link Web site can be referenced for a comprehensive list of all the regional efforts that are underway.

The Ewing Marion Kauffman Foundation, the world's largest foundation focused on entrepreneurship, is located in Kansas City and adds to the energy and philanthropic support for the entrepreneur ecosystem. Their programs are numerous and span education, convening experts, research, and programs supporting innovation and entrepreneurship. All of these add to the entrepreneurial IQ in the region and bode well for discovering new applications for the Google Fiber asset.

Kansas City appears to be putting in place the infrastructure and entrepreneur ecosystem that is needed for the region to discover the new economy and society that are possible with a Smart City. Building a Smart City network and developing a vibrant ecosystem both take a long time, a lot of collaboration, and some luck. The connectivity happening around Kansas City's entrepreneur development seems to be creating an entrepreneurial mindset and culture that will be attractive to entrepreneurs.

Some issues that the Kansas City might consider are:

1. Will the momentum be fast enough and have the longevity to ensure Kansas City achieves their goal of being America's number one entrepreneurial city?
2. Can Kansas City's ecosystem become fully market-funded so it is self-supporting, with Smart City companies becoming a significant contributor to the region's economy?

37.3 Conclusion

Smart City initiatives should invest in both infrastructure and ecosystems. Entrepreneurs who imagine and then pursue change are a critical component of success that needs to be intentionally nurtured. This should be done across a broad number of interest areas in which champions lead entrepreneur development efforts.

The role of the champion is to find the funding and then create collaborative environments that are engineered to connect entrepreneurs having similar interests. Leaders should put in place the infrastructure and also establish the incentives and environment that is inviting to entrepreneur development champions. Winning Smart Cities will find the resources and creativity to create the most inviting regions that retain and attract Smart City entrepreneurs. The leading Smart Cities will guide us in uncovering the new economic and social changes that are possible.

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Chapter 38
Connected Innovation Neighborhoods and Innovation Districts

David Sandel

Abstract The Smart City movement offers the potential for cities to utilize information and communications technology (ICT) to enhance their livability, workability and sustainability. However, Smart City initiatives often fail to gain traction because of their size and scale, the lack of leadership and well-understood socioeconomic value propositions and associated business models. To build the Smart City, the authors describe a holistic approach in which entrepreneurial and infrastructure ecosystems, and their associated socioeconomic business models, become integrated and connected, thereby creating an organic community foundation and entrepreneurial platform from which to support the long-term development of the Smart City.

Keywords Kansas City · Chattanooga · Gigabit city · Innovation district · Ecosystem · Entrepreneur · Smart City · Economic development · Entrepreneur development · Entrepreneur champion

38.1 Innovation Neighborhoods versus Innovation Districts

Smart Cities need the ability to collect data on a large scale and then use that data to produce improvements in community and government services. To make that possible, Smart Cities will need to have ultra-high-speed, ubiquitous and low latency communication infrastructure in place to collect data that will ultimately be used to enable local application and business model development.

Since cost justification and the time to construct an ultra-high-speed metropolitan Internet are significant, it is advantageous to start developing these advanced networks on a smaller scale. It would also be beneficial to develop prototype data collection capabilities, Smart City applications and their associated

D. Sandel (✉)
Sandel & Associates LLC, 6900 Delmar Blvd, St. Louis, MO 63130, USA
e-mail: davidsandel@gmail.com

business models at the same time. Together, this kind of early stage demonstration and proof of concept would go a long way to accelerate the development of the kind of political support necessary for the construction of a larger network.

In the St. Louis area, the best places to start developing on a small scale are the areas of town where there is already a unique creative class that is disposed to the use, and development, of advanced networks and their applications. In the St. Louis area, that would be both the innovation district and the innovation neighborhoods.

As they are evolving in the St. Louis area, however, innovation districts and innovation neighborhoods are uniquely different and should be discussed in the context of developing the overall entrepreneurial ecosystem and Smart City platform. Through understanding how innovation neighborhoods and innovation districts can collaborate together and thus create greater entrepreneurial activity, we begin to understand how regional economic development impact can be accelerated and improved.

In the Brookings Metropolitan Policy Program report "The Rise of Innovation Districts: A New Geography of Innovation in America," the authors describe an emerging urban model called "innovation districts" [1]. As described in the report, "these districts, by our definition, are geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators. They are also physically compact, transit-accessible, and technically-wired and offer mixed-use housing, office, and retail." These innovation districts also tend to be "where underutilized areas (particularly older industrial areas) are being re-imagined and remade."

Because innovation districts generally appeal to persons or organizations familiar with a university or institutional setting, they tend to be something of an exclusive club utilized by persons of a higher educational or socioeconomic status. Innovation neighborhoods, on the other hand, are at the center of community life and are inclusive in nature. They are neighborhoods that are capable of attracting a unique creative community that allows all comers, no matter what education level or socioeconomic class they may come from. Innovation neighborhoods thrive on talent, regardless of how it arrives. Because of this inclusionary effect, innovation neighborhoods should have higher potential for socioeconomic growth than innovation districts.

In some ways, the concept of innovation neighborhoods that has evolved in St. Louis is a unique and organic social impact response to years of socioeconomic segregation and numb political leadership in the St. Louis area [2].

Innovation neighborhoods seek to connect individuals across socioeconomic boundaries (through the use of ultra-high-speed Internet and inclusive access to entrepreneurial and educational organizations), whose residents, businesses and entrepreneurs ultimately realize the economic and educational benefits of collaboration whether on an individual, organizational or virtual basis. Because of this, innovation neighborhoods are distinctly different from innovation districts.

38.2   The Central Corridor

The St. Louis area has a central corridor that runs from the riverfront to the City of Clayton. The corridor comprises a unique mixture of neighborhoods and organizations that have a distinct creative class or cultural flair. This central corridor is also where most of the region's creative talent resides. Due to various historic and cultural forces that have been discussed in previous chapters, for the most part these neighborhoods have developed independently from one another from a socioeconomic perspective. The central corridor is currently where St. Louis's innovation district and innovation neighborhoods reside (Fig. 38.1).

38.3   Neighborhoods

38.3.1   The Delmar Loop Neighborhood

The Delmar Loop is known for its big picture thinkers, creative and performing arts, and media and university talent. It is a natural entrepreneurial meeting place because of the wide variety of places to sit and have a cup of coffee or tea.

During the 1950s, the Loop was the meeting place for University City youth. The Varsity Theater and the Tivoli showed first-run movies, and there were
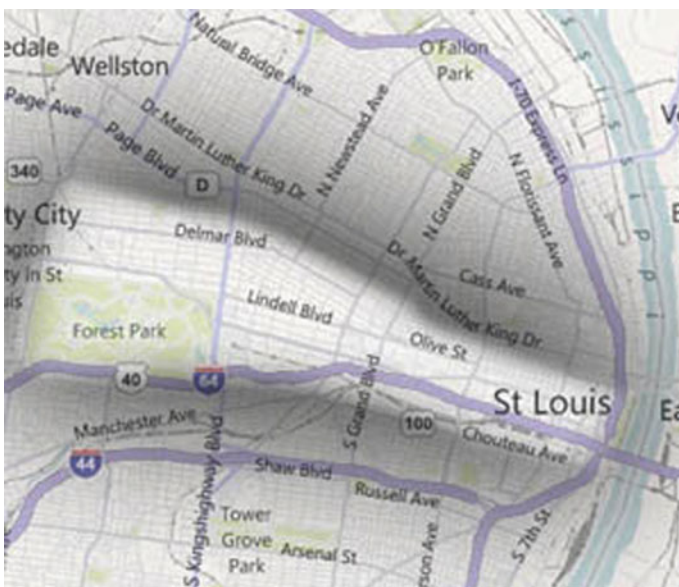
Fig. 38.1 Central corridor. *Source* City of St. Louis 2014

restaurants up and down the Loop area. Enright Avenue, which was part of the streetcar turnaround, had a drugstore, three restaurants and a record store. There was another drugstore on the corner of Delmar and Kingsland. Both drugstores had soda fountains. Delmar at Skinker was not yet considered part of the Loop but had both well-known restaurants and a well-known nightclub across from the intersection (Fig. 38.2).

The Loop has always attracted an eclectic clientele and has a wide variety of street life, due in part to its proximity to Washington University and dating back to the late 1960s when Street side Records and head shops dominated the retail landscape. Although the Loop is the natural college town area for nearby Washington University, few of the retail establishments and restaurants have found their primary support from college students. Visitors walk to the Loop from nearby residential streets and take the metro or drive in from all over the city.

Today, the Delmar Loop is a neighborhood in transition. Many of the entertainment and restaurant venues that developed successfully during the 1950s and 1960s are now in the fall of their season. Washington University now enrolls a large number of international students. These students look forward to international venues being developed for the Loop area. They also seek part-time student projects or employment opportunities that are related to the new digital economy.

Two very well-known companies, Twitter and Square, started in the Delmar Loop neighborhood. Both companies ultimately left the area because of the lack of availability of ultra-high-speed infrastructure and software talent.

Fig. 38.2 Delmar Loop neighborhood. *Source* The Delmar Loop business district 2015

38.3.2   The Delmar/Euclid Neighborhood

The Delmar/Euclid area has the Washington University Medical School and medical community to the south and the Delmar Divide to the north [2]. The Delmar Divide has one of the most significant socioeconomic divisions in the USA between the higher education and medical community and the socioeconomically disadvantaged community. The area is often perceived to be a dividing line between socioeconomic classes in St. Louis (Fig. 38.3).

Delmar Boulevard is a street that runs through the heart of the St. Louis metropolitan area. Delmar Blvd/N Euclid Ave real estate is primarily made up of small (studio to two bedroom) to medium-sized (three or four bedroom) units in small apartment buildings and single-family homes. Most of the residential real estate is renter occupied. Many of the residences in the Delmar Blvd/N Euclid Ave neighborhood are relatively historic, built before 1939 and, in some cases, quite a bit earlier. A number of residences were also built between 1940 and 1969.

One of the unique characteristics of the Delmar Blvd/N Euclid Ave neighborhood revealed by analysis is that the per capita income of residents here is lower than that found in the greater majority of the neighborhoods in America [3]. Also of note, a significant number of the children in this area live in poverty; an extraordinarily high percentage compared to other neighborhoods in the nation [4]. In a nation where approximately one in four children grows up in poverty, this neighborhood stands out for the depth of the problem manifested here.

38.3.3   Cortex Innovation District

Cortex is a traditional institutionally focused innovation district, but its foundation in a particular set of St. Louis strengths—the life sciences and information

Fig. 38.3 Delmar/Euclid neighborhood. *Source* Savor St. Louis 2014

technology—makes its collaboration with various of these innovation neighbor-hoods achievable and worthwhile.

Central to St. Louis' growing success is this Cortex district, Cortex developers are making plans for its future, including $2.1 billion in construction, 4.5 million square feet of new space for offices, research, hotels, retail and more; a new MetroLink station; and 13,000 permanent technology-related jobs [5].

Current American thinking says that if a modern American city wants to attract more innovation, it needs an anchor site like Cortex that can enable the university, the medical school, and the life sciences and bio-technology sectors.

A good example of how these assets help create an entrepreneurial climate in St. Louis, whose tech corridor is built around St. Louis University, Washington University Medical School, and several other hospitals where institutionally focused cutting-edge research is flowing over into the innovation district's other tech companies, is seen in the continuing flow of announcements of new businesses and funding activities in and around the Cortex innovation district.

The Brookings Institution describes St. Louis and Cambridge, Massachusetts, as the two cities exemplifying this kind of growth. However, because of Cortex's institutional and high profile focus, most persons in the St. Louis area are likely to never become part of the Cortex community. However, Cortex is an invaluable resource to the greater community. Connecting Cortex to the other innovation neighborhoods with ultra-high-speed Internet access allows those innovation neighborhoods to become on-ramps for persons who might not ever participate in the innovation economy, and who might ultimately want to become part of Cortex, or vice versa.

Combining both innovation districts and innovation neighborhoods in this way has the potential to create a greater socioeconomic impact than having a single institutionally focused innovation district.

38.3.4   The Grand Center Neighborhood

Today, the Grand Center neighborhood is home to a wide range of performing arts and media outlets. This includes the Fox Theatre, Symphony Hall, the Jazz Bistro and Jazz School. As such, this neighborhood's combination of talent could benefit from access to high-speed fiber optic infrastructure and would lend itself well to becoming a more connected part of the overall St. Louis entrepreneurial ecosystem or innovation neighborhood (Fig. 38.4).

Originally, Grand Center was a major Midwest tourist destination in the early 1900s—the premiere destination for entertainment of all kinds. Theaters, shops, offices, hotels and restaurants filled the blocks, and some of the most luxurious homes in St. Louis lined the streets.

As the automobile was adapted into the lives of Americans, St. Louisans embraced their new mobility and moved away from the city and into the suburbs, leaving Grand Center to fall into decline by the 1960s. Businesses and theaters

Fig. 38.4 Grand Center in the 1950s. *Source* Grand Center 1951

closed, buildings were left vacant and decayed. Many were replaced by parking lots, creating vast empty spaces within Grand Center. This is another example of how socioeconomic decline manifested itself across the St. Louis metropolitan area.

Saint Louis University, however, remained dedicated to the city of St. Louis, and chose not only to stay, but to become an engine for redeveloping our city. Today, this area has seen significant revival as a creative performing arts and media center close to St. Louis University.

While Grand Center's media and performing arts presence has improved greatly, to lessen socioeconomic divides such as those we see in the Delmar/Euclid area, this neighborhood might further benefit from ultra-high-speed Internet access to bring Grand Center's cultural resources to a wider audience who cannot afford to attend the events. This content could be distributed through community centers, churches, schools and other locations along both Grand and Delmar Boulevards.

38.3.5   Washington Avenue Neighborhood

Downtown St. Louis and Washington Avenue is the home to the Regional Commerce and Growth Association (RCGA) and the Technology-Regional Entrepreneurial Exchange (T-REX) (Fig. 38.5).

In this one neighborhood, there are many different kinds of living options nestled within the older and architecturally significant downtown buildings. This makes for a great urban living experience for young persons and millennials looking for an escape from the high cost of living found in cities like San Francisco, New York and Seattle. It is also a great location for millennials looking for an urban area that could benefit from the creative ideas of young people and hence create new
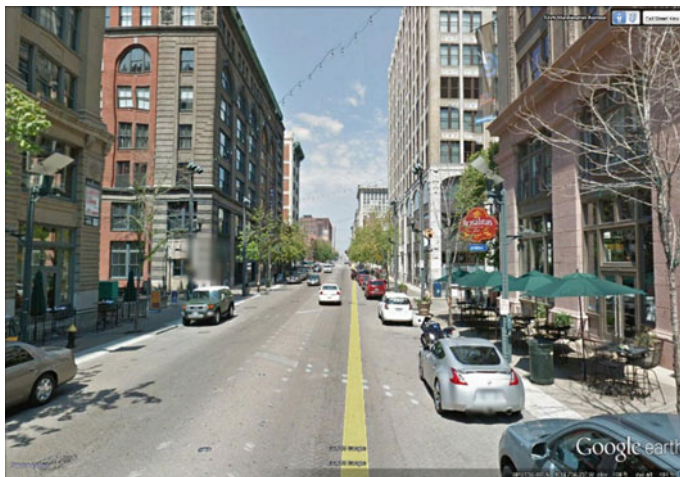
Fig. 38.5 Washington Avenue looking west. *Source* Rooflines 2014

entrepreneurial opportunities for young residents who prefer a highly urban living option.

Washington Avenue forms a link between the Mississippi River and the Downtown West District. Located along the entire length of Washington Avenue are key Downtown destinations including Laclede's Landing, America's Center, the Convention Headquarters Hotel, the Trans World Dome and the City Museum. Washington Avenue from Ninth to 18th Street, historically the garment district for St. Louis, is currently transforming into a dynamic urban loft district. This unique area, defined by Delmar Boulevard on the north, Locust Street on the south, Ninth Street on the east and 18th Street on the west, is a focus for immediate strategic actions.

The Washington Avenue Loft District consists of a handful of long-time, stable businesses. Institutional and educational facilities located near the Washington Avenue Loft District include the main Public Library, Webster University's Downtown branch adjacent to Lucas Park, and St. Nicholas Catholic School. The buildings along Washington Avenue include a great concentration of late 1800 to early 1900 buildings, predominately six to eight stories in height. These buildings are typically in fair condition creating living and business opportunities for young people, entrepreneurs and millennials. The most vibrant street life occurs late at night in spots along Washington Avenue where nightclubs are located.

The Washington Avenue area is rich with fiber optic infrastructure. Originally constructed during the Internet Bubble of 1995–2000, a fiber optic backbone connects almost all the buildings on Washington Ave. However, the real capacity of the fiber backbone did not really begin to be utilized until the 2015 timeframe [6].
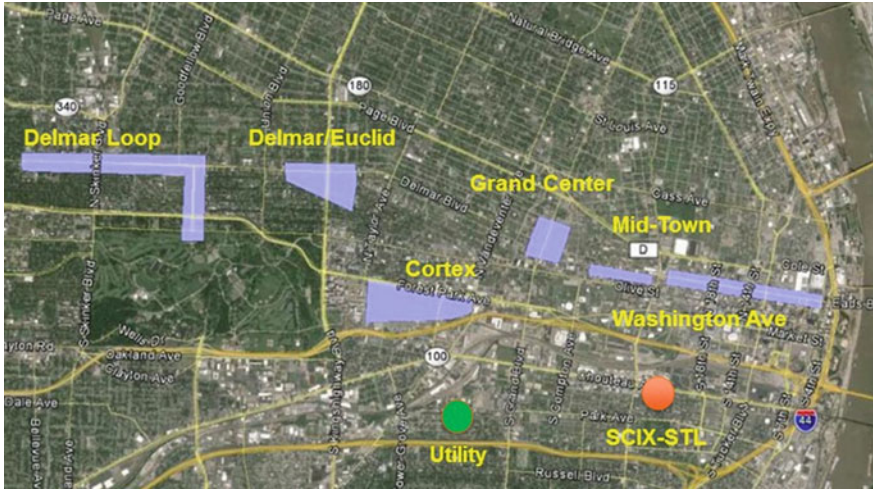
Fig. 38.6 SCIX—Cortex innovation district and surrounding innovation neighborhoods. *Source* Author

38.4   Smart City Internet Exchange

To efficiently interconnect the various innovation neighborhoods and innovation districts, the Smart City Internet Exchange (SCIX) is now being developed for the St. Louis region. The SCIX is a peering point for local innovation neighborhoods and innovation districts to exchange Internet traffic with the advantage of lower latency and lower costs for connectivity and Internet access [7]. The SCIX will also act as a service delivery point for Smart City services. These services could include a regional database for the collection of data and analytics, IoE, high-speed wireless networks, sensor networks and advanced security services. Public sector fiber optic networks could also terminate here (Fig. 38.6).

