Advances in 21st Century Human Settlements

T. M. Vinod Kumar *Editor*

Smart Global Megacities

Collaborative Research: Tokyo, Mumbai, New York, Hong Kong-Shenzhen, Kolkata

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Introduction

The Configuration of Smart and Global Mega Cities

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Abstract There are about 31 megacities of population size 10 million and above in the universe in 2016 as per UN-Habitat which is likely to be 41 in 2030. These gigantic habitats are significant as it has all the potential to convert into smart and global cities if configured for its sustainability. This creative configuration of megacities to smart and global is the outcomes of the book through city case studies. The vast population, cultural and ecosystem diversity, diverse institutional endowments, supply chains connectivity, global linkages and size of income and expenditure in these megacities creates opportunities for configuring to a smart global city. This chapter tries to understand the title of the book and surveys the growth, development, and distribution across geographic regions. Theories of global cities are studied briefly and finally ends up with broad approaches to configure these megacities to smart and global. In conclusion, the smart global economic community design strategy is detailed out and implemented in Kochi-Kannur megacity study. This chapter serves as a background of several case studies of megacity across many continents in this book.

Keywords Megacities · Smart cities · Global cities · Smart city configuration · Global city configuration · Megacity time-series growth and distribution · Theories on global cities · Sustainable approach · And methodology for configuring megacities to smart and global cities

1 Megacities

This book is all about configuring smart global megacities using a series of case studies from many countries and federal states in the country. The UN-Habitat in 2012 defined megacities as an urban agglomeration with 10 million or above population. Urban in the Indian census 2011 is defined as a settlement with a minimum of 5000 population, 400 persons per sq. km density and 75% male working population in a non-agricultural occupation. This combined attributed in a settlement defines a

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census town. When many census towns form a contiguous large settlement of the size equal or more than 10 million it is called Megacity. These urban centres need or need not be designated local bodies like municipalities, Cantonment Board or Town Committee. An urban agglomeration is continuous urban spread with towns and outgrowths with at least one statutory town and two or more towns physically contiguous. This incidentally is the definition a metropolis if the population size is below 10 million and for megacity if equal or more than 10 million. The megacity can be formed in many ways. Many metropolises when spatially joined can form a megacity. It can be linear or nonlinear. Kochi-Kannur is a linear megacity in the state of Kerala, India while Chennai is nonlinear in Tamil Nadu, cutting across many districts. The nonlinear megacity formation can be centred around at least one city as per the definition of urban agglomeration. Since megacity with 10 million-plus population and meta city with 20 million population formation in a country is rare many a time census does not care to define megacities or meta cities and stop at metropolises. Census operation generally takes place in some administrative boundary. For example, Indian census gives importance to District and we have many publications of the census of India for districts. Megacity many times have a geographical spread more than a district and often it can spread beyond state boundary as in the case of Delhi. This is not accounted for by the Indian Census which is fixated on districts within one state. The boundary of megacity is not static like an administrative boundary. It is always dynamic and changing.

The best way to understand the ever-changing geographic spread of Megacity is to modify the Watch Tower for the city view suggested by Patrick Geddes [1–9] to a stationary geocentric watch station in the sky using space technology. In a clear moonlit sky, you observe from there a megacity, like a contiguous array of lights, some bright in a dense and contiguous and clustered manner because of high population density and some less bright and scattered spread over with some empty spaces around. In daylight, you will not find agriculture fields the primary sector economic activities in megacities. The author of watchtower concept Geddes was first to identify urban agglomerations which he called conurbation. His work merits careful study for readers of this book.

The global cities with less population than 10 million existed before the first two global megacities came into existence in 1950s Tokyo and New York. These ancient global cities were without the prefix mega (being part of predominantly rural city regions with less population and low urbanisation level) and not smart with ICT and IoT as part of the city came much later in recent time. Global cities existed, as per archaeological findings many centuries ago even in ancient pre-historic times managed by communities. These historical global cities had an important role in making India rich in the past. The world has more experience to deal with global cities than large megacities and smart cities in the past when we do not have faster air, sea and land transportation, modern global communication system, digital data-driven cities and fintech that allows greater and fast mobility of money. Before British colonial era in India, we had many global cities recorded in history, but it became less in number and almost inactive as colonial empire took deep root in India that transformed rapidly ancient rich India to poor rapidly in two centuries. The trend of