The SCIX would be operated as a not for profit, community interest organization. Local higher education institutions, colleges, tech schools and entrepreneurial organizations would have collaborative access to the SCIX, and its partners, for purposes of developing Smart City technologies, applications and business models.

38.5   Conclusion

Interconnecting our innovation neighborhoods and districts with ultra-high-speed Internet capacity would create new collaboration and entrepreneurial opportunities within, across or between each neighborhood's entrepreneurial ecosystems. New Smart City technologies and their associated business models could be developed and tested. Community champions, essential to all forms of Smart Economy

development, could be identified and groomed. By hatching new Smart City public sector innovations on a small neighborhood scale first, this would help facilitate the acceptance and the development of the socioeconomic contract and associated business and use cases necessary to gain the support of local political leadership.

Interconnecting neighborhoods would also have a positive sociological effect on the community since these new ultra-high-speed connections would cut across neighborhood and political subdivisions and would be available to all persons within or around those neighborhoods. Furthermore, by including persons who are economically disadvantaged, we connect a larger community of ideas and inspirations that ultimately result in accelerating the public sector innovation process and sense of public good.

Together, the highly interconnected innovation neighborhoods and districts would serve as the early stage, community foundation and entrepreneurial platform from which to build our Smart City.

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Chapter 39
Estimating the Economic Impact of Smart City Innovation Neighborhoods

Patrick McKeehan

Abstract Capital investment projects use standard input–output modeling to estimate economic impact and justify decisions to move forward. In this chapter, I begin by breaking down the elements and inputs used in a standard economic impact analysis with some examples of how the "number" is used and misused. This is followed by an explanation of the traditional model for projecting economic impact. The subsequent chapter provides an introduction to a new Smart City model for determining the economic impact of ultra-high Internet deployment, especially in the innovation neighborhoods discussed in the previous chapter. The conclusion provides recommendations on how to improve this decision-making process and measure long-term economic impact for the Smart economy.

Keywords Economic impact · IMPLAN · Fifth utility · Equilibrium · Leakage · Input–output model · Smart economy · Smart city · Gigabit city

39.1 Introduction

As Smart Cities and ultra-high-speed Internet access proliferate globally, an expanding number of institutions, organizations, governments, businesses, entrepreneurs, and citizens are becoming increasingly reliant upon this invaluable tool for critical operations as well as daily functions. The Internet, and more specifically cloud computing, has moved into the ranks of water, gas, electricity, and the telephone as indispensible infrastructure, or the "fifth utility" [1]. A growing number of communities across the USA are deploying high-speed or gigabit-level Internet systems to meet this demand, including Chattanooga (TN), Kansas City (KS), Austin (TX), Charlotte (NC), Mesa (AZ), and St. Jose (CA) [2]. These communities, for the most part, are beginning to gain positive returns on investment—some intended and many unanticipated—across many sectors of their economies.

P. McKeehan (✉)
PMcK Consulting, 1012 St. Louis Street, Edwardsville, IL 62025, USA
e-mail: pmckstl@live.com

Public and private sector leaders use a number of information sets, including an analysis of potential economic impact, to inform their decision for making these Internet investments. While an economic impact (EI) analysis or statement has a place in the deliberations, use of the "number" or total estimated impact regularly extends beyond the initial decision-making process. Once decided, these same leaders tend to use these fiscal estimates to justify the capital investment through its potential economic benefits. Politicians, project stakeholders, economic developers, and representatives of the media use the estimate to explain and/or justify the decision. Put into the context of future jobs, wages, capital investment, and "indirect" economic benefits, it becomes very difficult to argue against the investment. Regrettably, the "number" is almost always overestimated and, in many cases, completely wrong.

A greater challenge arises when applying this flawed process to a planned investment in ultra-speed Internet deployment. The relatively low infrastructure cost of that deployment, compared to a new interstate highway bridge or electric power plant, limits the number of project-related jobs it would create and its capital investment impact. The installation of ultra-high-speed Internet, as compared to a new bridge or power plant, happens in a relatively short timeframe and significantly lowers total work hours and wages. Furthermore, a majority of the projected economic impacts are directly tied to the high-speed Internet user's ability to integrate this new infrastructure investment into operations. For example, ultra-high-speed Internet services reduce the download time of large data files, thereby improving work efficiencies and lowering operational costs. When and how effectively the user may tap into these advantages is very difficult to determine.

Given these challenges, is it possible to develop a method for comprehending, estimating, and ultimately measuring the Smart City economic impact of high-speed Internet deployment? If it is possible, will this process provide the same value to community leaders and those who use economic impact analysis to justify their decisions and actions? In this sub-chapter, I begin by breaking down the elements and inputs used in a standard economic impact analysis with some examples of how the "number" is used and misused. This is followed by an explanation of the traditional model for projecting economic impact. The subsequent sub-chapter provides an introduction to a new model for determining economic impact of high-speed Internet deployment, especially in the innovation neighborhoods discussed in the previous chapter. I conclude this chapter with a recommendation on how to improve this decision-making process and measure long-term economic impact.

39.2 Traditional Economic Impact Analysis Gone Wrong

Community leaders are constantly faced with a challenging decision related to the when, where, and how much of public infrastructure investments. Outside the unquestionable needs of replacing a collapsed bridge or water/sewer lines after an

earthquake, these leaders regularly consider a number of key factors in their decision process. These factors may include, but are not limited to:

- verifying the true cost of the investment;
- setting the project start and completion dates;
- determining the funding needed to build the project and make it fully functional;
- estimating economic, environmental, and social impacts;
- preparing for operational costs and long-term maintenance of the system(s); and
- assessing possible opportunity costs that may occur given the decision to fund one project over another.

Many of these factors are relatively easy to determine. For example, a professional engineering firm designing the project would estimate cost, project managers would establish timelines, and operational staff would determine functioning cost and repair/maintenance schedules. Engineers and technicians with expertise in the environment and social sciences would survey the project area and assess potential impacts. But in the area of economics, the process is treated differently.

Firms with expertise in planning or urban development are usually tasked with managing economic impact studies. On occasion, community leaders or public organizations might employ an economist to "run the numbers." In most cases, whether it is a voluminous report or simple summary, the estimated economic impact is the sum of known quantities (e.g., jobs, wages, capital investment) times a pre-determined multiplier that accumulates over a projected number of years, sometimes decades. The estimator usually applies a discount or interest rate to factor in growth and a percentage rate to the yearly aggregate to account for "leakage" of economic benefits outside of the impact area. A basic understanding of math and the compounding effect reveals that even modest inputs multiplied by a number greater than one and added together year after year will eventually become a very big number [3].

For community leaders and project advocates, the bigger the number the better. A large economic impact number more easily justifies project expenditures. A large economic impact number yields cost-to-benefit analysis that would sway the most ardent skeptic [4]. A large economic impact number tends to outweigh other key factors like the environment or social impact. It also allows decision makers to ignore opportunity costs and move forward on a project with little hesitation. Unfortunately, these numbers are, in most cases, grossly exaggerated due to inappropriate assumptions, ill-defined project boundaries, use of the wrong multipliers and/or discount rates, and the belief that impacts continue to compound instead of diminish over an extended period of time [5].

The St. Louis region has experienced a number of egregious examples of overblown estimates of economic impact. The list includes multi-billions in economic impact predicted from a new bridge over the Mississippi River; a professional baseball stadium built one block south of the stadium it replaced; the addition of eight miles of track with numerous stops to the region's light rail system; and a

relatively unused $1.7 billion airport runway extension that caused the removal of more than 2000 homes, 75 businesses and displaced thousands of families.

The latest addition to this list is an economic impact study completed in November 2015 by the Midwest Transportation Center (MTC) and the Institute for Transportation (InTrans) at Iowa State University [6]. The study was commissioned by a coalition of public/private concerns lead by the Terminal Railroad Association of St. Louis. This group wanted to learn about the "real" economic impact of replacing a 126-year-old railroad bridge over the Mississippi River north of City of St. Louis. The study, entitled, "Economic Benefits of Additional Rail Bridge Capacity: A Case Study on the Benefits of Replacing the Merchants Bridge Main Spans at Saint Louis," makes a very convincing argument for the bridge owner, Terminal Railroad, to receive large public support and funding for the bridge replacement. The report's Executive Summary clear states the case:

EXECUTIVE SUMMARY

The Merchants Memorial Mississippi Rail Bridge and MacArthur Bridge over the Mississippi River make up the most heavily used Mississippi River rail crossing in the country. A large contributor to the popularity of the Merchants Bridge is its accessibility to all railroads. However, the bridge is 126 years old and in significant need of repair.

Without improvements, the bridge will close in 2034 and all current traffic will be rerouted to longer routes, resulting in hundreds of extra miles traveled and more time spent. Repairing the bridge will cost approximately $250 million for construction, which includes the additional costs of closing the bridge during the repairs.

However, the project is set to generate billions of dollars in cost savings in the coming decades. At a discount rate of 7 %, improving the Merchants Bridge will lead to nearly $4.7 billion in net benefits over the next 20 years and approximately $6.6 billion in the next 30 years.

These benefits will not only be realized by the transportation industry, they will help the entire region. Therefore, reconstructing the Merchants Bridge will generate economic benefits that will protect the most heavily used Mississippi River rail crossing and provide sizeable benefits to the public, at large. [7]

In four succinct paragraphs, the report claims that the replacement bridge will achieve in 20 years a grand total of "$4.7 billion (US) in net benefits" to the region with another $1.9 billion (US) in the following decade. The details of the report provide the inter-workings of this extremely large economic impact estimate. The replacement bridge generates millions of dollars in economic benefit to the region from multiple sources, including

- transportation cost savings
- fuel cost savings
- environmental cost savings
- maintenance cost savings
- inventory cost savings.

These valuable savings are produced through efficiencies in time, distance, and the diversion of freight onto railcars that would normally travel by truck. The report writers even calculate the cost savings from reduction in noise pollution caused by switching freight from trucks and longer rail routes. Even with a 7 % discount rate, the 20-year totals reach well into the billions with $447 million (US) contributed by safety factors (reduced number of freight-related accidents) and another $636 million (US) in environmental related savings.

39.3   Numbers Behind the "Number"

Estimates of economic benefit or impact like the one mentioned above all begin at the same starting point—key project assumptions. For infrastructure-related projects, these assumptions include the cost of materials, jobs and wage totals, and expenditures on professional services such as legal, engineering, and inspection services. Estimates connected to events may include assumptions on number of attendees, entrance costs, hotel nights, average meal costs, and increases in sales tax receipts. For less tangible or time-specific activities, these assumptions are more difficult to define and measure. In many of these studies, the analysis of economic impact begins to include perceived impacts that are indirectly related to the primary event—case in point, the savings from a reduction in future accidents or value placed on projected noise reduction.

Once the projection assumptions are identified and agreed upon by stakeholders, a quantitative value is assigned along with the study timeframe (e.g., 5, 10, or sometimes 20 years). At this point, an economic multiplier is applied. Depending upon the type of investment or jobs created, the multiplier may vary. Many economic impact studies use a range of multipliers based upon the project's geographic location, boundaries, and types of jobs generated. These multipliers are usually found from one source—IMpact analysis for PLANning, or IMPLAN modeling.

IMPLAN modeling was devised by two US Federal agencies in the 1970s to more effectively use large data collected by the government [8]. Based upon the input–output modeling theory developed in the 1930s (see textbox), IMPLAN began the process of linking changes in economic activity with predictions of short-term and long-term impacts. In 1988, the University of Minnesota launched a commercial version of the estimating economic impact. The model uses social accounting matrices and pre-determined multipliers to calculate direct, indirect, and induced impacts [9]. When these impacts are added together over the life of the project period, the total economic impact estimate is created.

Nobel Prize winning American economist Wassily Wassilyevich Leontief developed the theory behind the input–output model. The Russian-born Leontief's input–output model explained in his book, "The Structure of the American Economy, 1919–1929" established the foundation for modern day economic impact statements.

As statisticians became more proficient in collecting and processing data, economists improved their understanding of input–output relationships between industry sectors leading to an increased use of IMPLAN for economic impact analysis and investment decisions. This new knowledge produced the capacity for additional layers of projected impact (e.g., environmental, safety, fuel, and time savings) in economic impact analysis. More and more economic impact statements produced bottom line numbers that were highly inflated, enabling community leaders and project decision makers to further justify the investment. The example listed above is a clear demonstration of how this process would translate a straightforward $100 million railroad bridge replacement project into a four billion dollar economic regional impact.

39.4 Finding a New Paradigm for Smart City Economic Impact

Efforts to create a Smart City clearly reflect a new approach to community/economic development. Smart City strategies are driven by wide-ranging, forward-thinking approaches that focus improving traditional systems (e.g., public safety, public education, commerce, and transportation) while increasing opportunities through access to and utilization of advanced technologies and data collection. These strategies extend beyond the traditional measures of economic growth—jobs, wages, and capital investment—to incorporate important values such as innovation, entrepreneurship, inclusion, and equity. To capture these values, a new formula must be devised to begin acknowledging these seemingly intangible assets while enabling community leaders and project decision makers to justify key investments.

39.4.1 First Steps

Traditional economic impact models are built upon an understanding of how new inputs—in this case, capital investment and wages—flow through the community like ripples on a pond positively impacting all that is in its wake. Basic calculations using IMPLAN will capture these essential numbers, although most of the value is affiliated with the construction activities and produce a temporary impact to the

impact area or community. The temporary nature of these impacts is due, in part, to the constant flow of expenditures and wages out of the impact area. An investment in broadband capacity, especially focused in a defined project area like an Innovation Neighborhood, would be easy to assess for these traditional inputs.

39.4.2 Extending Beyond Traditional Parameters

At this point, the alternative model to estimating economic impact begins to move away from IMPLAN's input–output analysis with an assessment of the key demographic factors within project area or Innovation Neighborhood. These factors should include, but are not limited to:

- age and education attainment of the target area population;
- job titles and wages of those employed; and
- unemployment levels and the skills of job seekers.

The next step is to assess the economic and growth potential of the target area, including:

- use of existing commercial and office structures;
- available real estate and land for development;
- sales tax revenues;
- any planned development and requests for zoning changes; and
- the ability to convert existing space to "higher and better" use.

The final step is to gauge the economic opportunities with the surrounding region. This would include evaluation target industry clusters, recent job growth/loss in key sectors, and the adoption rate of technologies that benefit from ultra-high-speed Internet access.

On counter side of these activities, this assessment must take into account economic leakage factors, the "turnover" rate of new monies that flow into the project area, and economic equilibrium, or those factors adversely impacted by new activities [10]. This last concept addresses factors such as how improved access to online shopping reduces the demand for local goods.

39.4.3 Sum of Many Disparaged Parts

The alternative model for estimating economic impact analyzes the information gathered and begins to create a projection of the project economic future based upon investment in and the implementation of Smart City strategies. The model places greater emphasis on what can be realistically captured by the project target area through increased utilization of existing economic assets, greater employment

of individuals residing in the target area, increases in sale and property tax revenues, and overall improvements in quality of life. These factors are weighed and used as additional inputs in the IMPLAN model to generate more accurate economic impact projections.

39.5 Conclusion

Elected officials, community stakeholders, and business decision makers play a central role in determining when and where ultra-high-speed Internet systems are deployed. These Smart City infrastructure investment decisions are based upon a wide range of important factors, including the long-term economic impact on the community. Traditional methods of estimating these impacts based upon input–output modeling are woefully inadequate in capturing the wide-ranging Smart City benefits.

Smart City advocates and leaders must adopt a new paradigm for understanding, assessing, and estimating the economic impacts of ultra-high-speed deployment and utilization. This paradigm should extend beyond a standard calculation of job creation, wage distribution, and capital investment to include a wide range of economic values generated by ultra-high-speed deployment. These values include the increased utilization of real estate, cost savings through use of smart technologies, higher level of education attainment, transportation and security system improvements, and greater access economic opportunities across a wider spectrum of socio-economic levels.
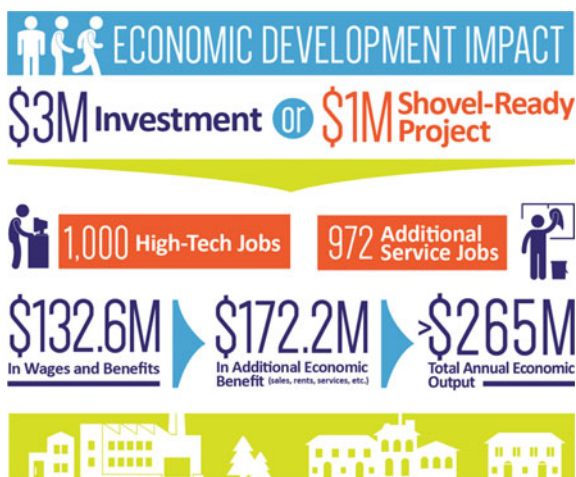
Source The Loop Media Hub Feasibility Study 2012
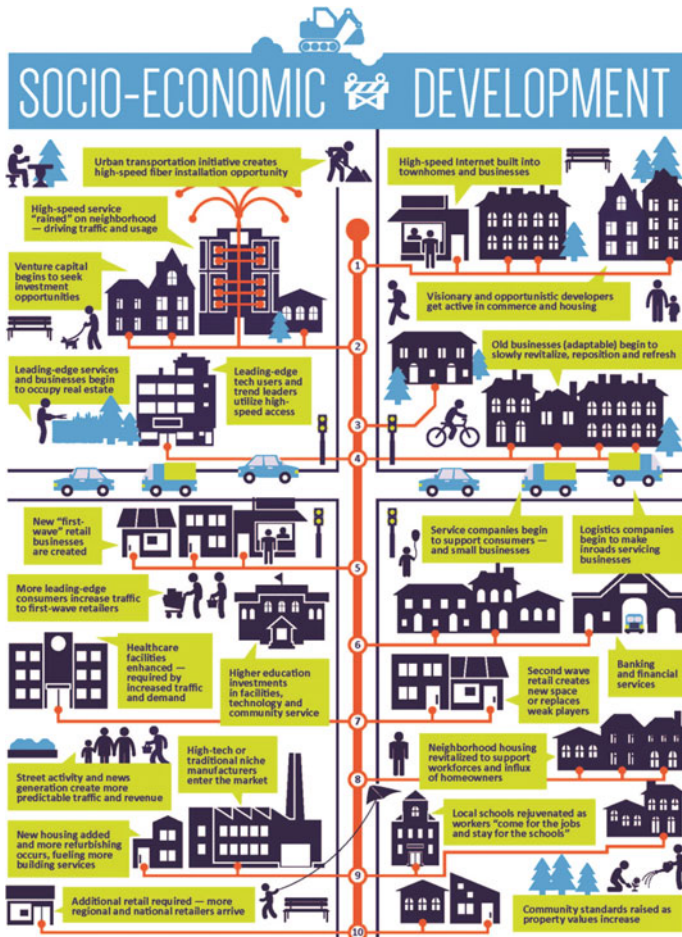
Source Ainsley Shea & Sandel Associates - 2014

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Chapter 40
Smart Cities Are 90 % Sociology and 10 % Infrastructure

David Sandel

Abstract Cities around the globe are not well prepared to become Smart Cities. Many of the challenges associated with getting Smart City projects going is currently related to traditional planning methodologies that make use of top-down master planning. Since Smart Cites are a relatively new and broad concept, it is necessary to engage the community at large and its entrepreneurial resources, to develop many of the aspects of community collaboration, business models, revenue and expense sharing agreements, and technologies that can be used to create real socioeconomic impact. As government observes the success of projects, it then becomes possible to plan on a larger scale across an entire metropolitan area. This section describes some of the key, overarching thoughts on leadership themes that surfaced and were developed during the course of this study and the development of this chapter.

40.1 Smart City Economic Relevance

As the Smart City movement takes hold, there is a very real window of opportunity for St. Louis to increase its market share of creative persons. By increasing our region's market share of creative persons, we increase the probability that new successful businesses will be created and stay in the St. Louis area. Cities that implement arm's length policies to encourage Smart City education and entrepreneurship (and that award sustainable socioeconomic impact solutions) will be the cities that, in the long run, win the Smart City economic development race [1]. The St. Louis area central corridor should unite around the theme of building

D. Sandel (✉)
Sandel & Associates LLC, 6900 Delmar Blvd, St. Louis, MO 63130, USA
e-mail: davidsandel@gmail.com

our Smart City platform, of building our innovation districts and neighborhoods, and of building our Smart City and the future St. Louis.

40.2 Smart City Socioeconomic Impact

We should build our innovation districts and innovation neighborhoods with a clear sense of urgency and purpose. The urgency should come from the need for St. Louis to end decades of socioeconomic division by beginning to create an inclusive smart economy where all persons from all walks of life are able to participate in innovation districts or innovation neighborhoods. Then, as the neighborhoods grow and ignite organic growth, the same socioeconomic and technological capabilities can be brought to the rest of the St. Louis region as the business case is proven.

Smart economy and inclusive policies should also be developed for our innovation neighborhoods and innovation districts. In this way, our St. Louis area residents and businesses will be able to gather ideas and entrepreneurial opportunity from the entire region, not just the central corridor. These kinds of policies would also send a clear message that St. Louis understands that inclusion is a fundamental cornerstone of the smart economy, and of our success, without which we will certainly fail.

Interconnecting neighborhoods would also have a positive sociological effect on the community since these new ultra-high speed connections would cut across neighborhood and political subdivisions, and would be available to all persons within or around those neighborhoods. Furthermore, by including persons who are economically disadvantaged, we connect a larger community of ideas and inspirations which ultimately result in accelerating the public sector innovation process and sense of public good.

40.3 Smart City Education

There is a general lack of education and understanding about what a Smart City is and how to achieve socioeconomic impact [2]. Smart City educational programs will need to be developed (similar to entrepreneurial educational programs) that educate persons at the middle school and high school levels, through tech school, colleges and at the university level. Professional and business programs will also need to be developed for executives, managers and lay persons who are currently employed.

At this early stage of development for Smart Cities, it is crucial that we adopt an easy to implement process to find and develop champions who can lead the development of Smart Cities at the entrepreneurial level. These same champions should be spiffed, then funded and celebrated at all stages of development. We should celebrate our champions' successes and failures.

40.4 Smart City Entrepreneurship

St. Louis needs to be assertive and thoughtful in its Smart Cities' initiatives. We cannot simply adopt what has worked in other regions, although the lessons learned can be very useful. There is a critical mass of entrepreneurial energy in this city that can be harnessed and directed toward the creation of a Smart City [2]. We need to formally adopt that challenge as a region, set out specific goals and work to accomplish them.

Smart City initiatives should invest in both infrastructure and ecosystems. Entrepreneurs who imagine and then pursue change are a critical component of success that needs to be intentionally nurtured. This should be done across a broad number of interest areas where entrepreneur development efforts are led by champions. The role of the champion is to find the funding and then create collaborative environments that are engineered to connect entrepreneurs with similar interests. Leaders should put in place the infrastructure and also establish the incentives and environment that is inviting to entrepreneur development champions. Winning Smart Cities will find the resources and creativity to create the most inviting regions that retain and attract Smart City entrepreneurs. The leading Smart Cities will guide us in uncovering the new economic and social changes that are desired.

40.5 Smart City Economic Impact Modeling— Infrastructure

Smart City advocates and leaders must adopt a new paradigm for understanding, assessing and estimating the economic impacts of broadband deployment and utilization [3]. This paradigm should extend beyond a standard calculation of job creation, wage distribution and capital investment to include a wide range of economic values generated by ultra-high speed deployment. These values include the increased utilization of real estate, cost savings through use of smart technologies, higher level of education attainment, transportation and security system improvements, and greater access to economic opportunities across a wider spectrum of socioeconomic levels.

40.6 Conclusion

For the last two hundred years, the USA has passed through the first industrial revolution with a measurable degree of success. As people moved from farms into cities, they received a public education and learned the necessary basic skills to

work in factories, related businesses and industry. Entrepreneurship, education and small business in all forms were central to this success.

In the coming Smart City industrial revolution, community engagement and education combined with advanced connected smart technologies will widen the playing field to ultimately include a much greater degree of participation of more persons in the development of the Smart City as we reinvent who and what we are. The long-term socioeconomic impact of this opportunity is staggering.

Smart Cites are 90 % sociology and 10 % infrastructure. Smart Cities that focus on educating and planning their Smart City in the early stages from an entrepreneurial and socioeconomic impact perspective will realize the benefits of Smart City transformation sooner.

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Part XV
Conclusion

Chapter 41
International Collaborative Research "Smart Economy in Smart Cities" and Conclusions of Cities Case Studies

T.M. Vinod Kumar

Abstract This chapter has two parts. In the first part, the organizational details of the international research project "Smart Economy in Smart Cities" are presented. In consultation with the team leaders of the city study, their general conclusions of the study are presented.

41.1 Smart Economy in Smart Cities: International Collaborative Research Programme

Smart Economy in Smart Cities can be conceived and developed emphasizing some total of integration of internet of enabling ICT technologies for smart economic development, embracing an economy of production and distribution in a carbon neutral environment monitored in real time transportation system that perform intelligent and smart mobility based on real-time information drawn from big data for the Smart Economy. Some can think of re-embracing capitalism that can create Smart Economy in Smart Cities, or others can think of going after socialism or communism with command economy and an ever growing bureaucracy to implement socialism or communism. The reality, however, points towards a different direction.

The authors of this book have adopted only one simple and dependable way of looking at Smart City economic development and governance through smart activation of Smart People. Smart People need not embrace Capitalism since they have found that without much capital, not owning a brick and motor stores, or a mall, they can be part of Amazon or eBay seller which is the biggest market place in the world sharing the ICT-enabled marketing and logistic system at low marginal cost and price. In the same way, they can also be a part of the largest taxi services like

T.M. Vinod Kumar (✉)
School of Planning and Architecture, New Delhi (SPA-D), Calicut, Kerala, India
e-mail: tmvinod@gmail.com

Uber with only one taxi at his disposal while Uber do not own even one taxi defeating the central concept of Capitalism. Since real-time information and big data guide all these economic activities, socialism and its consequent ills of proliferating and expensive bureaucracy for tax payers with no of value addition to urban economy are no use for the Smart City economic development. This does not mean no regulation or no law and order in Smart Economy. Like tax compliance by electronic filing of income and wealth tax, Smart Governance is there to replace age old and dysfunctional bureaucracy a legacy of sixteenth century in many countries.

We consider Smart People and smart community and their E-democracy as all powerful and capable building blocks of Smart Cities for Smart Economic development replacing capitalism and socialism at one go. For Smart People, there should be opportunities in Smart Cities for continuing training Smart People to make them smarter today compared to yesterday. Smart People can be everyone in a city irrespective of their wealth, educational qualification and social background and, therefore, an inclusive concept since all of them have a constructive role to play in Smart Cities. They can be below the poverty level or above, which does not matter but all of them should have the wish to be Smart People and can be part of never-ending learning mode to be smart. Smart People through their E-Democracy and E-Governance plan, design and govern the Smart Cities. Smart People are the creators, governors, regulators, managers and maintainers of Smart Economy in Smart Cities. The required Smart Cities technologies which are ICT-enabled can easily be designed by Smart People's creativity, and prototypes are made in Fabrication Laboratory (Fab Lab) if located in Smart Cities for mass production and use. Being the creators of the Smart City technologies, Smart People can maintain, repair, innovate and evolve the existing technologies to more cost-effective and functionally superior, next generation technologies. No one is running away from Smart People's creation and redevelopment of next generation Smart City technologies.

This book is the third in a series Professor T.M. Vinod Kumar conceived and implemented about articulating the various roles of Smart People in Smart Cities. The first book entitled "Geographic Information System for Smart Cities" edited by him [1] was aimed at creating comprehensive self-awareness of city functioning every second and every day in real time which is the foundation of Smart City. Geospatial technologies, sensors and analytics can be used to reach the awareness and use it in real time for various types of use by Smart People; how it can be used for a variety of urban issues commonly observed globally is what that book is all about. These Smart People progress towards their self-directed goals, such as they demand Smart Living and Smart Economic Development. They aspire to the highest level of quality of life in a Smart City environment and expanded economic development opportunities to satisfy higher income and employment needs to sustain Smart People.

No smart person in a city is an island or elite, but they share a common destiny and common urban space, urban realm, and social and physical infrastructure. Government as the regulator is required that none of the Smart People are denied of all city provides for irrespective of their income level and social status or they are above or below the poverty level. Hierarchy of government exists in a city, but their governance needs to be for a Smart City that is fully aware of itself every second

and a Government who comes to know about the issue when a case is filed in court. The existing governance systems are more or less obsolete being a product of sixteenth century or earlier designed for colonial rules which cannot be used or Smart City economic development, built on the model of East India Company's administration in India for sixteenth century. However, those who aspire to live in Smart Cities are in the twenty-first century and no more part of an exploitative empire under the iron hand of a colonial administrator. Therefore, the twenty-first century Smart Cities require Smart City e-governance system that was the subject matter of the second book entitled "E-Governance for Smart Cities" [2].

The third book in this series is this book, "Smart Economy in Smart Cities". To rapidly change the income level and employment opportunities of those Smart People below or above the poverty level in a Smart City, and to make the NDP growth rate to desired higher level consistently for the next many decades, the current trend of urban local economic development is required to be converted to Smart City Economic Development. For example, 10 % NDP growth rate envisaged for next three decades in India and many other countries can only be realized through Smart City Economic Development.

Smart Cities and the related conceptualization boasts of the Smart Economy but not much has been systematically researched or documented about it so far. This calls for a study of a number of cities across the world to document what constitutes a Smart Economy. There are two groups of cities being studied in this book. Some of them have been designated as Smart Cities by learned societies, but others are not but aspire to be Smart Cities. These call for different approaches to research design and studies. It was seen from case studies both these counties emphasize different approaches, establishing that there is no cook book solutions. The cities being studied in this book are spread in several major continents and regions, including North America, Europe, Africa, Indian subcontinent and East Asia. They are Ottawa in Canada; Stuttgart in Germany; Bologna in Italy; Heraklion in Greece; Dakar in Senegal; Lagos in Nigeria; Nairobi in Kenya; Cape Town in South Africa; Rawabi in Palestine; New Delhi, Varanasi, Vijayawada, Varanasi, New Delhi and Kozhikode in India; Hong Kong in China; Amphawa in Thailand; and Cape Town, Dakar, Nairobi and Lagos in Africa, which are plotted in the map below (Fig. 41.1).

The fourth and fifth books planned for the book in this series are "E-Democracy for Smart Cities" and "Smart Technologies in Creative Smart Cities". The world over, participatory democracy is worshipped and preached but what is actually practised is representative democracy at the city level and beyond. It is believed that in megacities and metropolitan cities, only representative democracy with elected representatives will work. However, democracy practised in small cities like Athens in Greece, Licchavi in India in ancient times and many parts of the world documents face-to-face democracy in practice. In these cities, everyone in a city sat together and jointly decided on all aspects of the city. Citizens not only participated in decision making but acted together as one government. With the advent of ICTs in Smart Cities of twenty-first century, it is possible to go back to the face-to-face democracy that, by any measure, is much superior to representative democracy. The fourth book will be all about E-Democracy in Smart Cities in action. It is divided

MAP OF STUDY CITIES

Fig. 41.1 Map of study cities

into three parts, State of the Art Surveys, Domain Studies and Tools and Issue of E-Democracy in Smart Cities. The field research for the fourth book is being completed in many cities.

The fifth book in the series will be "Smart Technologies in Creative Smart Cities". The city studies for the Smart Economy in Smart Cities result in many proposals on many smart technologies such as Internet of Things, Internet of Democracy and Internet of Governance oriented to specific issue of a town; since the Smart City is an integrated six systems of which Smart Economy is an integral part. It can be connected with Smart Mobility, Smart Environment or Smart Living. Vinod Kumar has discussed the Smart City System in the first chapters of two books already published [1, 2] and elaborated it further in Chap. 1 (Sect. 1.2). Based on the elaboration of Smart City System, if one has to develop city-, region- or country-specific smart technologies for a Smart City, it has to be designed locally by local industrial designers. Location-specific and culturally acceptable technology can be locally fabricated, repaired, maintained and managed. This is the only way local culture will find expression in Smart City Technologies by utilizing local, creative talents in many institutions in Smart Cities. Fab Lab propagated by the Massachusetts Institute of Technology gives us the facility to design the prototype of Smart City technologies which are generally ICT-enabled technologies, required in a specific Smart City locally and to manufacture prototype first and then in massive scale elsewhere where the cost of production is lowest. The Kerala State in India, with a population of 33 million, already has two Fab Labs that speaks very high of the popularity of Fab Labs. These Fab Labs are making large industrial establishments—that can only develop prototypes, redundant just like our desktop

and laptop computers have virtually replaced but not killed the mainframe computers of the past used in the 1970s for the same computational needs. It also changed centralized industrial structure into a more decentralized one. It is likely to replace the current industrial structure based on ancient capitalism seen during the industrial revolution to Smart People-oriented industrial structure. This will also have far-reaching effect on land use structure of cities. There are industrial design departments as well as other technology and engineering departments in many universities, which can design appropriate Smart City technologies. Then why not we combine the proposals emerging from our third book on "Smart Economy in Smart Cities" to design appropriate smart technologies using Fab Labs by local universities in their respective study cities, study countries and study continents of the third book in respective countries?

41.1.1 Smart Economy in Smart Cities—A Collaborative Research

The editor and coordinator of the book T.M. Vinod Kumar felt that if there is a gap in knowledge about Smart Economy in Smart Cities, it is the duty of each country to fill in this gap at no extra cost. Universities of these countries of these nations have a responsibility to conduct the research to fill in the gap. This can only be done with a year-long and in-depth study of selected cities around the world. No attempt was made to make a stratified sample of such cities the world over, and these city studies do not represent the universe of such "smart" cities. We believe that each city is unique but the experience of dealing with Smart City economic development in a number of cities world over can be of use to aspiring Smart Cities to a certain extent anywhere. We also believe that no city can copy the experience of another city or clone another Smart City economic development practice since every city is a unique sociocultural, ecological and economic system.

Funding for such collaborative research project was another issue. Universities and research centres dominated in collaborating this research project. We also found that along with Universities, some not-for-profit national and international networks and institutions, city governments and regional governments in certain countries also came forward to participate in this collaborative research programme. The editor and coordinator of the project again felt that this international project shall not seek any external funding other than the internal resource mobilization from within the participating universities. He was able to convince all participating institution on this. The participating Universities and other research partners are tabulated below (Table 41.1).