India getting poorer continued in independent India with 2–3% GDP growth rate for many decades until 1991. In the postcolonial era after Independence, the bureaucracy under socialism with a mixed economy in India was characterised by over-regulation using mindlessly old, outdated and oppressive colonial legislation that made India poorer, and administrative rules and dysfunctional micromanagement of economy copied from Soviet Russia's central planning system which went against an open free market economy that existed before that. in India. The adverse administrative control on communities in pre-existing global cities retarded their well-known, innovative initiatives to reach out and to become more global. Besides, communities in ancient global cities were frustrated by permit and licence raj which cultivated corruption and nepotism among of post-independent Governance. These activities paved ways to a corrupt bureaucracy supported by rent-seeking political leaders whose intention is to be greedier and more corrupt, than before. No wonder in Indian Parliament today we have about 30% lawmakers with First Information Report registered under many sections of Indian Penal Code mostly for major heinous crimes awaiting final judgement. They are considered innocent until proved by the court which had a snail speed of progress in disposing of crimes with their judgements. No wonder we have noisy scenes that disrupt serious deliberations in the parliament and important bills passed with inadequate and intelligent and well-prepared deliberations. These negative and harmful tendencies are to be eliminated by an enlightened mass movement and judiciary in a democracy based on the rediscovery of the constitution, for human rights, environmental rights and right for work and living. The Indian judiciary is setting up fast track courts to dispose of pending cases of lawmakers all over India and further strengthen judicial manpower. India is striving to remove these shortcomings at a slower pace and growth rates of the economy are accelerating because of progressively removing these obstacles to growth and development. This is happening in many countries like China and India but to a limited scale and at a much slower pace than required. Once this happens then we have global cities with smart economic communities with potential for higher achievement. The global city is the centre of such a transformation. These megacities have been growing despite the fact Government investments in cities has been minimal for many decades because India believed It is a rural India.

Megacities are the bright and dense clustered lights spread over the large area from many buildings and streetlights as well as gateways like seaports, airports and bus terminals. When viewed from a space station in the night. They are also the bright light of globally connected prosperity for the population living there with ample opportunity to progress from their skills, innovations, and achievements locally that is connected globally. These mega cites do not care very much in their spread, about the electoral district of Member of Parliament or legislative assembly or Municipal ward boundary, Municipal Boundary, District Boundary of revenue districts or planning area of Urban Planners all fixed based on different criteria and static for a long time. They become the habitat of megacities only when the population of urban agglomeration reaches 10 million and above. Megacities may expand the boundary every day while political and administrative boundaries discussed above are static, fixed and remain there several decades. So, nobody knows the extent of a megacity

in area and population today without the use of geospatial technologies on a day to day basis with spatial modelling techniques to know its spread [10]. Delhi Chief Minister may say no I can look after Delhi city alone as a democratically elected chief minister of Delhi but under Federal System of Governance under the Indian constitution, he cannot since Delhi is part of Rajasthan, Uttar Pradesh and Haryana states besides the Union Territory of Delhi, four federal states and urban development is a state subject. His way to megacity development of Delhi is only democratic and cooperative federalism and not mere command administration in an overlapped program region using such institutions as National Capital Regional Board. Perhaps in future, Megacities may be ideally carved out of several federal states and given the status of an independent state with an independent state assembly, administration and judiciary and a constitutional frame of a state and made equivalent to a city nation.

Urban area terminology world over is developed by the national statistical authorities such for example, the Census and the statistical division of the United Nations. They are at liberty to use their terminology and area definition based on well-informed judgement. For example, Australia calls the urban area as urban centres, Canada Population centre, Denmark, Finland, the Netherlands, Norway, Sweden, and the United States calls it urban Area, United Kingdom the built urban area while India and the United Nations called it Urban Agglomerations in last few censuses and before that urban complexes. A metropolitan, megacity or meta city (20 Million and above population) area may include more than one urban area. For example, the Los Angeles metropolitan area includes several urban areas, such as Los Angeles, Riverside-San Bernardino, Mission Viejo, Santa Clarita, Simi Valley, Oxnard-Ventura, and Palm Springs. The United States designates combined statistical (metropolitan) areas, which are routinely used, as opposed to their smaller metropolitan statistical area (MSA) components. Some but not most nations formally designate metropolitan areas (such as the United States, France, Brazil, India, Argentina, and Canada). Caution is appropriate concerning the term. Other countries have their definition. A term "Greater" is often used to denote a metropolitan area, such as "Greater Los Angeles", "Greater Mumbai" or "Greater Chicago." Again, this term is imprecise, because it is also used in some situations to denote municipalities that are only a part of a metropolitan area or megacity. For example, the municipality of Mumbai is formally called the Municipal Corporation of Greater Mumbai and does not encompass either the entire urban area or the entire metropolitan/megacity area. There is considerable confusion over the term "city" and urban terms, such as "urban area" and "metropolitan area". By its very nature, urbanisation in both the spatial sense and the economic sense is not defined by the borders of single municipalities, large or small. There is a requirement for standardisation of metropolitan areas definition jointly perhaps by a United Nations body to help the cause of scientific integrated metropolitan, mega and meta city development.

Considering increasing levels of urbanisation, the United Nations defined the 'mega-city' as a new population dependent category in 2012: 'In 2011, 23 urban agglomerations qualified as megacities because they had at least 10 million inhabitants'. 'Alongside the category 'megacity', UN-Habitat introduced the term [11] 'Meta city' which describes 'massive conurbations of more than 20 million people

or above'. 'Termed by some as 'hyper cities', cities with more than 20 million inhabitants constitute a new type of settlement above and beyond the scale of megacities. Driven by economic development and rising population numbers, they gradually swallow rural areas, cities, and towns, thus becoming single, yet multi-nuclear gigantic entities. These Meta city agglomerations, many of which accommodate populations larger than entire countries, are a truly unprecedented phenomenon.