Table 41.1 Details of participating universities and research partners

Canada
City: *Ottawa*—**Institutions**: *I-CANADA; Invest Ottawa: Office of Chief Information Officer, City of Ottawa; Telfer School of Management. IBM Centre for Business Analytics and Performance, University of Ottawa; Partnership and Applied Research at Algonquin College; National Capital Commission Ottawa; Center of Excellence in Next Generation Network; EFS1; Conference Board of Canada*
China
City: *Hong Kong, HKSAR*—**Institutions**: *Institute for sustainable Urbanization; UDP International; School of Architecture, Chines University of Hong Kong*
Germany
City: *Stuttgart*—**Institutions**: *Stuttgart University of Applied Sciences; Fraunhofer Institute Gesellschaft*
Greece
City: *Heraklion*—**Institutions**: *Crete Lab; International Society of Biourbanism*
India
City: *Calicut (Kozhikode)* **Institutions**: *National Institute of Technology Calicut*
India
City: *New Delhi*—**Institutions**: *School of Planning and Architecture, New Delhi, New Delhi*
India
City: *Varanasi*—**Institutions**: *Indian Institute of Technology Kharagpur; SandHI—Science and Heritage Initiative, Tata Consultancy Services*
India
City: *Vijayawada*—**Institutions**: *Department of Regional Planning, School of Planning and Architecture, New Delhi: School of Planning and Architecture, Bhopal; Royal Institute of Chartered Surveyors (RICS), Amity University, NOIDA*
Italy
City: *Bologna*—**Institutions**: *International society of Bourbonism; Municipality of Bologna, Department of Economy and International Relationship*
Kenya
City: *Nairobi*—**Institutions**: *Global Observatory linking to Action; African Migration and Development Policy Centre; Technical University of Kenya, School of Architecture and Built Environment University of Nairobi, Department of Urban and Regional Planning*
Nigeria
City: *Lagos*—**Institutions**: *Global Observatory Linking Research to Action; Nigerian institute of Social and Economic Research; UN-Habitat, Monitoring and Research Division*
Palestine
City: *Rawabi*—**Institutions**: *Fletcher School of Diplomacy and Law, Tufts University*
Senegal
City: *Dakar*—**Institutions**: *Global observatory Linking Research to Action; Agence Nationale de la Statistique et de la Demographie University of Maryland Consortium d'Enterprises et de Services International Suarl, International Food Policy Research Institute, Brookings Institutions, Africa Growth Initiative. Global Economy Development, Population Council Club de Reflexion sur I'Urbain, University Cheikh Anta Diop. Department of Geography*

Table 41.1 (continued)

South Africa
City: *Cape **Town**—**Institutions**: Global Observatory Linking Research to Action; South African National Spatial Agency*
Thailand
City: *Amphawa*—**Institutions**: *Chulalongkron University, Social Research Institute (CUSRI)*
USA
City: *St. Louis*—**Institutions**: *Washington Univei'iity*

41.1.2 Design of the Collaborative Research Programme

Research Collaborations worked out is purely voluntary. Since collaborators are universities, Government, research institutions, professional networks and not-for-profit associations from Asia, Europe, Africa Middle East and America, complete independence for pursuing the research with no baggage of ideologies is given. Coordinator of the project has no financial or administrative control over any institution participating in the project. Typologies of the institutions involved in this international project are given in (Fig. 41.2). All these autonomous institutions are guided by the highest standard of scholarship and timely completion of research and publication.

Fig. 41.2 Types of institutions involved in Smart Economy in Smart Cities research

41.1.2.1 Research Questions

The kind of collaboration in this international research project requires that all participating institutions shall formulate their own research questions and research methodology which are of use to the country where these study cities are located. Depending upon the type of city some of which are leading Smart Cities and some are not Smart Cities, the approaches have to differ.

However, the paucity of empirical evidence on Smart Economy in Smart Cities opens a new area of research: How and what changes Smart Economy in Smart Cities brings to social, cultural development and ecological (environmental) management? This question lies at the heart of the proposed international collaborative research programme, and unpacking it gives us four interrelated research questions, as follows:

1. What makes Smart Economy in Smart Cities? This will need identification of the key ingredients and their role in making Smart Economy in Smart Cities.
2. What changes Smart Economy in Smart Cities brings to social development, cultural preservation, heritage conservation and ecological management? This calls for understanding the inter-linkages between Smart Economy in Smart Cities on one hand, with social development, cultural preservation, heritage conservation and ecological management on the other.
3. How and what processes facilitate the changes that Smart Economy in Smart Cities brings to social development, cultural preservation, heritage conservation and ecological management? These may include: (a) innovation–diffusion (by ICTs and other modes), (b) spatial planning, (c) sectoral planning (including economic, social development, cultural preservation and ecological management), (d) heritage conservation and management plan and (e) institutional and governance processes, among others.
4. How and what changes can be brought to improve the processes to achieve improved/optimal results? These changes related to the various processes as mentioned in Research Question 3.

A deeper understanding of changes in the social, cultural and ecological system of the Smart City with the advent of Smart Economy is the focus of study. This research programme and the institutions selected for this purpose as academic collaborators are an effort to address this research gap.

41.1.2.2 Scope of Research

The following outlines the areas that may be covered when conducting research under the "Smart Economy in Smart Cities" programme. This is an indication only, and it is left to the team to decide what is appropriate.

1. A time series study of changes in the urban economy and identifying distinct features of evolving Smart Economy.

2. Study of theories of local economic development and smart economic development and modelling for study city.
3. Study of spatial organization of evolving city in comparison with envisaged spatial organization given by the Master Plan.
4. The concept of accessibility in the Master Plan and its changes with respect to increasing use of ICT in Smart Cities.
5. Changing needs for spatial access in a Smart Economy for goods and services with an increase in the use of ICT and consequent changing needs.
6. Changing the role of hierarchy of service areas in a Smart Economy in a Smart City as influenced by increasing use of ICT.
7. Evolving structure of metropolitan urban agglomeration and changes required in a Smart City.
8. Evolving structure of cities in urban agglomeration and changes required in view of the increase in the use of ICT.
9. Change of spatial standards in a Smart City.
10. Changes required in zonal policies and plans.
11. Study of legislation of Metropolitan Planning Committee (for instance, in India) and suggest changes as per special requirement of Smart City
12. Change of role of community-based organizations (for example, Residential Associations in India) in a Smart City with an increase in the use of ICT.
13. Change of role of Ward Committee in a Smart City with an increase in the use of ICT.
14. Change of role of Municipal Council in a Smart City with an increase in the use of ICT.
15. Change of role of Metropolitan Planning Committee in a Smart City with an increase in the use of ICT.

Note: The scope of research can be further elaborated by the collaborating institutions but need not be uniform for all study cities. Each department of university participating in this research programme shall incorporate relevant Smart Economy features appropriate to the goals for each department. For example, while a Department of Architecture can emphasize urban design and land management as related to Smart Economy, Department of Regional Planning shall emphasize Metropolitan Planning and Management of Smart Cities of study city and Department of Transport Planning shall concentrate the contribution of emerging smart mobility and also change meaning and modelling of Urban Access in Smart Cities. The coordinator of this project does not intend to dictate the direction of the research and have a diverse group of collaborating universities, and they should orient their study strictly based on academic goals of their department.

41.1.2.3 Study Areas

The Smart City will be selected as study area by each of the collaborating universities independently, which will be the place the one-year and two-semester

combined effort to conduct this research. Universities participating in this programme adopted different types of collaboration. Some universities used on their doctorate and post-doctorate students, while others used students at master's and first professional degree level. Post-doctoral student of the department can work on a narrow subject area in the study as individual work. While graduate and undergraduate students can work on design solutions for the Smart Economy in Smart Cities, Research institutions can charter their own areas of research.

41.1.3   Way of Working the Programme

41.1.3.1   Integrating "Smart Economy in Smart Cities" Research with Academic Programmes

This international collaborative research programme, with the participation of 13 countries and 16 study cities was conducted by many diverse university departments, research institutions and others as shown in the graph above. In Smart Economy in Smart Cities, work, place of work, nature of economic activities, carrying capacity of economic activities, livelihood and income are not variable that can be studied only by Department of Economics alone. Purposefully, we did not enlist department of economics in this study although business schools are there. Authors feel that GDP rate will be considerably higher in Smart Cities, and it will be computed periodically by respective cities and/or nations using the country's economic and statistics infrastructure. Therefore, there is no need for a computational study for Smart City economic variables and modelling by this research programme. For the conventional economist, the place does not matter but for land economists, regional planners, urban planners, landscape architects and applied scientists, success and failure of economic activities depends on upon the location, local resources, place and people. For example, heritage tourism depends on the character of heritage and economic activities that can be woven around it and for ecotourism it is the ecology of the area and tourism that is within the carrying capacity of the ecosystem. The conventional macroeconomist lacks such perspective and capacity to develop such areas. In fact, there is no department of economics participating in this project which in no way doubting their specific capacity to GDP and employment computation.

Since this exercise involves the vast accumulation of empirical knowledge and analysis in the study city, a two-semester work of all students and faculty in collaborating universities is envisaged as part of their ongoing academic programme. Participating universities decided to have one year of the Smart Economy in Smart City programme focussing on this topic in selected cities in several of their ongoing academic subjects and programmes. We found that exploring boundary of knowledge is within the terms of reference of any university. This can be conducted as design studio programmes or small projects as parts of theory classes. It can also be independent post-doctoral work. Within each partner university, the

collaborating faculty may design this research programme, and thereafter faculty compiles the research findings for publication based on students foiled and class work.

In most of the partnering universities, there are studio programmes with 9–15 h per week programmes where a project is executed by a group of students under close supervision and guidance of faculty with higher faculty–student ratio, and also there are theory papers where a student has to work independently on a topic under the guidance of generally one faculty. This work can be a mini-project, which she/he completes within one semester or a term paper. The department integrates the "Smart Economy in Smart Cities" research programme with their academic programme by deliberately having studio programmes and term papers centred on this area of study (Smart Economy in Smart Cities). We are looking at the diverse approach to Smart Economy in Smart Cities. From Department of Transport Planning, we expect different output than Department of Regional Planning who is participating and so also with Architecture department and Business administration department. The same is true for other departments and other universities and other countries.

41.1.3.2 Role of Students

This international collaborative research programme is essentially meant for students being part of an internal academic programme of the university. We consider they are the main actor and shall be given important role in this programme. Perhaps a number of that age group will live in the Smart Cities than their older faculty.

A monthly bulletin of the programme shall be prepared, edited and published by faculty and students participating in this project as shown in Table 41.2.

At the very start of the programme, we found Italian universities had a number of universities per city participating in city studies than from any of 16 cities being studied. The coordinator suggested that one student each from three universities from Italy shall form the editorial back born of the Bulletin to publish the monthly bulletin in the pdf format and distributes by email to all participant's authors. The content may include introducing the study city, the country programmes, participating departments, faculty and students and brief methodology are envisaged. It can include profiles of the Smart City being studied, the monthly progress of all work being executed or any other matter the editorial board of students may find. Each month City study team will join hands with Italian group of editors to edit a monthly Bulletin and distribute exactly on the last date of every month.

At the initiative of students, web broadcasting of their project work can be presented keeping in view of a convenient time for all countries participating that are living in different time zone. Necessary infrastructure exists in these universities.

By giving all these responsibilities to students, we are empowering student community in this research programme.

41.1.3.3   Role of Faculty

The faculty is the designer of "Smart Economy in Smart Cities Research Programme" within the framework of existing curricula in design studios and theory courses of each participating university.

1. The project duration is one academic year or two semesters.
2. They guide and monitor student work as usual as part of the academic programme.
3. They monitor students' input to the monthly progress report.
4. They rewrite the output of the project for a book to be published by an international publisher.

41.1.3.4   Co-design and Co-production of Knowledge

This international collaborative research programme is founded on the principles of co-design and co-production of knowledge. In today's interconnected world, such collaboration is physically and intellectually possible—thanks to the Internet and ICTs. The collaborative aspect of the research programme will be actualized in the form of:

1. Co-design the programme with the partner academic institutions.
2. Co-production of knowledge through an interactive process of sharing, reviewing and finalizing research findings.
3. Within each partnering institution, co-design and co-production of knowledge can be implemented through design studio/laboratory work between faculty and students.

41.1.3.5   Research Output

The key output of the "Smart Economy in Smart Cities" research programme will be a book edited by the coordinator Professor T.M. Vinod Kumar, to be published by Springer, an internationally reputed publisher.

41.1.4 Bulletin—Smart Economy in Smart Cities

During the conduct of research through 12 months in 2015, a Bulletin has been used to communicate with the international teams of researchers. Monthly Bulletin highlights Study City profiles selected by the various study teams, and introduces to the research network the research methodologies adopted, and the profiles of authors of the research outputs for the book, "Smart Economy in Smart Cities. The Bulletin is jointly edited by a study team each month and three doctoral students from three universities have been participating in this project from Italy, namely Giglielmo Minervino, Silvia Paldino and Gianluca Lecque. The list of Bulletin produced with respective case studies is shown in Table 41.2 (Figs. 41.3 and 41.4).

41.2 Summary of Conclusions of City Case Studies

Team leaders of authors were requested to prepare summary of conclusions of their city studies and the Editor compiled it and given below.

41.2.1 Canada–Ottawa Study

Ottawa, the Capital city of Canada, has been ranked as Canada's best large city to live in based on factors such as income, unemployment rate, housing, weather,

Table 41.2 List of bulletins

No.	Country	City	Bulletin month
1	Italy	Bologna	January
2	India	Kozhikode	February
3	India	Vijayawada	March
4	Germany	Stuttgart	April
5	India	New Delhi	May
6	Canada	Ottawa	June
7	China	Hong Kong	July
8	Greece	Heraklion	August
9	Thailand	Amphawa	September
10	South Africa	Cape Town	September
11	Senegal	Dakar	October
12	USA	St. Louis	October
13	India	Varanasi	November
14	Kenya	Nairobi	November
15	Nigeria	Lagos	December
16	Palestine	Rawabi	December

Year 2015   November   Num. 11

Bulletin

Smart Economy in Smart Cities

EDITED BY

JOY SEN ~ GORA MBOUP

GUGLIELMO MINERVINO ~ SILVIA PALDINO ~ GIANLUCA LECOQUE

The Bulletin is a monthly news letter for private circulation only
from and for the research group of "Smart Economy in Smart Cities" project

In this issue we explore Varanasi in India, and Nairo-bi in Kenya. Joy Sen is the author of the former case and Gora Mboup coordinates the latter. The December Bulletin will be the last one, and we will focus on the last two cities, Lagos in Nigeria, and Rawabi in Palestine. Along with December issue the Table of Content (TOC) will be published with chapters and authors. the TOC on dropbox must be filled up before the 23 of December.

COUNTRIES
Canada, China, Germany, Greece, India, Italy, Kenya
Nigeria, Palestine, Senegal, South Africa, Thailand, USA

AUTHORS
Abdul Razak, Alanus von Radecki, Ale Badara Sy, Alioune Bakhoum, Antonio Caperna, Aparna Soni
Arame Tall, Ayesha Patel, Babacar Mane, Banji Oyelaran-Oyeyinka, Barry Gander, Bharat Dahiya
Bimal P, Bruce Lazenby, Bud Albers, Charles Duffett, David Sandel, Debolina Banerjee, Deepak S Kumar
Deepti Jayakrishnan, Dennis Mwaniki, Edward Yiu, Eleni Ploumidi, Essy Baniassad, Femi Olokesusi
Gianluca Lecoque, Gora Mboup, Guglielmo Minervino, Greg Richards, Joachim Lentes, John Oucho
Joy Sen, Kumar Ashok, Lakshmi Manohar, Luisa Bravo, Mark Hoddenbagh, Mark Kristmanson
Michael Bucher, Michael Kinyanjui, Mame Cheikh Ngom, Mohammed Firoz, Momar Diongue
Moustapha Diop, N Sridharan, Naledzani Mudau, Omondi Odhiambo, Paida Mhangara, Patrick McKeehan
Peter Ngau, Pradip Sarkar, Priyanka Singh, Ragupathy Sambasivam, Raktim Ray, Ravi K. Govada
Ritch Dusome, Robert Ndugwa, Roland Blach, Romanus Opiyo, Samba Ndiaye, Sarah Gitau, Satyendra Singh
Silvia Paldino, Sorin Cohn, Stefano Serafini, Stephan Wilhelm, Sujata Govada, Suwattana Thadaniti
Suzana Jacob, T.M.Vinod Kumar, Themis Pellas, Tim Rodgers, Tony Bailetti
Wandia Riunga, Widemar Spruijt

Fig. 41.3 Sample cover of bulletin

VARANASI

INDIA

Joy Sen

"Benares is older than history, older than tradition, older even than legend,
and looks twice as old as all of them put together."

Mark Twain, explorer

Varanasi is one of the most ancient and continuously inhabited, and hence, sustainable, habitats in the world. Besides being one of the holiest of Hindu pilgrimages, this sacred geography is a repository of traditional knowledge systems. Indian Institute of Technology (IIT) Kharagpur, under its flagship project named 'Science and Heritage Initiative' – appropriately abbreviated as 'SandHI' meaning confluence – has taken up Varanasi as a mega-exploratory case study. 'SandHI' is an interdisciplinary research project funded by the Ministry of Human Resource Development, Govt. of India and is exploring the potential of a Heritage Smart City model for Varanasi. This is in tune of the recent initiative by the Govt. of India which has signed a memorandum of association (MoU) with Kyoto, Japan in 2014 as partner cities. Moreover, Varanasi is also one of the cities in the Govt. funded scheme for National Heritage City Development and Augmentation Yojana (HRIDAY) and the Smart City Challenge.

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Fig. 41.4 Sample page of bulletin

lifestyle and culture which above all created a communication age for Canada the very foundation of Smart City. The telephone, an invention of Canada, generated the world's first long-distance telephone call, and later Canada invested in the first digital telephone exchange. Canadian heard the first voice transmission from radio and launched first communication satellite Anik and had first Direct to Home satellite transmission. Ottawa is undoubtedly a prominent Smart City of the world. Based on broadband communication connectivity, knowledge workforce, innovation, digital inclusion and community marketing, Intelligent Community Forum lists Ottawa as a top 21 Smart City of the world. The need to communicate forced Canada to invent the tools of the modern Communications Age, which are now being used worldwide. Ottawa, in particular, became a hotbed of communications technology development, as it was home to government Research and Development Labs. It also had a heritage of innovation from local inventors who pioneered many of the electronic aids used in households today. Innovation, therefore, was given a springboard for growth in Ottawa's culture. Innovation is the driver of the Smart Economy today, responsible for three-quarters of all economic growth in the USA since World War II. It is triggered by associations of ideas are intuitive; it arises from hunches and that vague hard-to-describe sense that there is an interesting solution to a problem that has not yet been addressed. The number of innovations in a centre is directly tied to the number of linkages in a centre: the higher the linkages between people, the greater the momentum of the innovation. To be effective as an economic force, a second ingredient is needed: the ability to find the commercial value of the innovation. This value-adding characteristic has thus far been difficult to assess due to the tentative nature of innovations in their early stages. In Ottawa, a new assessment tool is being used that can detect the overall intensity of the "Smart City" environment, based on hundreds of factors. Another new tool drills down to the organizational level and assesses the efficiency of the organization's ability to commercialize innovation. These tools can be used by any city wishing to obtain a Smart Economy.

Ottawa has risen to lead global organizations like the G7 because its intense Innovation Economy has provided it with advantages in almost every area of economic and social life. Because of the need to excel in a knowledge-based world, Ottawa has developed educational systems in its universities, colleges, labs and research institutions that have made it—literally—the most educated city in the world. Smart Community author Richard Florida ranks Ottawa as Canada's number one city based on the three Ts of economic development: Technology, Talent and Tolerance. Ottawa leads all cities in Canada in knowledge occupations—that is, occupations characterized by their use of high technology, computing, knowledge-intensive processes and creative activity. More than one in four workers are employed in the knowledge field, and 61 % of the workforce have a post-secondary degree. Factors that are forcing the rise of the smart community movement continue to shape the direction of Ottawa's growth. This has created an

environment where some 2000 highly innovative companies give birth to "off-spring" and have spurred the highest value of Initial Public Offerings (IPOs) of any city in Canada. Cities following Ottawa's pattern can expect the same high levels of achievement.