These megacities and meta cities are especially important for the National economy. Most of the GDP in India, China and many countries are created in urban areas and a maximum of this GDP is generated in the meta cities than megacities, megacities than metropolises and smaller cities. As can be seen, it is the individual and households the new addition to megacity that created the megacity which is being continued if immigration continues. They move to the city with the mind of an entrepreneur to sustain themselves that results in wealth creation. Many decisions have been made by them at a speed of the megacity creation much faster and efficient than all institutions existing in the megacity. They have vacated the primary sector of employment once for all and moved towards secondary and tertiary sectors in the megacity. They have moved not to the organised sector of employment in large number but to the informal sector finding a new way to work and live than habituated in the rural area. Their hope for the future in a megacity is skilling them to earn more income for good living and adapting them to the needs of megacity every day and further the idea of human development. This results in megacity based human development that makes them smarter and productive with multiple skills.

1.1 Configuring Megacities

This book is all about configuring megacity futures. A smart megacity configuration is achieved through ICT, IoT and based on the effective use of the internet and the virtual city cyberspace. We understand it better by looking at the computer system and megacity side by side. Configure means arrange, shape, or order a megacity (like a computer system or an element within it such as computer chip) to fit it for a designated task of good living and sustainable income generation from work opportunities. The designated task of the configuration of megacity encompasses social, cultural, economic, and environmental conservation and sustainable development of megacity for the unique cultural system and ecosystem of all living and non-living in the city and hence it is complex. This also includes never-ending skilling and human development to achieve these sustainable but ever-changing economic tasks and smart community development. In communication or computer systems, a configuration is an arrangement of functional units according to their nature, number, and chief characteristics, but in the megacity, it is the urban components, parcels of land owned, land uses, zonal designations, public realm and networks and services that is configured with the unique cultural system and ecosystem. The configuration is the way components are arranged to make up the computer or megacity system to achieve the objective functions of components. The configuration consists of both hardware

and software components. The hardware is the built environment, natural environment and infrastructure of the megacity and software are how it can be monitored, managed, developed, and run in the most efficient and cost-effective and sustainable way. Sometimes, it is referred to specifically as hardware arrangement as hardware configuration and to software components as software configuration, but both are integrated into the clouds of cyberspace in a smart city. Understanding of megacity configuration is important as for certain hardware or software applications just like the specialised role of global megacities in the universe. Configuring allows users to determine whether an application can be run or not. It could also aid in decisions on upgrading or purchasing a new system to execute certain applications. Configuration can aid users in optimal usage of the megacity system to prolong the performance and life of the system. Megacities are interconnected and networked locally and globally. Network configuration is the process of setting a network's controls, flow, and operation to support the network communication, goods, and services flow of the megacity. This broad term incorporates multiple configuration and setup processes on network hardware, software and other supporting devices and components. Megacity Network configuration is also known as network setup. to arrange something or change the controls on a computer/megacity or another device so that it can be used in away.

1.2 Smart Global Megacities Configuration

This configuration of smart global megacities requires a strong sense of direction to be effective. In a systemic framework of the smart global megacity, it is self-directed by smart communities and happens even without the so-called command planners and administrators of megacities such as evident in the past in Mao's China and the now-defunct Soviet Union and East Germany before the fall of the wall of Berlin and state Planning Board of Kerala State in India today where a communist party ruled in a democracy for the first time leaving its negative institutional impacts which is more systematic with expensive and inefficient and largely non-responsive bureaucracy than dynamic and systemic and demonstrated in the last decades that it cannot sustainably give high positive outcome in agriculture and industrial development in Kerala. This resulted in lack of job opportunities, high dependency on food consumed from outside and lack of industries 1, 2, 3 and 4 in Kerala in comparison with other south Indian states such as Tamil Nadu, Karnataka, Telangana etc. and there is no household in Kerala without a person outside India and money order economy in Kerala predominate than self-generated regional smart and a global economy based on production. This recommended a new systemic approach leaves us with two directions. They are these, megacities need to be smart and megacities should be global. The Smart cities are self-aware [12] using ICT, IoT technologies, domain knowledge base and e-governance [13] and e-democratic system [14]. While ICT and IoT system is the hardware component of the smart city along with domain-specific hardware mentioned above; e-democracy and e-governance are the software to run the megacity in 24 h and 7 days a week.

Megacities do not have walls around it with a moat, bridge, and a well-guarded gate like the medieval cities. They are open to the internet-based global flow of information, data-driven and based on responses to instant demands and supplies of goods and services with varying degrees of Government Controls based largely on self-regulation using E-Governance and E-Democracy with near-zero cost on bureaucracy. People of megacities are not under any dictator who creates a wall around megacity and restricts people within the wall like the Berlin wall but is open to the rest of the world. A system of global cities can have a common workflow using a common cloud-based software that integrates global cities production and services deliveries highly synchronised and most efficient, managed by machines and people such for example a supply chain. This has a high impact on spatial planning. Industrial areas can be small, scattered and not isolated in the periphery of the city as well as commercial activities can have near-zero physical commercial areas, instead of a virtual mall of the website on the internet and not separate land use. It can be mixed with household and community in terms of intelligent neighbourhood. Areas earmarked for Government offices can be much smaller with e-Governance widely used. Land use and transportation system can be data-driven using real-time data used by people through their smartphones. There can be the death of petroleum run vehicles such as railways, bus and cars resurrected as a renewable energy-based electric vehicular systems. Socialism and Capitalism the right and left can die and remerge as sharing the economy with the strong resurrection of ancient community spirit thorough caste relationships as in India or other similar. All these calls for rewriting textbooks of spatial planning. The megacity can be a destination for open sourcing, outsourcing, offshoring, supply-chaining, insourcing, and informing and demand physical space can be much smaller and locational criteria can be much different than practised today. A new planning standard for smart global megacity needs to be evolved based on a variety of functional smart communities specialised requirement.