Many CEOs of leading Ottawa companies were surveyed for their views on the ingredients that are most helpful in creating a commercially strong innovative company. All the leaders defined innovation in commercial terms: the addition of value to new or existing ideas, to redefine, improve and create new opportunities. The key factors involved in success were identified as the allocation of investment and resources, time, acceptance of calculated risk and failure, a clear and concise vision that is communicated and the "right" people to create value. In addition to education and skill, these people needed initiative, judgment, creativity, curiosity and the ability to apply and build upon knowledge and experiences. Ottawa's leaders were unanimous in stating that innovation is not only affordable but that it is impossible to move forward without being innovative.

The most difficult barrier to creating a Smart City is finding the right way to take the first step. Based on its experience as an award-winning Smart City, with knowledge of developments around the world, the example of Ottawa can be used to help provide a playbook for Smart City movements. The first and critical step is to establish the Governance of the Smart City project, the framework that aligns leaders from many sectors to fulfil the Smart City mission. Once established, a status check is useful in determining the city's current position along the Smart City continuum. This involves assessing how each sector of the community views its progress. Each sector is then challenged to provide a vision of where they would like to be in 3–5 years' time, assuming that they had the adequate broadband infrastructure to support their goals. The visions are linked, a final plan is drawn up, and a network map is created. The network is the final stage, for, in the last analysis, the creation of a Smart Community is 90 % social, and only 10 % technological. The job for social leaders is to tame this and create for citizens an "intentional future"—a framework that puts them in control of their lives in a time of unparalleled turbulence.

41.2.2 China: Hong Kong City Study

The purpose of the Hong Kong study is to develop a framework for Smart City development and showcase some of Hong Kong's initiatives in developing a Smart Economy and Smart City, to highlight its achievements and also to suggest ways in which Hong Kong could be improved in this regard. A case study of Kowloon East is highlighted which is an old industrial area that is currently being transformed with urban regeneration and Smart City initiatives.

Hong Kong in China consists of Hong Kong Island, Kowloon, and New Territories as well over 260 outlying islands. Hong Kong is a compact vertical city and is one of the top-ranked global cities in terms of per capita GDP, and a

world-class financial, trading and business centre. Located on the coast of South East China, Hong Kong is strategically placed to provide an important trading link between the East and the West and has been doing so for decades. As of mid-2015, Hong Kong has a population of 7.29 million people, with a land area of just 1104 km^2 consisting of three major territories; Hong Kong Island, Kowloon, and the New Territories, as well as over 260 outlying islands. Only 25 % of Hong Kong is developed with over 40 % being country parks. As a result, Hong Kong has a land population density of 6690 persons per square kilometre. The urban population, however, can easily reach 100,000 persons per square kilometre making it one of the most densely populated cities in the world. Hong Kong has experienced unprecedented growth in the past century with regard to its increasing population, urbanization and densification of urban development. It transitioned from a quaint fishing village into a major global financial centre. Hong Kong's unique colonial history, strategic location and status as a Special Administrative Region (SAR) of China since 1997 have contributed to the growth and success it experiences today. Since the handover, the city has also become special for the people of Hong Kong with a new sense of identity and a strong sense of community emerging. Hong Kong has a world-class public transport system and ICT infrastructure. All these factors together create a strong foundation for the Smart City.

Currently, with its growing economy and established finance, commerce and logistics industries, the government is beginning to develop more interest in improving other aspects of society and the environment through the adoption of technology and sustainability initiatives. Existing smart growth planning in the latter half of the twentieth century paved the way for an extremely accessible and efficient transportation network utilizing railways as the core mode of the network, complemented with a strategically planned Transit Oriented Development (TOD) with higher density station-related developments. In addition, the importance of Hong Kong as a finance and logistics hub facilitated the need for a well-connected and high-speed telecommunications network, which has become advantageous in supporting the population in becoming tech-savvy.

With these essential foundations in place, the government is now tackling other measures such as enhancing the quality of public spaces, encouraging Smart City initiatives and technology integration and adopting environmental sustainability targets to reduce energy consumption and improve the air quality. The Smart City concept is well suited to approach the Government's economic, social and environmental objectives that benefit from Hong Kong's advantageous position as a dense, fast-paced, highly connected city inhabited by hardworking, tech-savvy citizen's eager to utilize technology to improve their quality of life. Hong Kong's successful economy, efficient transportation system and high broadband penetration will further enhance its productivity, mobility, growth and sustainability with the adoption and integration of Smart City initiatives into new and existing city infrastructure and urban developments.

Hong Kong has experienced unprecedented growth in the past century with regard to its increasing population, urbanization and densification of urban development. The shift to a financial and logistics hub in the past half century has

resulted in technological developments in relation to urban form, transportation networks, quality of life and governance.

The Institute for Sustainable Urbanization (ISU) and UDP International (UDP) posits that currently the Smart City discourse is too focused on the implementation of technological innovations in an urban environment as the sole approach to Smart City development. ISU/UDP believes this focus is misplaced, and although there are good intentions to incorporating advanced technologies, rather than technology being the driver of the Smart City movement, technology should be seen as the enabler through its implementation and application throughout the urban environment. To support this view, UDP International has developed a conceptual model that places a primary emphasis on Smart People, Place and Planet as the central values to a Smart City. The driver of this conceptual model is Smart Thinking through effective Design and Planning of cities. The vision is that a city which prioritises good urban planning and design will effectively enable the formation of smart mobility, infrastructure, and living within the city, and cultivates a smart environment, economy and government. This will consequently lay the foundations for the successful implementation and development of the six Smart City elements (Smart Living; Smart Governance; Smart Mobility; Smart Economy; Smart Environment and Smart Infrastructure).

In order to assess Hong Kong as a Smart City, research was conducted in the past, present and future projects and initiatives occurring and being implemented in various aspects of the city. Hong Kong was assessed using the six elements identified by UDP International, and within these categories there were numerous projects and initiatives that could be classified as "smart", but also many areas that were identified as lagging behind the progress made in other cities. Hong Kong scores well in regard to a number of indicators relating to the Smart City elements, including having a highly efficient transportation network, fast and affordable telecommunications services, a mature and gradually diversifying economy and promotion of environmental sustainability initiatives.

While Hong Kong is well known for its efficient metro system MTR (mass transit railway), it is relatively unknown that 40 % of the land mass is protected country park and special areas, while another 30 % is rural countryside. Therefore, only circa 30 % of the territory is urbanized. Abundant in mountainous terrain, the majority of development has occurred in areas near the coastline as many parts are too steep or too remote to support urban development. Hong Kong has also taken advantage of construction techniques such as land reclamation, hillside clearing, slope engineering and maintenance to cultivate land suitable for urban developments. The limited availability of land area has led to compact high-rise and high-density urban development on either side of Victoria Harbour. This compact urban form, in conjunction with integrated land-use and transport planning and mixed-use development, has facilitated very high ridership of the MTR and other forms of public transportation. Large-scale new towns have been developed with a central role for mass transit, and Hong Kong thus scores well on public transport mobility indicators and sustainable mixed-use development indicators with over 90 % of the built-up urban area accessible by mass transit.

While there are quite a number of successful and beneficial Smart City initiatives being piloted and implemented around Hong Kong, there lacks a central management system and/or information system that is able to easily monitor, control and publicize big data and information gathered through initiatives to reach the full potential of being a Smart City. Too often Smart City initiatives are undertaken at both small and larger scales, but in a piecemeal fashion with no cooperation and unification of information or services. Hong Kong can benefit from a more holistic approach to the Smart City development. A focus on more than the technology and data is essential in order to better comprehend the influences and impacts of the people, place and planet on the effective or ineffective advancement of the Smart City as a concept and a reality.

This research highlighted that Hong Kong is relatively transparent in its organization, and access to information is easy with its City Gallery, an interactive venue showcasing the history of Hong Kong's urban development along with a wealth of information also available online. The Government has initiated a number of good public policies in public transit, education and public rental housing serving the needs of 50 % of the population instrumental in improving the quality of life of people in the past, but it is clear that policies in some fields fall short of current Smart City objectives. In addition, there exists a disconnect between policies developed by different stand-alone Departments and Bureaus, and efforts are being made for better interdepartmental coordination. Initiatives such as the Harbour front Commission, which was set up by listening to the community to better plan and enhance Hong Kong's harbour front. A Smart City should have the structural ability to develop and implement cross-cutting policies and plans, and in this respect Hong Kong will need to become more effective.

Hong Kong falls behind on environmental sustainability, and only recent efforts have placed greater emphasis on the quality of the environment and quality of life issues with regard to poor air quality, green building, energy savings, recycling, waste management, public space and walkability. In addition, while Hong Kong champions operational efficiency and profitability in the realm of public transport and deserving of the classification of having Smart Mobility, the government could do more to streamline bus operations, kerb the growth in private vehicles on the road and encourage more people onto sustainable zero-emission forms of transportation. This lack of understanding of a holistic and comprehensive approach to tackling unsustainability within the city, and targeting smart initiatives in one area but ignoring a problem elsewhere, will restrict the ability of Hong Kong to become a truly Smart City.

One promising area of Smart City development in Hong Kong is the Government's commitment to revitalizing and developing the area of Kowloon East, an old industrial area, into a new Central Business District and pilot scheme for Smart City Initiatives. In the redevelopment of the area, the objective is regenerate Kowloon East from an old industrial area with displaced manufacturing into a mixed-use development, and to incorporate Smart City and Smart Economy principles and ideas to enhance the quality of the area and promote it as an attractive destination. The formation of the Energizing East Kowloon Office, an

interdisciplinary government office set up under a Bureau, located on-site in Kwun Tong dedicated to the regeneration of the area, is taking the initiative to put forward Smart City initiatives and see them through to completion. Some of these projects include improved pedestrian connectivity, pedestrian crosswalk sensors, a smart waste management system and proposed environmentally friendly transportation system.

Still in the early phases of the redevelopment, a focus has been on quick wins such as improving pedestrian crossings and revitalising back alleys to enhance connectivity and walkability. There are also technologically innovative and environmental sustainability projects, although in the very initial planning stages. As traffic congestion and pedestrian safety were major issues in the area, the early planning and implementation stage focussed on people with pedestrian environment improvements, which is equally important to a Smart City. The more major Smart City initiatives will be implemented during the construction and redevelopment of the old Kai Tak Airport, also part of Kowloon East. Nevertheless, a number of meaningful policy changes should be adopted in order for this new development and redevelopment to include a full spectrum of Smart City measures and initiatives, and to ensure their successful implementation.

From our research, it was concluded that Hong Kong excels as a Smart City regarding most aspects of Smart Mobility and Smart Economy, but faces some challenges regarding some aspects of Smart Governance, Smart Living, Smart Environment and Smart Infrastructure. The views are mixed and vary depending on the indicators assessed. There are global cities that perform much better than Hong Kong with regard to both quality of life and environmental sustainability, yet Hong Kong outperforms many major cities with its excellent transportation system and mature, highly connected economy.

With the successful transformation of Kowloon East as a Smart City, lessons learned from this pilot scheme can be applied to other older districts and newer development areas within Hong Kong. In conjunction with improved city management, central control and monitoring of Smart City initiatives around Hong Kong, there is potential for Hong Kong to effectively become a world leader in Smart Economy and Smart City and become a model city for others in both the developed and the developing countries.

41.2.3 Germany: Stuttgart Study

Stuttgart, the sixth largest city of Germany is spread across the hills, valleys and parks with an area of about 210 km^2. The population in Stuttgart is 590,000, while the greater Stuttgart metropolitan region has a population of 5.3 million (2008). The main city, with a high population density of 2850 person's/km^2, is surrounded by small satellite towns which have relatively low population density. Various surveys

on quality of life in German cities indicate that Stuttgart offers best quality of life with highest per capita income among German cities. Being a birthplace of Mercedes and Porsche, it is considered by many to be the starting point of the worldwide automotive industry and is sometimes referred to as "The cradle of the automobile".

Stuttgart being a hub of high-tech auto industry and also known for its advanced ICT industry. The city offers a conducive environment to develop highly innovative green technologies. Stuttgart's healthy innovation climate is fostering the development of environmentally friendly and sustainable technologies for the future. The City of Stuttgart ranks among the most important economic locations in Germany. The Stuttgart metropolitan region attracts numerous regional and international companies. It is also Germany's leading export region. Compared to other economic locations, Stuttgart and the Stuttgart region are perfectly positioned, also relating to growth, employment, purchasing power and investment and the great diversity of innovative fields of research.

The world's increasing urbanization has the consequence that today more than half of all people live in cities and this number is expected to grow in future. City regions are constantly evolving themselves to deal with global megatrends such as climate change, resource scarcity and demographic change. Cities which are considered as one of the largest future markets in the world continue to develop innovative technologies and intelligent concepts leading to sustainable development. Urbanization, climate change, growing online culture, ageing populations or pressures on public finances, call for an innovative solutions and researchers communities all over the world are constantly drafting various concepts and recommendations for Smart Cities which has solutions to such problems.

In Germany, Smart Cities are largely perceived as "CO_2 neutral, energy and resource-efficient, climate-adapted cities of tomorrow". The leading scientific research organization Fraunhofer Society is also propagating that a Smart City is an "informed, networked, mobile, safe and sustainable city". Cities in Germany are making significant changes in turning to smart administrative, cultural, educational and infrastructural practices through the use of information and communication technologies. It is generally considered that these changes will have a positive impact on all levels of society. Cities such as Southampton, Stockholm, Amsterdam or Vienna are already marching ahead, while cities in Germany like Stuttgart, Frankfurt, Berlin and Munich have taken similar steps in this direction.

Aiming for the sustainable reconstruction of the cities to explore the best technologies and solutions in the world of tomorrow, the Fraunhofer-Gesellschaft initiated the Innovation Network "Morgenstadt" which means future cities. Morgenstadt serves as a neutral knowledge platform for the integration of various approaches to find a solution to such complex dynamics. The network which consists of partners from the industry and representatives of cities, emerging technologies and concepts for sustainable urban systems offers the ideal framework to analyse future trends of city development. The partners draw on existing "best

practices" in the sectors of mobility, energy, communications, buildings, resources, security and governance, as well as on existing studies and strategies to analyse these on common opportunities and challenges. Current partners in the network include global companies such as Bosch, Fichtner, Daimler, EWE, Drees & Sommer, EnBW, TÜV Süd, Siemens and Volkswagen. A consortium of twelve Fraunhofer Institutes spread across Germany contributing its technical expertise for the joint processing of arguments for the city of the future. The long-term goal is the establishment of new concepts and innovations in the respective cities in the world.

This chapter discusses the outcome of three research project undertaken by IAO Fraunhofer Institute Stuttgart along with Stuttgart University and other European and private sector partners. These projects deal with economic and innovation aspects of Smart Cities. The Stuttgart region is developed to be with specific core competencies which result from integrated socio-economic interaction, the evolution of firms, institutions and political actors in the past. Stuttgart and its surrounding region have already set various example of smart practices while ensuring the provision of environmentally friendly and people-oriented mobility for everyone.

The whole chapter is divided into four sections. First, a general profile and the socio-economic profile of Stuttgart and its surrounding region are presented. This section then focuses more closely on governance structure of the Stuttgart region with a unique blend of its innovative potential. This section also emphasizes how industrial clusters, the institutional set-up within the region, training and education, regional R&D infrastructure to a large extent determine the innovation profile of the city. The innovation applied in governance by Stuttgart region with its unique way of functioning and decision making has also set an example for its all-around spatial and economic development.

The second section argues that smart technologies for cities require a fundamental shift in business model paradigms. A synthesis of business models is presented by combining a set of elements that require radically new forms of investing, building and operating urban solutions. A Smart City value model is conceptualized with unique shared economic approach which also considers challenges of market barriers, organizational and leadership challenges. The section also touches the aspects of technology trends, key challenges of investing, building and operating smart solutions, opportunities and some details around the cores of transition in planning. The section concludes with a suggestion to conceive smart solutions as a structured and reproducible set of technologies, services, actors and benefits.

The third section propagates the innovative concept of urban manufacturing, i.e. coexistence of living and manufacturing zones in the backdrop of urbanization and growing demand for industrial real estate in Stuttgart region. The term urban manufacturing means the production of goods close to conglomerates of humans and their living areas. The project considers high technology with resource and energy efficiency as an important factor for the future competitiveness of Stuttgart region. The idea is that companies with the concept of urban manufacturing can create production networks and share resources for optimized capacity balancing.

The regional sourcing may help to improve the product life cycle and resource cycles.

The fourth section emphasizes the significance of public participation in a mega construction project for sustainable development. This is particularly relevant for the development and re-development of city centres and urban areas to improve residential conditions and public services. This can safeguard interests of both public as well as private stakeholders, and the interests of citizens and community members. The section also explores the importance of visual communications, visualization techniques targeted to different groups and adaptation of these key visualization methods to ensure informal public participation. This whole idea is seen as minimizing the confrontation between different groups like one has witnessed in project Stuttgart21.

The synthesis of above-mentioned aspects which deal with Urban manufacturing is of visual communication and shared economy-based approach have a potential to lend the city a unique profile and are vitally important for city's future economic development. These constitute the framework within which future economic profile of the Stuttgart can be determined.

41.2.4 India: Calicut Study

Calicut is a vibrant business city in the state of Kerala, Southwest India. Calicut urban agglomeration has a population of about 2 million in 2011 census, and the district is about 66 % urban. Historically, it was a major trade centre in the ancient maritime silk route exporting spices. It has a long history of international contacts from Europe, China, African Countries, and the Middle East. During British Colonial period, it became an important centre for timber trade which was used to build railway lines. Now there is a real estate building boom, mainly targeted to non-resident Indians working in the Middle East Gulf countries. Calicut is booming up to become the next IT hub of Kerala in particular and South India in general with two major IT parks to be operational in near future which is likely to create 100,000 jobs. There is an expectation that the third Birla IT park in Mavoor will also come up in near future. There will be sufficient IT manpower in Calicut to guide it to a Smart City. A Malaysian satellite city at Kinaloor along with a few other industrial park is making Calicut a booming city. There is an international airport at Karippur and a small intermediate port in Beypore in the city showing high potentials. There are few fishing harbours in Calicut.

Even during the medieval period, Calicut was a major centre of learning. The king Zamorines promoted centres of teaching and attracted scholars from South India. The Kuttichira Misqual Mosque was also historically significant learning centre for Islamic and Arabic literature. English university education came to Calicut in the nineteenth century. Today Calicut is the hub of higher learning in India. It has got National Institute of Technology Calicut and Indian Institute of Management Kozhikode considered as institutions of National Importance. There is

Calicut University, Calicut Medical College, apart from many colleges and schools of repute. Calicut is a million plus city Kerala Government wanted to develop Calicut as Smart City.

Building up brown field Smart City Calicut is designed by spatial modules of five square kilometres each was attempted. Calicut Study delineated three zones namely Umami (Food Tourism Capital of Gods own country), Velika (Fish processing city bringing Lakshadweep Closer) and Trance (Electronic city), for an exploratory research study of brown field Smart City development in Calicut. They are within Official Calicut Planning Area which is much smaller than Calicut urban agglomeration in 2011 census of 2 million plus population. A gross density of 200 persons per hectare was assumed as per urban compaction policy of State Urbanisation report of Kerala which resulted in a population base of about 100,000 for this density with an area of about 5 square kilometres. Umami is selected for presenting in this publication.

Then the most appropriate economic theme for Smart Economy development discussed in Chap. 1 for the area was identified based on what exists in the zone and what locational advantage this site has for that particular Smart Economy theme. For example, one zone Umami out of the three studies conducted found a related complex of economic activities as a theme. Spices which were the main commodity for international trade of Calicut many centuries, traditional Malabar cuisine valued by all, food industry of heritage value of Calicut and Ayurveda wellbeing treatment and connected tourism were selected as the economic theme of Umami. Two other zones delineated had Smart Economy theme electronics which caters all metropolitan cities around Kozhikode such as Kochi, Coimbatore, Mangalore, Bangalore and Mysore as well as Naval ship design centre NIRDESH near Beypore. Fisheries processing city Velika takes advantages of vast and unexplored marine fish resources of Lakshadweep special fishing zone as well as fisheries resources of Kozhikode district. Lakshadweep and Calicut have social, cultural and spatial linkages for centuries and requires land for big scale fish processing and marketing from Kerala which is mutually advantageous.

Then Calicut was subjected to a detailed study of Urban Demography and Economics past, present and potential future to find ways and means to convert urban economy of Calicut to Smart Economy. This also includes economic history of Calicut during the past centuries to establish past global linkages of Calicut with Africa, Middle East, Europe and China. This linkage has resulted in the distribution of the population of Kerala all over these countries who will constitute the main client of the Smart Economy of Calicut in addition to other tourists from these countries and others. This conversion is realized by making the service area of Calicut urban economy international and very large using ICT and e-commerce where distance does not matter. Leveraging on the deployment on ICT in Smart City and smart mobility, smart environment and smart energy production and use results in the efficient Smart Economy due to powering of a Smart Economy with near zero marginal cost inputs discussed.

Calicut in the past was a meeting place for international trade and dissemination of culture, except for less than 200 years. Calicut was never a colony only under British rule. This saw the past economic linkages for centuries disappearing. Therefore, it was required to the market city as an ancient well known brand to help in E-marketing of city was the objective of one chapter. So this chapter illustrates an attempt to capitalize on some of the geographical, cultural, economic, lifestyle and traditional roots of Calicut to market and brand Calicut as a Smart City destination. Due to the changes in the economic, cultural and social changes in the global landscape, there exists a fierce competition among multiple places for resources, business relocation, foreign investment, visitors, even for migrants and residents. Most of the nations across the globe are trying to market themselves and to manage their brand identity so as to attract more tourists, foreign investments, exports, talented human resources, so on and so forth.

The task of spatial/urban design for Umami was an attempt to translate in urban planning/design spatial policies enunciated in the State Urbanisation report and Perspective Plan 2030. The perspective plan mentioned special activities zones as the nucleus of city development as well as the various aspect of truly desired city morphology of Kerala which was acceptable for a Smart City like Umami. Indian constitution calls for participatory planning and governance under its seventy-fourth constitutional amendment and gave this responsibility to Municipality under 12 the schedule. The models practised in Kerala for participatory planning in the preparation of Master Plan were far from satisfactory since it considers this activity as namesake administrative process of calling objection and accepting some which Town Planners accept is far from satisfactory. However, annual planning activities of local self-government bodies in truly participatory and it is called people's planning (janakiya asuthranam). Since annual planning was merely felt need assessment to generate the project, it was easy. The demand for spatial planning and urban design calls for unleashing local creativity in spatial design requires another approach. E-Urban design in an interactive web design was found to be more efficient in enforcing Indian constitution for planning and governance than what is being practised in Kerala. Here website invites all to participate in urban design structured well into components and then showing at least one or two possible solutions to the component. Finally, whenever implementation has initiated a group of competent professional select from what is best for the interactive web based on extensive discussion on the website which is elaborated in another chapter.

There is a need to correctly assess the land use requirement which fully accept mixed land use. Only zonal plan with detailed zonal code can provide for, and no other alternatives exist. This participatory zonal plan process in the interactive web is discussed for Umami in another chapter. This chapter demonstrates how urban design of Smart City Umami can be accomplished by creating spatial urban design components for Smart People, Smart Economy, Smart Environment, Smart Mobility, Smart Living and Smart Governance; all these aspects in an interactive world wide web. Form-Based Codes have got a capacity of designing enforceable urban design codes whose outcome can be predicted. When Form-Based Codes also incorporate zonal plan, then it is called Hybrid Form-Based Codes. How this is

implemented under web-based participatory urban design is the subject matter of a chapter. The constitutional right of People to design their Smart City is protected in the e-design process.

Smart Economy dominates in the E-Urban design of Umami. These six components totally based on Internet of things together or partial subset generates Smart Economy by designing for marginal cost to near zero condition. Producers of goods and services of Umami directly interact with consumers individually like as e-commerce does give a personal touch. The marginal cost of adding a consumer or producer of services and goods is near zero for such e-commerce instituted in Umami since it avoids brick and motor buildings, middlemen organized as inefficiently as Indian bureaucracy. The marginal cost of mobility in Umami is nearing zero since aesthetically designed with the attractive spatial ambiance of walkways and cycle paths replaces fossil fuel consuming motor vehicles roads. Electric vehicles charged free by photovoltaic-generated charger can create mobility with near zero marginal cost. Smart mobility to the airport can be achieved through remote sensing information to logistical services with the objective of reaching there faster. Near zero marginal cost of food processing industry arises mostly out of creating a marginal cost of energy and water to near zero. Umami is designed as a hybrid solar city where Kerala Electricity Board role in supplying electricity is progressively reduced and replaced by solar rooftop photovoltaic, electricity generated from biogas from the vast amount of biodegradable waste of food processing industry, and waste disposal incinerator. Taking advantage of contours of Umami site analysed using GIS has created a series of interconnected retention and detention ponds storing rain water which will be used in food industry reducing the marginal cost of water near zero. The quantum of water in these ponds is supplemented by rainwater harvesting using a well-designed system of drainage. The internet of things of sensors in all these six systems eventually talks to each other to optimize the Smart Economy of near zero marginal cost. Smart Governance component of Smart City shall direct to achieve the objective of zero marginal cost in all aspects of the urban economy of Umami.

Converting urban land at Umami to Smart City is a complex task. One chapter explores this complexity by analysing the legal provision of urban land management, how these legal provisions are implemented in Calicut in the past by two case studies and conclude that the existing provision cannot bring about Smart City transformation at a rapid rate. Then, the chapter explores how participants can be trained by an interactive website called E-ULM Umami to be active partners for this transformation using the broad land management legal framework available in Kerala. This is executed in a website. As an alternative to the present approach, a sharing economy model of land management as business is detailed out taking a land development of the Smart City in one part of Umami.

41.2.5   *Indian: New Delhi Study*

Delhi is Capital of India and the second largest metropolis of India after Mumbai. Delhi's population has grown from 2.38 million in 1911 to 13.85 million in 2001, and 16.75 million in 2011. Delhi state has 97.5 % urban population. Urban area of Delhi is 1,113,65 km^2 in 2011. Delhi metropolis is not only centre of politics being national capital, but also a manufacturing and service city. The per capita income of Delhi in 2001–2002 was INR 43,000 double that of the average per capita income of India which became INR 127,026 in 2009–2010 and then INR 173,686 in 2011–2012 and INR 201,083 by 2012–2013.

Ministry of Urban Development through its Smart Cities Mission has placed New Delhi Municipal Council (NDMC) as one of the selected Smart Cities in the first phase. NDMC hosts only 1.79 % of the total population of Delhi as per Census of India, 2011 on 2.95 % of the total area of Delhi. Miniscule area and a tiny per cent of total population of Delhi are not the only issues that defy justification for the selection of NDMC as a Smart City; this part of the city is highly planned, well endowed with infrastructure which is provided to almost all residents, and per capita expenditure by the municipality is several times higher than what other municipalities in Delhi spend. NDMC started using modern technologies even before the launch of the Smart Cities Mission in 2015. Although NDMC's smart initiative has been discussed, the core argument of the New Delhi study titled "Making Delhi a Smart City: Economic Buoyancy with Spatial Justice" is that the Smart Cities Mission presents a disjuncture and a severance between the actually existing needs of Indian cities and citizens facing a number of critical urban challenges on one hand and its primary goal of creating wealth by embedding advanced technologies in the built environment on the other hand. The authors believe that there does not have to be a disjuncture between economic growth and distributive justice resulting in fair distribution of city resources for all citizens. It is in this sense that the acceptance of New Delhi Municipal Council area as one of selected 20 Smart Cities for central funding in the first phase is puzzling because it further highlights that disconnect between ground actuality and policy utopia. In order to present these fissures in this study, first presents five challenges of urbanization facing the city of Delhi. These challenges include the challenge of infrastructure with a specific focus on sanitation, the challenge of mobility, the challenge of environment, the challenge of slums and the challenge of governance. Separately, these challenges have been discussed by scholars but this is the first attempt when urban development challenges are being examined in the context of the Smart Cities Mission. These urban challenges are also selected because they form critical elements of the Smart Cities generally and the Smart Cities Mission in India in particular. Examining these challenges leads to explore whether the Smart Cities, as conceived and currently being built by Indian and global corporate builders, could face up to the urban challenges presented by the Indian urbanization. The case of Delhi is appropriate within the Smart City discourse because it is counted among the top-performing metropolitan cities of the country. The chief

argument of this study is that narrowing down of disjuncture between experienced city realities and policy perceptions is useful even for economic growth, the prime public policy goal of government at the present moment. The city of Delhi would become a Smart City only if it can strike a balance between economic buoyancy and spatial justice.

The key objectives of the Smart Cities Mission are: "Economic growth is the key objective, technology is the key driver, knowledge production is the key resource, and high quality of life is the key promise". The main point is that these smart solutions may not touch the lives of the urban poor as the poor do not have access to smart technologies and even if they have the ability to use smart technologies, they simply will not be able to afford such solutions.

To be a held as a Smart City would include complete elimination of manual scavenging and honourable resettlement and rehabilitation of those involved in this inhuman social practice. This is the greatest Smart City challenge, and the NDMC having 10,000 households living in slums does face the problem of open defecation, although to a lesser extent than the rest of the NCT Delhi. It must also be stated that a study carried out recently does not mention the word open defecation. Aloofness about the lived city of NCT Delhi and a singular focus on making the NDMC area (a small pocket within the city) a Smart City represents disjuncture and a severance. Not only this, it also represents spatial injustice for those living beyond the NDMC area.

According to the Census of India in Delhi, 10.5 % households did not have access to any form of latrine facilities within premises. In other words, in Delhi 1 in every 32 persons is defecating in the open and every second person defecating in the open is an urban poor, who has either inadequate access to basic sanitation or completely deprived of it. The smart thing to do in a smart Delhi is to create an environment of "smart maintenance" of all services being provided by the public as well as the private sector. Provision without proper maintenance would be wastage of public funds. The NDMC smart does make room for smart maintenance. Delhi also displays a curious mix of high technology in the form Delhi Metro running atop slums, for example, the Kathputli slum in the western part of Delhi. Both coexist in the same place but never meet and mix for the emancipation of slum dwellers. The processes that produce such unfair mixing of smart technologies on the one hand and barely livable human habitats on the other need to be challenged. The Smart City would be one that could successfully close technological and moral gaps between slum dwellers and metro riders, who are primarily middle-income group individuals. NCT Delhi has enough funds to invest in its infrastructure, transport and housing in order to make the entire city smart with and without the help of the Smart Cities Mission. This unequal and inequitable distribution of public funds between urban local bodies is one of the Smart City and Smart Economy challenges.

41.2.6   India: Varanasi Study

Varanasi, an ancient city and the holiest of Hindu Pilgrimage centre is located on the western bank of a holy river Ganges in the state of Uttar Pradesh, India. Varanasi is a historic city majestically seated on the banks of river Ganga in India for over 3000 years now. It is popularly known as the "spiritual capital" of the country and is thronged by pilgrims and tourists alike. It is a repository of ancient and modern knowledge system. The city spreads over 3131 km^2, houses a population of 1,201,815 people in 2011 census. There is a large floating population of tourists both domestic and foreign. The 3-km-long river front is dotted with 84 stepped embankments called ghats where a variety of religious rituals are performed. Varanasi is a birthplace of many cultural forms, ranging from art and architecture, music, literature and philosophy. More than half of the workers in Varanasi are engaged in weaving traditional silk saree (women's garment), wooden toys, metal crafts and other major cultural industries. Unlike the ICT-driven "Smart City" concept as envisaged for many cities across the world, "smartness" for this city lies in its strength in traditional knowledge systems. Presently, the city's economy is largely driven by many activities which are rooted in its traditions, belief systems/rituals, characteristic school of thought which have originated and have been nurtured by the city and its deep ecological environs. Tourism and handloom industries are the key economic drivers of the city.

Varanasi suffers from the challenges which are typical to many medium-sized cities in India, namely inadequate civic infrastructure and provision of municipal services, inefficient governance and topped by the severe environmental threat to river Ganga—the lifeline of the city. In this light, it has been argued that the Smart City development model for Varanasi shall not purely be based on modern advancements in Information and Communication Technology (ICT), rather largely on its traditional knowledge systems and also on the local economy of cultural products, goods and services. To substantiate this argument, the research team on Varanasi has studied the two major tradition-based economic sectors of the city: ecological innovation-based and the other being cultural industry-based.

Ecological innovation stimulates creative environs which are conducive to innovation, learning and knowledge-based income-generating activities. In this regard, the case of Greater Rajghat-Sarnath Region and Trans-Varuna Zone of Varanasi has been discussed. This city segment has been chosen by many visionaries to set up humane-exploratory labs envisaged by them, such as the Jiddu Krishnamurti Foundation Campus near Rajghat. The following approach has been adopted by the study team to identify the potential of an area to attract innovation, talent, creativity, academic and spiritual institutions and livelihood generating creative economic centres.

Three patterns of development—physical-environmental, socio-economic and sociocultural—have been overlaid using GIS to establish the highest potential of

this zone for ecological innovation in comparison to Varanasi city at large. Further, the study identifies and clusters the various innovation hubs to form a network of innovation zones. Hence, this case study indicates ecological innovation to be a driver of the economy, leading to sustainable and resilient overall growth.

Culture-driven smart economic development has been discussed by illustrating the major creative-cultural industrial hubs from the City of Varanasi. These are the creative centres of cultural products which is famous for, namely silk "saree" (traditional female clothing), betel-leaf (traditional mouth freshener) and wooden toys. It also discusses the case of porcelain pottery from the nearby town of Chunar. These household-based industries are essentially small in scale. The creative workers almost lack support and protection from the government, and they have to compete with other stronger market forces and mainstream forms of manufacturing.

A large section of the city's economy is composed of such small-scale household industries which have been instrumental in building its economic base for centuries now. Moreover, such products have turned into traditional items with high cultural value and are appreciated by a large number of tourists and exporters alike. Thus, Varanasi can be a good example of culture-driven smart economic development, given adequate support from the government in framing appropriate cultural policy strengthening such industries. Challenges lie in adopting the strengths of modern advancements in technology and management—particularly, ICT-based services, organizational and managerial networks—for such traditional production processes. Unwise adoption of the so-called smart modern tools and techniques, without appropriation, may have the danger of "commercialization of creative arts" which might be detrimental to the very root of these industrial processes—creativity and diversity of cultural expression.

The smart growth of Varanasi is being envisaged by adopting a bipartite approach, as detailed below.

- Digitally upgrading the core infrastructure of the city based on the technology triad of "Information and Communication Technology" (ICT), "Internet of Things" (IoT) and "Geospatial Technologies" (GT).
- Enabling the citizens to amalgamate the inherent strengths of the traditional economy that ranges from knowledge-based institutional services to unique cultural products along with the smart infrastructure.

To create a supportive ecosystem for entrepreneurial activities, innovation and economic growth, the "technology triad", as discussed above, need to be grafted over the traditional knowledge and skill system, thus strengthening the existing economy of Varanasi into an innovation-driven Smart Economy.

In a nut-shell, Varanasi sets a good example of a city whose smartness does not rely only on the modern advances in technology, but largely upon its strength in traditional economies and knowledge-base. Such an evolution from the traditional base makes the city's economy more resilient and the development "smarter".

41.2.7   India: Vijayawada City Study

The Census of 2011 shows city population of Vijayawada and Guntur are, respectively, 10.5 and 7.5 lakhs. The Vijayawada region is characterized by 10 urban centres of different sizes located along the river. The proposed capital region is spanning 7068 km^2 in 29 Mandals (sub-districts) in both the district of Krishna and Guntur.

The focus of the smart economic approach in case of Vijayawada is on embeddedness of the economic activities on the spatial fabric. This was targeted through achieving spatial efficiency. The spatial efficiency is achieved through innovation, time efficiency and inclusion.

The innovation is achieved through proposing innovative clusters. The idea behind the clusters is to link the local product with global value chain market.

  i. Innovation: The smart economic plan has proposed nine specialized clusters.

    (a) Integrated Food Processing Cluster: Keeping into consideration the rich agricultural base of the region, the food processing cluster will help the local agro products to get marketed in the global market. This cluster focuses on increased productivity through technological advancement.