Many of the global and smart megacity activities are based on household or community of like-minded people with common economic or social objectives. The role of Government is as an outside supporter of the local and global economy and be a regulator as per legislation based on the constitution of the country. During the colonial era, megacities served as gateways for trades of the finished commodity from the empire to the colony and raw materials from colonies and slave trades. In the socialist era metro and megacities were used for shared production among socialist countries. The vertical linkages of the colonial period are now mostly horizontal. In recent time, megacities have turned to be a field for household and community enterprises of their knowledge base and high values services and goods. The community can be physical and spatial and virtual in cyberspace. While most spatial communities are within a nation most cyber communities can be from many countries. They co-exist in megacities.

2 The Birth and Growth of Megacities

Megacities came into existence as a part of global urbanisation where the population tends to get over-concentrated due to immigration in certain locations of high advantage mainly due to the economic vibrancy that gave rise to a superior quality of life and ability to produce many high wage employment and creating a multicultural society and rapid support for required institutional development. When economic vibrancy retards and the society cannot cope up with changing needs of megacities and technological advancement and mainly due to wrong national policies unrelated to megacities, the population of megacities can shrink and so also it's economy. It is happening in many megacities including Tokyo the biggest megacity and will continue unless new approaches such as international migration policies are found to arrest it.

2.1 World Urbanisation Trend and Cities

The year 2007 was a landmark year for urbanisation, globalisation, and smart cities. We will discuss in this para only on urbanisation and megacity formation. The growth of the urban and rural population is given below (Fig. 1.1).

Urban population growth was mostly upward from 1950 to 2030 to about 5 billion while that of rural was flat and tending to downwards. This downward and upward movement of rural and urban population accelerated further in the year 2007–2008 when the urban population was equal to rural and were 50% each. The UN projection shows a rapid gain in urban population after 2007. Figure 1.2 shows how much urban population gains from the projected years in absolute figures.

In 2016, an estimated 54.5% of the world's population lived in urban settlements. By 2030, urban areas are projected to house 60% of people globally and one in every

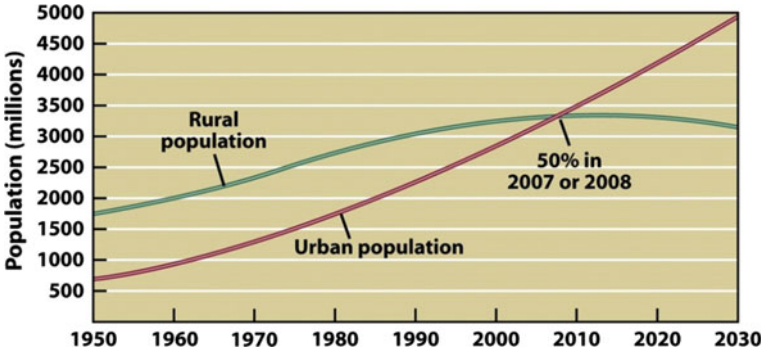

Fig. 1.1 Urban and rural population growth of the world 1950–2030 (*Source* UN)

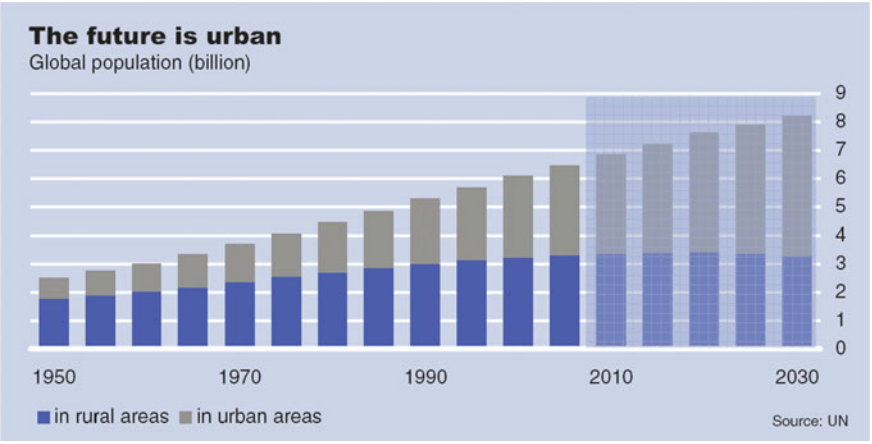

Fig. 1.2 Urban and rural population from 1950 to 2030 (*Source* UN)

three people will live in cities with at least half a million-population size as per UN-Habitat estimate. This trend means larger cities shows more propensity for higher employment opportunities and higher income that drives people to move there for a better quality of life. When more households in the world for example in India decide to transform from rural to urban households, by the change of occupation, migration or the village become urban; secondary and tertiary sectors of the economy have expanded at the expense of the Primary sector in the National Domestic Product, for example by the Indian Census [15, 16]. Megacities world over share a larger per cent of Gross National Products than other cities of lower population range mainly because of the high paying secondary and tertiary occupation and higher income and expenditure in these cities. There is also extremely high potential still untapped in these cities to increase this share for National Domestic Product.

3 Urban Population by Regions [17]

Urban Population as a percentage of total Population by regions in 1970, 2000 and then projection for 2025 is as given below. While North, Central and South America are reaching saturation points in urbanisation, there is much to catch up in Africa and Asia (Fig. 1.3).

In 2016, there were 512 cities with at least 1 million inhabitants (metropolitan Agglomeration/cities) globally. By 2030, a projected 662 cities will have at least 1 million residents. Cities with more than 10 million inhabitants are termed "megacities". As hubs of trade, culture, information, and industry, they will be vested with such power that at many levels they will act as city-states that are independent of national and regional mediation. Today megacities are home to less than 10% of the

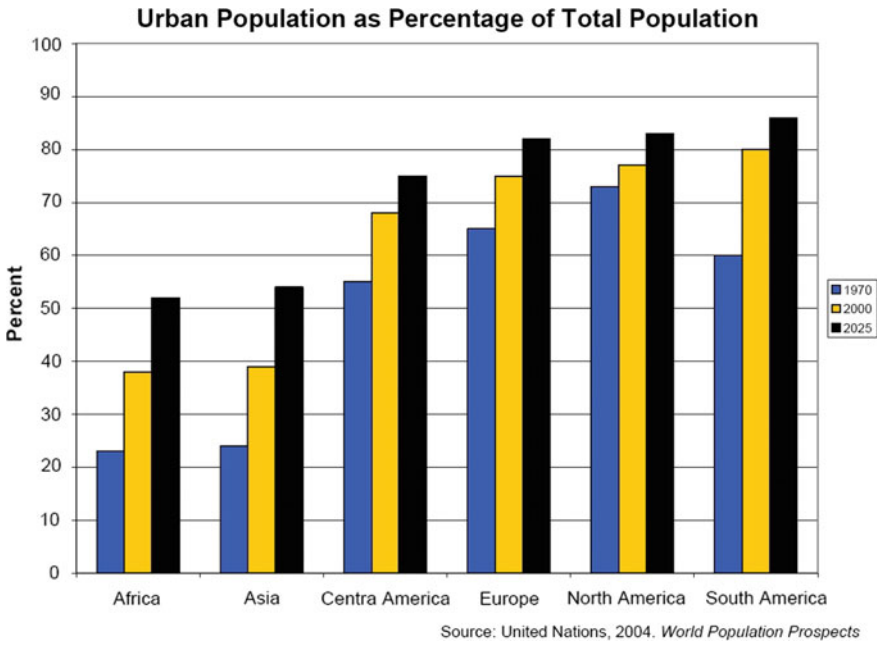

Fig. 1.3 Urban Population Growth 1970 to 2025 by Geographic Regions. *Source* United Nations, 2016 "World Cities in 2016 Data Booklet New York. United Nations, 2016 "World Cities Report 2016, New York

global urban population. In 2016, there were 31 megacities globally and their number is projected to rise to 41 by 2030. These 31 megacities by region are colour coded in the following graph as per the region they belong to and tabulated below.

3.1 Population Distribution by the Size of Settlements

The world population was aware of population growth and the need for more agricultural products for the growing population in urban and rural areas. The technological advancement in agriculture replaced human labour in agriculture for the increased production of agricultural products for human consumption to urban occupations. The rural folks found themselves redundant in rural areas and changed their occupation to secondary and tertiary sector employment and some of them moved to urban setting on their own. This transition created entrepreneurship for the rural folks in urban areas and great hardship for their livelihood. The spirit of entrepreneurship made them fill in the nonformal sector of urban employment with no institutional safety nets of organised industries and services to protect them. These migrant spirits have created urban centres for good living and prosperity world over, although they

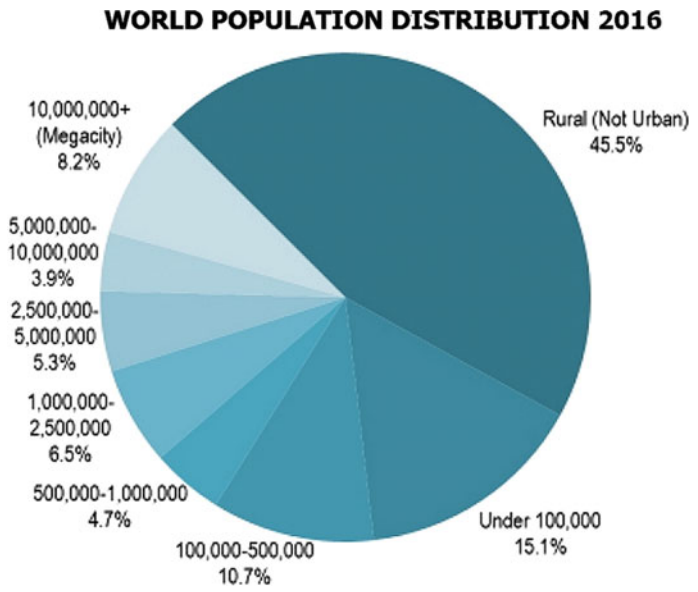

Fig. 1.4 Projected world population distribution 2016 (*Source* UN)