    (b) Integrated Auto Engineering Cluster: Reviving the existing auto cluster and integrating it with engineering cluster. This cluster has a huge potential for absorption of labour force.

    (c) Vijayawada Pharma Cluster: Hyderabad is listed among the top priority location for Pharmaceutical hub, but simultaneously Vijayawada is emerging as a second preference because of upcoming capital as well as centrally located in the Coastal Andhra. The region has already observed influx of floating population due to hospital tourism. The proposed pharma cluster is planned to capitalize the opportunity of hospital tourism.

  ii. Time Efficiency: To achieve time efficiency, the plan proposed Multi-Modal Logistic Park. A Multi-Modal Logistics Park provides all types of transportation facilities at a place for the end user or defined as a rail, road-based inter-modal traffic handling facilitation comprising container terminals, bulk break cargo terminals, warehouses, facilities for mechanized handling, inter-modal transfers, aggregation/desegregation, etc. to handle freight traffic. The key components of a Multi-Modal Logistics Park are warehousing, transport and value-added services. The potentiality lies in:

    (a) Connected to National Highway.

    (b) Major junction for lorry operations for several decades with 1000 vehicles carrying goods throughout country daily.

    (c) Well connected to largest junction in South India, over 300 express, passenger and freight trains passing through it daily.

    (d) Expansion of Gannavaram Airport is bound to give a fillip to growth of entire south coastal A.P.

(e) High availability of labour but low or managerial workforce

iii. Inclusion: Initiation of Guntur start up village which will enable skill development activities among the local residents. Skyrocketing smartphone usage, a rapidly spreading internet, a burgeoning middle class and massive online distribution platforms will help to grow this. It will also include Skill Development Institutions.

With the help of these three interlinked approaches, the area will achieved a smart economic growth.

41.2.8 Italy: Bologna Study

Bologna is a metropolitan area and the regional capital of Emilia-Romagna of Italy. The goal of the Bologna study was to understand how and what changes the Smart Economy in Smart Cities brings to social, cultural development and ecological management. More, in particular, research has tried to understand some interrelated questions, such as (i) identify the key factors and their role in making Smart Economy in Smart Cities; (ii) understanding the inter-linkages between Smart Economy in Smart Cities with social development, cultural preservation, heritage conservation, ecological management on the other.

About Smart Economy in a Smart City, the study hypothesis describes the Smart Economy as characterized by the use of ICT in all activities. Smart Economy is characterized by: (i) innovation and new approach to economic activities; (ii) capacity to generate entrepreneurship; (iii) aptitude of the city to create new economic imaging, branding and trademark; (iv) productivity of labour and capital; (v) labour market flexibility; (vi) international embeddedness; (vii) transformations bought by economy in the transformation of Smart City.

This study shows that metropolitan city of Bologna has a good economy as its levels of per capita income at €34,000 are well above the EU27 (The European Union of 27 states) averages of €24,500. However, there is an obvious weakness in the quality of governmental policies and practices that appear to be hindering innovation in the region.

According to Regional Innovation Scoreboard 2014, metropolitan area is an "innovation followers" area. This is a discrete position in Europe and has a leader position in Italy.

Bologna is the regional capital of Emilia-Romagna, a region that aims to increase the competitiveness of the service sector and to turn it into a real leader of service innovation in Southern Europe and also into one of the main innovation actors at European level. For this, Emilia-Romagna policy makers intend to reinforce the service sector and the proactive integration of services into the manufacturing sector and thus boost the region's competitiveness and its capacity to face the societal challenges of the future.

Regional assets and baseline with the strong manufacturing sector, such as automobile, food production, ceramics. Usually, the regional economy shows strong entrepreneurial activities with many start-ups mostly located in clusters.

There are, however, several challenges that the region of Emilia-Romagna has to face, as suggested by ESIC's report 2014. In particular, ESIC study identifies some key challenges, such as the size of the start-ups that remain small and, especially for the smallest service companies are highly dependent on the region's manufacturing sector. The market for services is fragmented with numerous micro-enterprises vying to provide low value-added services to local manufacturing firms. On average, a service firm in Emilia-Romagna employs the equivalent of only 3.5 workers. Only a few services companies in these complementary industries have managed to move up the value chain to provide innovative services to clients beyond Emilia-Romagna itself. The region remains a net importer of business services and productivity, and wages in the services sector are relatively low compared with those in manufacturing. There is no services cluster in the region with the exception of a tourism cluster situated on the Adriatic coast.

Emilia-Romagna is currently not providing the best possible environment for innovation, as it is performing at a below average level in four of the five dimensions of structural indicators. The only exception is in "innovation and business model generation" within the region. In particular, its levels of high-tech patent applications and of innovators collaborating with others are very poor. However, in business R&D expenditure and employment in strong clusters, the region is performing very well.

About the metropolitan area of Bologna, the result can be summarized as follows.

The entrepreneurial activities have many start-ups, a high share of small and very small businesses, widespread entrepreneurial attitude.

Many start-ups remain small and are highly dependent on large manufacturing companies.

In terms of knowledge development and transfer, we have identified as strengths/assets the sharing of GDP spent on research and development has risen sharply, a high number of patent applications. On the opposite side, the weaknesses/challenges concern the low number of high-tech patents, and the share of employees with higher education still lower than comparable regions and EU27.

Innovation and business model generation shows an asset with strong local demand for innovative services from an internationalized manufacturing base.

Several challenges have been identified, such as the fact that many services are characterized by very low barriers to entry, which has increased pressure on wages and makes the development of brands and a competitive market position difficult due to the relatively high labour costs in Italy.

The outsourcing as a good starting point for developing the services sector. Where delocalisation of the area's manufacturing firms occurs, such outsourcing might help keep part of the value added of the manufacturing sector in the metropolitan area.

Another important challenge concerns the weaknesses of employment in service innovation-intensive industries compared to Italy and EU27. In the area of IT, the metropolitan area does not have large companies that could attract investment or become the focus for the development of a cluster. Also before the crisis, there was less of a need for smaller companies to develop their client bases and engage in innovation due to the benign competitive environment. With this environment now was gone, some companies are struggling and others are adapting.

Financing innovation and growth have an asset with a high share of private R&D expenditure although there are weaknesses about the significant fluctuations in R&D over time with a particularly marked effect in the first years of the economic crisis.

As with for the regional economy, collaboration and networking show a strong asset of clusters in manufacturing demanding services, strong demand for services from manufacturing, network of universities and research institutions, although there is a weakness about the dependency of service companies on manufacturing companies.

Metropolitan area is part of the High-Technology regional Network created with the aim to boost the supply of qualified industrial research, increasing synergies between regional universities and research centres. The Network stimulates the development of a critical mass of high-level industrial research and of a more efficient method for the transfer of new technologies from the research system to the industrial system. In the intentions of the policy maker, the network combines the expertise of several research institutions in centres of excellence whose aim is to promote the shift of production systems, districts and value-chains towards a greater technological dynamism and a stronger commitment to R&D.

As innovation policy instruments at present metropolitan government are developing a strategy around two dimensions: development of the high-technology network and stimulation of demand for innovation. These two dimensions are integrated by some measures addressing the upgrading of the regional industrial system and other actions addressing human capital development, innovation awareness and mentoring.

In terms of **Innovation Policy Governance**, metropolitan government in cooperation with the regional government are doing several efforts to plan actions and opportunities for innovation. Innovation Policy revolves around an early acknowledgement of the importance of the implementation of the High-Technology Network, a very ambitious initiative that is turning one of the most industrialized regions in Europe into a knowledge economy, strengthening linkages between industry and research institutions and fostering business innovation activity.

In the near future, the metropolitan government aims to gradually increase the level of specialization of competencies available in the High-Technology network in order to better respond to innovation needs. The regional administration needs to continue to rationalize the network, conjugating demand-based self-sustainability to

a technology-push approach, promoting the identification of technologies that are becoming relevant in the international scenario but that not yet used in Emilia-Romagna because of some technological lock-ins.

The metropolitan administration needs to continue to invest in the upgrading of the regional industrial base stimulating demand for innovation. There is a large base of potential innovators that must be made aware of the necessity to innovate and the opportunity offered by the Network to meet industry needs. It is especially necessary to increase demand for innovation supporting firms' absorptive capacity. The employment of graduates is still low, and without an effective upgrading of the human capital, it will be much harder to stimulate demand for innovation.

The territory has a long tradition about the Third Sector, and Regional legislation supports non-profit organizations with social aims with several benefits, such as fiscal benefit, the use of public buildings and the possibility to establish a memorandum of understanding with public bodies for the social promotion.

Bologna is developing a strategy in order to build a strong relation between "social world" and the governance of the city by using ICT.

Actually, it emerges that the ICT is being used as a tool to highlight and release the potential of this sector, with good results. These results are also due to the parallel e-government process of modernization of the Municipality. Rely on an e-government strategy, which made efficient the administrative processes, was crucial to get the collaboration of social organizations. In fact, the use of ICT allowed solving many of the problems linked to the high complexity of the Third Sector. For example, the people engagement is just the first step and the chance to engage properly is based, before all, on credibility. A good government might be enough to make an administration credible, but to guarantee effectiveness in working on projects and producing results on a long time it is crucial to have efficient tools and a feedback process which takes into account the role and responses of citizens, like in the case of the *iperbole2020* project. The ICT if utilized properly can do the job. The case of Bologna seems to confirm that, and it worth for the city a position among the best cases in Europe. Bologna case shows as the e-government and ICT when sharing the same path they can have positive effects, also on the social field. The aspect that emerged more is that ICT helps the Smart City process by its capability to act strongly on the field, with the result to raise up local micro-economies spread over a very wide territory and related to non-profit organization. When such organizations are many and form a strong network, like in the case of Bologna, there is the potential to act on great energies and leading them, by the use of ICT, in support of the whole city, with large benefit in terms of economy and social capital. To summarize our research on Bologna, we can affirm that smart initiative does not guarantee any economic growth, especially in a context of the general crisis. A good digital infrastructure can, of course, facilitate the circulation of information and offer new opportunities to economy and society, but it is not enough. We have observed that the traditional, local social structure founded on cooperation may rather represent a very interesting starting point towards a new peer-to-peer organization of economy and society.

Notwithstanding, traditional social structures badly need an infrastructural update in order to effectively enforce new socio-economic strategies.

For example, the great spread of small enterprises with an average of 6–9 employees in the area of Bologna shows an outstanding adaptability and flexibility in a liquid context. Nevertheless, these small companies would greatly benefit from an e-communication platform able to bring their forces together in the global market.

41.2.9 Kenya: Nairobi Study

Nairobi, the capital city is the largest city in Kenya is with 3,138,369 populations and 696 km^2 area in 2009. The city was established in 1899 as a railway stop for Kenya–Uganda railway. Nairobi is now the engine of Kenyan economy contributing between 45 and 60% of the gross Domestic Product. Nairobi has got a youthful population that can sustain long-term economic growth. Nairobi was named the most intelligent city in Africa by the Intelligent Community Forum in 2014 and 2015.

A Smart City foundation is the collective of the core physical and policy components that a city is built upon, and without which it cannot function. The key elements of a Smart City foundation include urban planning and design, basic infrastructure and policies. The degree of provision of these elements, their quality and their inter-linkage defines how well city functions, how much time its citizens spend on economically productive activities, and in turn, the city's level of and the potential for productivity. Nairobi study discusses the evolution of the various components of Smart City foundation and highlights how the existing and future patterns are defining the city's prospects for smart growth. The key finding is that Nairobi's rapid population and spatial growth has happened without adequate planning, which has greatly affected the basic services provision. The distribution of the services is also unequal, with better access and reliability being evidenced in the wealthier neighbourhoods and limited access coupled with unreliable supply witnessed in the poor settlements. These distribution patterns mean that the poor spends more time and resources accessing the services, thus limiting their productive hours and also reducing their disposable income that can be invested in income-generating and wealth-creating opportunities. The study also identifies that as a fast technology consumer, Nairobi can leverage on various emerging approaches to basic service provision, which have already been tried and proven to work in the poorest parts of the city, the slums. The integration of some of the emerging smart technologies, in addition to more core investments in the development of various city foundation components, will promote equitable growth for all residents, creating the required framework for smart economic growth.

Empirical evidence from both developed and developing countries points to a positive correlation between development in the physical, social and policy and regulation aspects of infrastructure and economic development. The synergetic

development of these components creates Smart City systems which promote smart mobility, smart environments, smart living; sets the platform for Smart People and Smart Governance and ultimately results in smart economic growth. The emergent smart systems further promote inclusive growth, reduce natural disaster vulnerability and exposure and improve resilience among the urban poor.

Infrastructure development in Kenya, particularly investments in Information Communication Technologies (ICTs), electricity, and transport infrastructure have been in rapid positive transition. These developments, which have been promoted by a friendly policy framework and hugely benefited from foreign assistance, have largely been beneficial for Nairobi, Kenya's capital. In just under two decades, Nairobi has grown to near universal mobile phone penetration, and internet connectivity is above 60 %. The city is now one of the most important ICT innovation cities in Africa, with several incubation centres, a growing number of ICT professionals and a youthful population that is technology savvy. These developments have opened Nairobi to many economic growth opportunities.

This study discusses the level of infrastructure development in Nairobi and Kenya in general, particularly developments in ICT, energy and transport and how these are giving the city a comparative advantage against other African cities for smart growth. The key findings are that, with the exception of ICT, growth in other infrastructure sectors has been slow and largely unequal. The chapter also identifies that adoption of ICTs has been working towards improving efficiency in the existing and although the progress is slow, the future prospects for high-efficient ICT-integrated systems are high.

A city's future sustainable growth and prosperity depend upon its investment in education, health, peace, security and other social capital stocks. Successful cities create a peaceful and secure environment for investment; encourage high human capital development through well-educated and healthy citizens; and such cities report lower levels of inequalities and poverty. Advances in information and communication technologies in the past few decades have enabled globalization, which is itself associated with urban growth and development. Recent studies have, however, also noted that globalization is making cities vulnerable in new ways, especially by opening them up to destructive networks that undermine security and development. Smart Cities must continuously make efforts to raise the competencies and quality of its citizens and thereby improve its competitiveness, increase innovations and overcome other challenges such as unemployment, insecurity and lawlessness. This study highlights the enormous efforts that Nairobi city has made in addressing and improving its safety and the social capital of its citizens through investments in technological advancements in health, education and security services as part of its developmental pathway to achieving a Smart City status. The study discusses insights, challenges and opportunities presented by Nairobi's demographic dividend, its growing human capital and improving security status alongside its emerging economic opportunities, which together are expected to turn the city into a globally competitive and Smart City.

Kenya intends to transition into a middle-income economy by 2030. According to the 2008 Kenya Vision 2030 strategy, this goal would be achieved by growing the country's gross domestic product (GDP) at an average rate of 10 % per annum between 2012 and 2030. Eight years after enactment of the vision 2030 strategy as the country's long-term growth blueprint, the country's economy is still dragging behind, with an average GDP growth rate that is about half the target rate. Recent reviews by the World Bank indicate that for Kenya to achieve the middle-income country status by the end of the planning period, her gross national income per capita needs to triple from the $1290 recorded in 2014 to $4125 by 2030; and her GDP needs to grow at a rate of about 7 % until 2030.

In a country where the productive sectors of the economy (manufacturing) are overshadowed by both agriculture and low-technology small-scale enterprises and informal activities, this goal seems far-fetched. Recent investments in infrastructure development, and particularly information communication technologies (ICTs) have, however, opened a new growth trend, which when properly explored could trigger rapid economic growth, and help the country to achieve the 2030 goal. The rapid adoption of ICTs in various economic sectors, particularly on the growth of e-commerce, e-finance and e-governance, coupled with friendly policies and rapidly emerging middle-income populations, are already causing an economic revolution, particularly in Nairobi—the country's capital city and commercial hub.

This study explores Nairobi's economic growth trajectory within the framework of Kenya's long- and short-term economic goals. It identifies that an ICT drove smart economic growth revolution has started in the city, in both the formal and informal sectors, and establishes that there are massive opportunities for sustained growth. These opportunities, which emanate from increasing investment in ICT infrastructure development, ICT education, an innovative population and suitable government policies, will greatly help shape the country's economic growth in the next decade. The chapter also identifies that challenges such as cyber security, a thin manufacturing sector, slow adoption of e-commerce, a hugely informal sector and little research on new technologies and their adoption are limiting the city's smart transition; but that good progress is being made to improve the prevailing conditions.

41.2.10   Nigeria: Lagos City Study

The urban agglomeration of Lagos is part of the Lagos State that encompasses an area of 3577 km^2 of which 787 km^2 are lagoons and creeks. It has a population of 17.5 million [5]. Metropolitan Lagos, an area covering 37 % of the land area of Lagos State, is home to over 85 % of the State's population and about one-third of Nigeria's urban population [6]. While the population density of the state is about 4193 persons per square kilometre, the density in the built-up areas of Metropolitan Lagos, made up of Lagos Island, the original city and the Mainland, is over 20,000 persons per square kilometre. Despite the movement of the federal capital to Abuja

in 1991, Lagos has remained as the country's dominant economic, social and financial centre as well as the hub of national and international communications. It is a thriving industrial and commercial centre with two seaports, local and international airports, and industries concentrated in the Apapa, Ikeja and Ilupeju industrial estates. In 2006 Lagos contributed 30 % of Nigeria's GDP, consumed more than 60 % of its energy, collected 65 % of its value-added tax (VAT) and accounted for 90 % of its foreign trade and 70 % of its industrial investments. In addition, Lagos is a major educational centre, providing a well-educated and highly skilled labour pool. The employment opportunities continue to attract both domestic and international migrants.

One major way to foster international integration in development is through information and communication technology (ICT). Incidentally, advancements in ICT in terms of mobile telephone and high-speed computer with networking facilities (intranet and internet) have practically redefined many aspects of our living. To this extent, the ICT revolution has proven to be further beneficial to Lagos residents in the following ways: (i) Traffic monitoring; (ii) Environmental Data Collection and Monitoring and (iii) Security Controls and Crime tracking. Another important aspect of the application of information and communication technology was the introduction of the Lagos State Government Electronic Banking System of Revenue Cycle Management (LASG EBS-RCM) project. Partnering with the private sector, Lagos State used high-level technology to ensure more effective monitoring of collected revenue. Revenue performance-enhancing measures included creating a robust database of taxpayers, eliminating ghost workers and plugging tax loopholes. Nigeria has experienced a robust growth in her ICT sector over the past decade and has become a major attraction with technology companies. With an improving investment and business environment, Lagos is developing an ICT-themed start-up ecosystem that is drawing international investment and has seen the launching of several incubators. The ongoing and proposed investments in ICT in Lagos, coupled with the city's huge manpower capacity are a sure way to boost the growth of a Smart Economy in Lagos.