were largely unskilled. Such movement of population is projected to have a population size distribution of the population in the urban area and rural areas as given in Fig. 1.4.

The subject matter of the book is a megacity and its inhabitants which constitutes only 8.3% of the total population of the world in 2016, but different countries showed a different percentage split. Japan boasts the largest city in the world of Tokyo which have influenced the population distribution and projected population of Japan is given below in Fig. 1.4. Japan had the same number of meta/megacity (20 million and above), and metropolitan area 1 million and above in all benchmark years which speaks about the stability of the urban system of Japan. Many things can be learned from a stable urban system in Japan which survived many decades. Number of cities with million and below peaked up in 2018 and gradually reducing its numbers in 2030. It can be concluded that the Japan population by and large are meta city-megacity and metropolitan population.

3.2 The Time Series Growth of Megacities

The time-series growth of megacities is given below in two tables (Tables 1.1 and 1.2).

Another estimate of probable megacities is as given below.

Table 1.1 Meta cities and megacities population 1950, 1975, 2000, 2005, 2015 (*Source* UN)

Population of cities with 10 million inhabitants or more, 1950, 1[1]/75,2000,2005 and 2015														
1950			1975			2000			2005			2015		
	City	Population (millions)		City	Population (millions)		City	Population (millions)		City	Population (millions)		City	Population (millions)
1	New York-Newark	12.3	1	Tokyo	26.6	1	Tokyo	34.4	1	Tokyo	35.2	1	Tokyo	35.5
2	Tokyo	11.3	2	New York-Newark	15.9	2	Ciudad de Mexico (Mexico Cily)	18.1	2	Ciudad de Mexico (Mexico Cily)	19.4	2	Mumbai (Bombay)	21.9
			3	Ciudad de Mexico (Mexico Cily)	10.7	3	New York-Newark	17.8	3	New York-Newark	18.7	3	Ciudad de Mexico (Mexico Cily)	21.6
						4	Sao Paulo	17.1	4	Sao Paulo	18.3	4	Sao Paulo	20.5
						5	Mumbai (Bombay)	16.1	5	Mumbai (Bombay)	18.2	5	New York-Newark	19.9
						6	Shanghai	13.2	6	Delhi	15.0	6	Delhi	18.6
						7	Kokata (Calcuta)	13.1	7	Shanghai	14.5	7	Shanghai	17.2
						8	Delhi	12.4	8	Kokata (Calcuta)	14.3	8	Kokata (Calcuta)	17.0
						9	Buenos Aires	11.8	9	Jakarta	13.2	9	Dhaka	16.8
						10	Los Angeles-Long Beach-Santa Ana	11.8	10	Buenos Aires	12.6	10	Jakarta	16.8

(continued)

Table 1.1 (continued)

Population of cities with 10 million inhabitants or more, 1950, 1[1]/75,2000,2005 and 2015														
1950			1975			2000			2005			2015		
	City	Population (millions)		City	Population (millions)		City	Population (millions)		City	Population (millions)		City	Population (millions)
						11	Osaka-Kobe	11.2	11	Dhaka	12.4	11	Lagos	16.1
						12	Jakarta	11.1	12	Los Angeles-Long Beach-Santa Ana	12.3	12	Buenos Aires	15.2
						13	Rio de Janciro	10.8	13	Karachi	11.6	13	Buenos Aires	13.4
						14	Al-Qahirah (Cairo)	10.4	14	Rio de Janciro	11.5	14	Al-Qahirah (Cairo)	13.1
						15	Dhaka	10.2	15	Osaka-Kobe	11.3	15	Los Angeles-Long Beach-Santa Ana	13.1
						16	Moskva (Moscow)	10.1	16	Al-Qahirah (Cairo)	11.1	16	Manila	12.9
						17	Karachi	10.0	17	Lagos	10.9	17	Beijing	12.9
						18	Manila	10.0	18	Beijing	10.7	18	Rio de Janciro	12.8

(continued)

Table 1.1 (continued)

Population of cities with 10 million inhabitants or more, 1950, 1[1]/75,2000,2005 and 2015														
1950			1975			2000			2005			2015		
	City	Population (millions)		City	Population (millions)		City	Population (millions)		City	Population (millions)		City	Population (millions)
									19	Manila	10.7	19	Osaka-Kobe	11.3
									20	Moskva (Moscow)	10.7	20	Istanbul	11.2
												21	Moskva (Moscow)	11.0
												22	Guangabov, Guangdong	10.4

Source United Nations, Department of Economic and Social Affaire, Population Division (2006). World Urbanization Prospects: The 2005 Revision. Working Paper No. ESA/P/WP/200

According to the United Nations, Department of Economic and Social Affairs, Population Division (2012). World Urbanization Prospects: The 2011 Revision the following 37 cities will be megacities in the year 2025. Population in millions and current within parenthesis:

- Tokyo, Japan, 39 (37)
- Delhi, India, 33 (22)
- Shanghai, China, 28 (20)
- Mumbai, India, 27 (19)
- Mexico City, Mexico, 25 (20)
- New York, USA, 24 (20)
- São Paulo, Brazil, 23 (20)
- Dhaka, Bangladesh, 23 (15)
- Beijing, China, 23 (15)
- Karachi, Pakistan, 20 (14)
- Lagos, Nigeria, 19 (11)
- Kolkata, India, 19 (14)
- Manila, Philippines, 16 (12)
- Los Angeles, USA, 16 (13)
- Shenzhen, China, 16 (10)
- Buenos Aires, Argentina, 16 (13)
- Guangzhou, China, 15 (10)
- Istanbul, Turkey, 15 (11)
- Cairo, Egypt, 15 (11)
- Kinshasa, DR Congo, 15 (8)
- Chongqing, China, 14 (10)
- Rio de Janeiro, Brazil, 14 (12)
- Bangalore, India, 13 (8)
- Jakarta, Indonesia, 13 (10)
- Chennai, India, 13 (9)
- Wuhan, China, 13 (9)
- Moscow, Russia, 13 (11)
- Paris, France, 12 (11)
- Osaka-Kobe, Japan, 12 (11)
- Tianjin, China, 12 (9)
- Hyderabad, India, 12 (8)
- Lima, Peru, 12 (9)
- Chicago, USA, 11 (10)
- Bogotá, Colombia, 11 (9)
- Bangkok, Thailand, 11 (8)
- Lahore, Pakistan, 11 (7)
- London, UK, 10 (9)

3.3 Megacities and Meta Cities and Growth [17]

There is also the Meta city, or hyper city, an epithet that refers to massive sprawling conurbations of more than 20 million people. Tokyo became the first hyper city in the mid-1960s when it crossed the 20 million thresholds. Today it is the largest meta city in the world. Tokyoites—more than 35 million—outnumber Canadians. By 2020, Mumbai, Delhi, Mexico City, Sao Paulo, New York, Dhaka, Jakarta, and Lagos all will have achieved meta-city status, someone dozen to fifteen meta-cities as per the listing above. These meta cities are so huge that they have changed the dynamics of urbanisation. People commute to work in megacities from densely populated outlying suburbs. City centres stagnate as the economic base shifts outwards to peri-urban areas that are more attractive but less well-regulated but self-regulated by communities. Secondary cities and city systems become interconnected through manufacture and other business enterprises. Meta cities and Megacities are a key to globalisation, a state of interconnectedness around the globe that transcends and largely ignores national boundaries and ever-growing protectionism as manifested in Britain and the USA recently under Brexit and America First. Global urban economies rely on advanced producer services such as finance, banking, insurance, law, management consultancy, advertising, and other IT services. The technology revolution and advancement in university education everywhere has made it possible for business enterprises to hire these services anywhere in the world.

Urban Growth the world's largest cities are given below. Thirty-six large mega and meta-cities by geography are also given below (Fig. 1.5.).

Asia especially the Indo Pacific region leads in the number of megacities leaving far behind other regions such as the Americas, Europe, and Africa. Also, the 8 largest mega-cities/meta cities are in Asia. Further barring Moscow, all Europe megacities

Table 1.2 Meta-Cities and megacities of 2016 and 2030 (*Source* UN)

Rank	City, Country	Population in 2016 (thousands)	City, country	Population in 2030 (thousands)
1	Tokyo. Japan	38 140	Tokyo, Japan	37,190
2	Delhi, India	26 454	Delhi. India	36 060
3	Shanghai China	24 484	Shanghai, China	30,751
4	Mumbai (Bombay) India	21 357	Mumbai (Bombay), India	27,797
5	Sao Paulo Brazil	21 297	Beijing, China	27,706
6	Beijing, China	21 2*0	Dhaka Bangladesh	27 374
7	Ciudad de Mexico (Mexico City), Mexico	21 157	Karachi Pakistan	24 838
8	Kinki M.M.A. (Osaka) Japan	20 337	Al-Qahirah (Cairo). Egypt	24 502
9	Al-Qahirah (Cairo), Egypt	19 128	Lagos, Nigeria	24 239
10	New Yak-Newark. USA	18 604	Ciudad de Mexico (Mexico City), Mexico	23 865
11	Dhaka Bangladesh	18 237	Sao Paulo, Brazil	23 444
12	Karachi. Pakistan	17 121	Kinshasa, Democratic Republic o{the Congo	19,996
13	Buenos Aires, Argentina	15 334	Kinki MM.A. (Osaka), Japan	19,976
14	Kolkata (Calcutta, India	14 900	New York-Newark USA	19 885
15	Istanbul Turkey	14 365	Kolkata (Calcutta), India	19,092
16	Chongqing, China	13 744	Guangzhou Guangdong. China	17 574
17	Lagos, Nigeria	13 661	Chongqing, China	17 380
18	Manila, Philippines	13 131	Buenos Aires, Argentina	16 956
19	Guangzhou, Guangdong, China	13 070	Manila, Philippines	16,756
20	Rio de Janeiro, Brazil	12 981	Istanbul Turkey	16,694