Despite its potential to be a sustainable, inclusive and prosperous city, Lagos smartness has been hampered by its weak city foundation. The city is not well planned with sufficient land allocated to streets and public spaces, and it lacks smart basic infrastructure and smart institutions and laws [7]. Many settlements in the city lack a sewerage system and rainwater drainage facilities, and adequate waste management sites are missing, which are key components of smart basic infrastructure along with a connection to water and energy. Flooding during rainy seasons as well as uncollected garbage is frequent phenomena in all parts of the city, but particularly in the poor settlements. Frequent energy shortages also affect the city's economy. These challenges are associated with poor land administration and governance, characterized by a lack of transparency and corruption. The fact that about Lagos metropolitan area accounts for more than 85 % of the entire state population and about a third of the total urban population in Nigeria has serious consequences for land use planning in the urban area. It also has great implications for infrastructure and for other socio-economic, cultural and administrative issues.

Among the key challenges facing Lagos include, a decaying infrastructure, widespread urban poverty, massive unemployment, pervasive security inadequacies, land tenure challenges, slum emergence and growth, high settlement density, conflicts in land use, narrow and poorly constructed streets without drainage, traffic congestion, flooding, environmental decay, technical inadequacies and lack of manpower, unreliable power supply and corruption.

Faced with continued slum proliferation associated with weak city foundation, the Government of Lagos State is developing various urban development programmes and projects that if adequately implemented will contribute to the smartness of Lagos as a city of the twenty-first century, a city which is sustainable, inclusive and prosperous. At the time of independence, the focus of development in the country was simply sectoral and economic planning was favoured to conscious efforts aimed at resolving physical planning challenges. National Development Plans, whose adoption had started a few years before independence with an objective to create policies, programmes and projects for achieving economic development in the country, become the independent government's development pathway. In response to the enormous transport challenges, the state government has embarked on heavy investment in the periodic maintenance and expansion of roads, construction of new roads, vehicular and pedestrian bridges, and implementation of Lagos Urban Transport Project. The project was designed to create an efficient, effective, integrated, intermodal mass transit system, involving land, water and rail transport—and in the process, to contribute to poverty reduction. The state government's policy thrust on transportation development has been centred on providing a safe, efficient and sustainable integrated mass transit system, Improving transportation infrastructure and the traffic management system and Introducing rapid rail transportation.

The Lagos state government has also initiated various projects, which when fully implemented will promote the growth of a sustainable, inclusive and prosperous Lagos. Among the main initiatives include Proposed development of "Lagos Smart City" and policy and institutional reforms. The Lagos state government has initiated various policy and institutional reforms since 2000 to enhance the performance of various sectors and to spur the state's rapid economic growth. To address the housing challenge in the state, the government introduced the Real Estate Developers Association of Nigeria and a Ministry of Lands, Housing and Urban Development in 2000 as well as restructuring the housing development system. Computerized land registries have also been introduced in Lagos, and the state government has established an electronic documents management solution to fast-track title and mortgage documentation. *Environment sustainability*—The Lagos state government is making several efforts to create a safe, friendly and sustainable environment conducive to residential, business and recreational purposes. *Disaster Preparedness*—The policy targets of flood control; Develop a Storm Water Drainage Master Plan for the entire Lagos and implement by 2025; Develop a regulatory framework for wetlands management; Sustain, Improve and Promote the Involvement of Private Public Partnership; Develop Institutional frameworks and community involvement for the upgrade, maintenance and

de-silting of primary and secondary urban storm-water drainage infrastructure networks; Develop frameworks for communication with stakeholders and institutions involved in storm-water infrastructure management; and Develop policy and guidelines on storm-water infrastructure management.

41.2.11   Senegal: Dakar City Studies

Dakar is located in the western part of Senegal. Dakar urban agglomeration has a population of 2.8 million, while urban population of Dakar was 3.3 million in 2015. The population of the city is 1.2 million in 79.7 square kilometres. The gross density of Dakar is 15,780 people per square kilometres in an area of 178.3 km^2. Dakar has a concentration of nearly half of Senegalese civil servant population. Nine out of ten employees in Senegal's trade, transport, banking and industrial enterprises are in Dakar. Therefore, converting the urban economy of Dakar to Smart Economy and making Dakar a Smart City makes a lot of sense. Dakar's youthful demography has got a potential to sustain long-term economic development in a Smart City. However, the city is not well planned, with deficient physical and social infrastructure and proper legal foundation befitting the post-colonial era.

Dakar offers multiple opportunities as a hub of economic activities as well as a link to local, regional and global economies. Today, with its population of 3.4 million, it has an added advantage associated with its high population density and its youthful population, two important drivers of economic productivity and growth. Half of the national urban population live in the agglomeration of Dakar, and the city contributes nearly 55 % of the national Gross Domestic Product [3] (GDP). However, Dakar's opportunities to be a Smart City are shadowed by human-made challenges, characterized by three main factors: (a) poor urban planning; (b) insufficient provision of basic services and (c) inefficient urban policies. This has led to frequent occurrences of flooding and traffic congestion among others. By affecting social development with inaccessibility of most services, the economic development of the agglomeration is severely affected with significant decline of productivity of the active population.

For these past 15 years, along the economic power of Dakar, the Senegalese government has taken various initiatives favourable to the development and use of ICT at all levels. It creates legal institutional framework to support regulatory mechanisms on the development and use of ICT and introduces ICT platforms such as E-Governance, E-Education, and E-infrastructure and supports education and training on ICT. Along the government programmes and policies on ICT, there are several other initiatives from private sectors, NGOs, Civil society, Academic that invest on the expansion of ICT and education to bridge the digital divide [4]. Today mobile telephone is present in each household of the city of Dakar easing potential access to internet and multiple applications, and by 2030, access to other ICT infrastructures at the household level such as computer and internet will be quasi-universal offering opportunities to live in a digital city. The penetration of

ICT is particularly effective in education institutions where they are helping to bridge the gap in a context where national and local authorities have not been able to meet the growing demand from a massive young population. ICT is slowly penetrating the employment sector, but it has been challenged by the fact that over three-quarters of the sector are informal. ICT employs less than 1 % of the job market, and most sectors have not yet fully integrated the ICT infrastructure in the service performance and delivery. However, the informal sector can benefit from the ICT in many ways, particularly to ease financial transactions.

While developing projects aiming to tackle flooding and traffic congestion in the agglomeration of Dakar, national authorities have taken bold urban policies with the creation of seven polycentric urban centres in the outskirts. Among these urban centres, features the Urban Pole of Diamniadio, which is already under implementation as part of the Plan Senegal Emergent (PSE), representing the first sustainable city model with the integration of climate risk resilience. These urban centres will integrate various dimensions of the sustainable, inclusive and prosperous city model as illustrated in Fig. 40.1; they will, indeed, represent the first generation of Smart Cities in Senegal. With the creation of urban centres supported by the ICT, Senegal is entering in the era of the end of big cities and the rise of digitally served urban centres and villages. Dakar may remain the only Senegalese city with a population of more than 1 million. With the development of ICT, all the advantages associated to large cities with high densities, such as economy of scale, agglomeration of economies, diffusion of ideas and innovation will be obtained through digital towns and villages interconnected through the Internet. In this situation, the planning of settlements must take into consideration the planning of other settlements, and calls for territorial planning which goes in tandem with intercity cooperation. Occupations will be more technology intensive, and analogue economic jobs will give way to digital economic jobs. Though this transformation is just starting in Dakar as in many developing countries, its development is irreversible, and we must anticipate living in a perfect digital country by 2050 or earlier as Senegal is committed to the development and use of ICTs. The PSE that has the ambition to create six urban centres has anticipated in strengthening the smartness of Dakar through the development and use of the ICT to boost intercity cooperation as illustrated in Fig. 40.1, with the first Virtual University being introduced in the Urban Pole of Diamniadio, which is one of the new urban centres.

However, create digital urban centres, and benefit from ICT innovations and good practices, there is need to sustain the liberalization of the ICT in Senegal. Harnessing ICT opportunities requires policies that lower the barriers to competition and market entry, in addition to investments in infrastructure and skills. This will require investments in skills and infrastructure as well as reform on regulatory barriers by overcoming vested interests to encourage all firms to compete by investing in the ICT. All this will require a strong rule of law, efficient bureaucracies, government stability, lack of corruption and a stable business environment that encourages domestic and foreign investors.

41.2.12   South Africa: Cape Town Study

The study on Cape Town brings a unique city setting: (1) one where segregationist development (apartheid) has been legally rooted in the city foundation and manifested through urban planning and design, institutions and laws and access to basic services and (2) followed by an inclusive post-apartheid development through urban planning, housing, social development and economic development. Although Cape Town has made commendable progress since the end of apartheid in 1990 that led to its awarding as the 2014 World Design capital, efforts are still needed to create a Smart City, a city which is sustainable, inclusive and prosperous.

   The city of Cape Town is the oldest city in South Africa with recorded continuous settlement dating as far back as 1652. With a population of 3.7 million people in an area of 2461 km^2, Cape Town is South Africa's second most populous city after Johannesburg (4.4 Million) and the tenth most populous city in Africa. South Africa has three capital cities: Pretoria, the administrative capital; Cape Town, the legislative capital; and Bloemfontein, the judicial capital. Cape Town, as the legislative capital, is the seat of the nation's Parliament that consists of the National Assembly and the National Council of Provinces. As the provincial capital of the Western Cape region, Cape Town is home to about 64 % of the province's 5.8 million population and represents about 80 % of its GDP.

   Cape Town is a base for IT and manufacturing companies in the Western Cape region. The share of the city's population with access to internet increased from only 14 % in 2002 to 49.3 % of in 2011. With this growth, continued investment in the ICT sector by the local authority and the subsequent progress in ICT, media and call centre industries, Cape Town became the first African city to enter the Intelligent Community Forum's "Smart21 Communities" in 2008. In its commitment to build an opportunity city, the city is heavily investing in the broadband infrastructure programme. The programme was the single biggest capital expenditure item in the Corporate Services budget for the 2012/2013 financial year with an allocation of R61 million, and an additional R152 million for the 2013/14 and 2014/15 financial years. The 7–10 years project is greatly expected to reduce telecommunication costs, improve connectivity speeds, link different sectors of the city via high-speed networks and improve the city's competiveness both locally and internationally. The network is further anticipated to create and establish 250,000 jobs throughout the Cape Town metropolitan area, improve business communication, facilitate high-speed data communications to municipal facilities and ultimately help drive economic growth, development and inclusion—especially in previously marginalized areas. As the core of Smart Cities, Cape Town's continued investment in ICT infrastructure and its plans to link both the public and private sectors with high-speed broadband network will not only create a "digitally inclusive and equal opportunity" society in which economic growth is possible, but will also cement the city's place as the first Smart City in Africa.

   Cape Town was the centre of the apartheid regime in South Africa that lasted from 1948 to 1990 and has been named as being among the most unequal cities in

the world. The City Foundation of Cape Town has historically been guided by a segregationist ideology manifested through institutions and laws, urban planning and design, and access to basic services and amenities. Systematic segregation would continue into the late 19th and early twentieth centuries, effected through manipulation of urban planning and design principles, and sustained through a diversity of institutional setups and various laws and policies.

The long march to freedom and social inclusion was through both peaceful and violent protests held in the city between 1950s and 1990 when apartheid was officially abolished, each with varied outcomes. With mounting economic hardships, international pressure and increased local protests throughout the 1980s, the government secretly began negotiations with Nelson Mandela, who had been jailed since 1964. Although police still used violence against peaceful protests, the momentum of the protests was unrelenting and would culminate in mass voting against the government by white Capetonians in the 1989 elections, the release of Nelson Mandela in 1990 and the subsequent repealing of segregationist laws. The first multiracial democratic elections in 1994 won by the African National Congress and the enactment of South Africa's new constitution, which enfranchised blacks and other racial groups, marked the official end of the apartheid system.

The dismantling of apartheid in the early 1990s came with calls for inclusive development in South Africa, mostly guided by Nelson Mandela's ideal of a democratic and free society carried in his 1964 *speech.* By the early 1990s, however, Cape Town's urban form and structure had long been physically segregated, and over 3.5 million people had been forcefully removed from the "whites-only areas" and shunted off to less desirable areas. The task of promoting social inclusion in an already separated city bestowed upon the new "African" government was thus very hard to achieve, even more given that the new leadership did not take time to plan for long-term growth. This challenge has persisted to date and with an inequality coefficient (Gini) of 0.67 in 2011/2012, Cape Town remains one of the most unequal cities in the world. More than two decades later, aspects symbolic of apartheid segregation are still being adopted in the form of gated communities separated from the city by perimeter walls and security guards. Although some strides have been made especially in the past decade, much remains to be done to avail equal growth opportunities for all city residents.

Cape Town has formulated and adopted several policies with an aim of making the city more sustainable, inclusive, livable, prosperous and smart. In 2012, the city joined the livable streets movement in a bid to promote streets for all, and to make the city more livable and more pedestrian and cyclist friendly by reducing motorized transport. As part of this movement, the city has already put in place policies within the Integrated Transport Plan and invested in the construction of pedestrian and cycling lanes as well as parks and other public spaces. In addition, the city organizes "open streets-type events" for which car-free zones are temporarily set up to create safe public spaces in which citizens can experience and appreciate their city in a new way. Four of such events had been set up between 2013 and 2015 and have greatly been received by the city dwellers and applauded for creating social spaces where people of all races interact.

41.2.13 USA: St. Louis City Study

St Louis is a port city in the state of Missouri located in the west Bank of Mississippi River with a population of 319,294 in 2010. The St Louis metropolitan area includes the city, Missouri and Illinois with a population of 2,905,893. The economy of St Louis relies on services, manufacturing, trade, transportation and tourism. The city produces more than 25,000 graduates and postgraduate.

As the Smart City movement takes hold, there is a very real window of opportunity for St. Louis to increase its market share of creative persons [8]. Increasing market share of creative persons, there will be increase in the probability that new successful businesses will be created and stay in the St. Louis area. The St. Louis area central corridor should unite around the theme of building our Smart City platform, of building our innovation districts and neighbourhoods and of building our Smart City and the future St. Louis. The St Louis is building innovation districts and innovation neighbourhoods with a clear sense of urgency and purpose. The urgency should come from the need for St. Louis to end decades of socio-economic division by beginning to create an inclusive Smart Economy where all persons from all walks of life are able to participate in innovation districts or innovation neighbourhoods. Then, as the neighbourhoods grow and ignite organic growth, the same socio-economic and technological capabilities can be brought to the rest of the St. Louis region as the business case is proven. Smart Economy and inclusive policies should also be developed for these innovation neighbourhoods and innovation districts. In this way, St. Louis area residents and businesses will be able to gather ideas and entrepreneurial opportunity from the entire region, not just the central corridor. These kinds of policies would also send a clear message that St. Louis understands that inclusion is a fundamental cornerstone of the Smart Economy, and of our success, without which we will certainly fail. Interconnecting neighbourhoods would also have a positive sociological effect on the community since these new ultra-high-speed connections would cut across neighbourhood and political subdivisions and would be available to all persons within or around those neighbourhoods. Furthermore, by including persons who are economically disadvantaged, St Louis connects a larger community of ideas and inspirations which ultimately result in accelerating the public sector innovation process and sense of public good.

There is a general lack of education and understanding about what a Smart City is and how to achieve socio-economic impact [9]. Smart City educational programmes will need to be developed (similar to entrepreneurial educational programmes) that educate persons at the middle school and high school levels, through tech school, colleges and at the University level. Professional and business programmes will also need to be developed for executives, managers and lay persons who are currently employed. At this early stage of development for Smart Cities, it is crucial that St Louis adopts an easy to implement process to find and develop champions who can lead the development of Smart Cities at the entrepreneurial level. These same champions should be spiffed, then funded and celebrated at all.

St. Louis needs to be assertive and thoughtful in its Smart Cities initiatives. We cannot simply adopt what has worked in other regions, although the lessons learned can be very useful. There is a critical mass of entrepreneurial energy in this city that can be harnessed and directed towards the creation of a Smart City [10]. St Louis needs to formally adopt that challenge as a region, set out specific goals and work to accomplish them.

Smart City initiatives should invest in both infrastructure and ecosystems. Entrepreneurs who imagine and then pursue change are a critical component of success that needs to be intentionally nurtured. This should be done across a broad number of interest areas where entrepreneur development efforts are led by champions. The role of the champion is to find the funding and then create collaborative environments that are engineered to connect entrepreneurs with similar interests. Leaders should put in place the infrastructure and also establish the incentives and environment that is inviting to entrepreneur development champions. Winning Smart Cities will find the resources and creativity to create the most inviting regions that retain and attract Smart City entrepreneurs. The leading Smart Cities will guide us in uncovering the new economic and social changes that are desired.

Smart City advocates and leaders must adopt a new paradigm for understanding, assessing and estimating the economic impacts of broadband deployment and utilization [3]. This paradigm should extend beyond a standard calculation of job creation, wage distribution and capital investment to include a wide range of economic values generated by ultra-high-speed deployment. These values include the increased utilization of real estate, cost savings through use of smart technologies, higher level of education attainment, transportation and security system improvements, and greater access to economic opportunities across a wider spectrum of socio-economic levels.

For the last two hundred years, the USA has passed through the first industrial revolution with a measurable degree of success. As people moved from farms into cities, they received a public education and learned the necessary basic skills to work in factories, related businesses and industry. Entrepreneurship, education and small business in all forms were central to this success.

In the coming Smart City industrial revolution, community engagement and education combined with advanced connected Smart technologies will widen the playing field to ultimately include a much greater degree of participation of more persons in the development of the Smart City as we reinvent who and what we are. The long-term socio-economic impact of this opportunity is staggering.

Smart Cities are 90 % sociology and 10 % infrastructure. Smart Cities that focus on educating and planning their Smart City in the early stages from an entrepreneurial and socio-economic impact perspective will realize the benefits of Smart City transformation sooner.

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