(continued)

Table 1.2 (continued)

Rank	City, Country	Population in 2016 (thousands)	City, country	Population in 2030 (thousands)
21	Los Angeles-Long Beach-Santa Ana, USA	12 317	Bangalore, India	14 762
22	Moskva (Moscow) Russian Federation	12 260	Tianjin China	14 655
23	Kinshasa, Democratic Republic of the Congo	12 071	Rio de Janeiro. Brazil	14 174
24	Tianjin, China	11 558	Chennai (Madras), India	13,921
25	Paris, France	10 952	Jakarta, Indonesia	13,812
26	Shenzhen China	10 828	Los Angeles-Long Beach-Santa Ana, USA	13,257
27	Jakarta. Indonesia	10 483	Lahore, Pakistan	13,033
28	Bangalore India	10 456	Hyderabad India	12 774
29	London, United Kingdom	10 434	Shenzhen, China	12 673
30	Chennai (Madras), India	10 163	Lima Peru	12 221
31	Lima Peru	10 072	Moskva (Moscow), Russian Federation	12 200
32			Bogota, Colombia	11,966
33			Paris, France	11,803
34			Johannesburg, South Africa	11 573
35			Krung Thep (Bangkok), Thailand	11 528
36			London, United Kingdom	11,467
37			Par es Salaam, United Republic of Tanzania	10,760
38			Ahmadabad, India	10 527
39			Luanda Angola	10,429
40			Thanh Pho Ho Cht Minh (Ho Chi Minh City). Viet Nam	10,200

(continued)

Table 1.2 (continued)

Rank	City, Country	Population in 2016 (thousands)	City, country	Population in 2030 (thousands)
41			Chengdu, China	10,104

Source United Nations, 2016 "World Cities in 2016 Data Booklet New York. United Nations, 2016 "World Cities Report 2016, New York

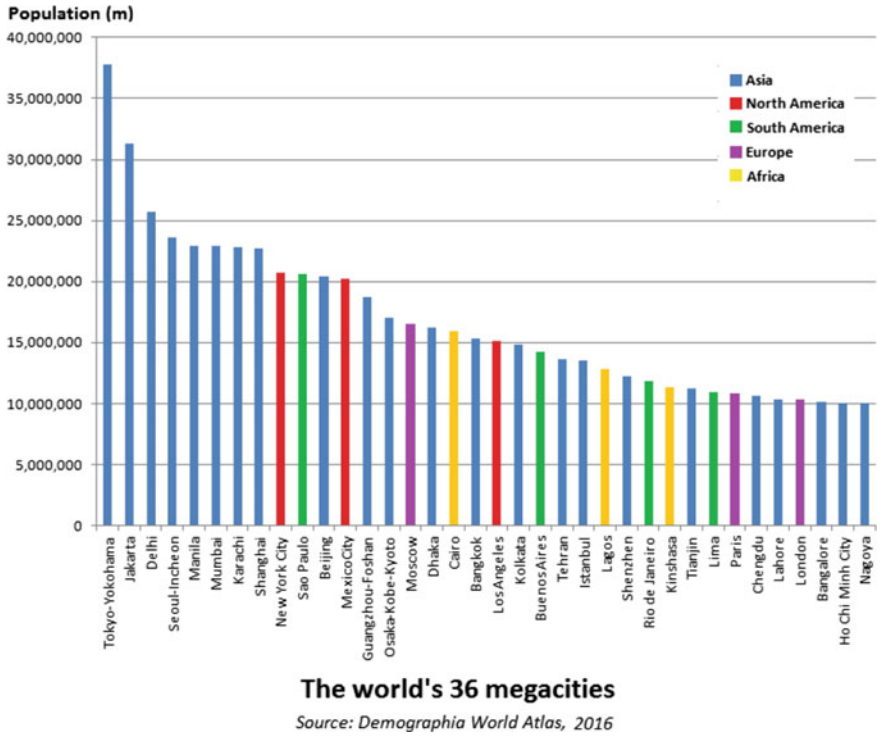

Fig. 1.5 Meta and megacities of the world by population and regions. *Source* United Nations, 2016 "World Cities in 2016 Data Booklet New York. United Nations, 2016 "World Cities Report 2016, New York

are of smaller size. With urbanisation reaching almost saturation and lower population growth, it is unlikely these trends cannot change in Europe.

Urban growth in some largest cities in the world is given below. Growth rates of Asian large cities are much higher than that in the other regions which substantiate further the earlier statement (Fig. 1.6.).

In 2016, 45 cities had populations between 5 and 10 million inhabitants. By 2030, 10 of these are projected to become megacities. Projections indicate that 29 additional cities will cross the 5 million mark between 2016 and 2030, of which 15 are in Asia

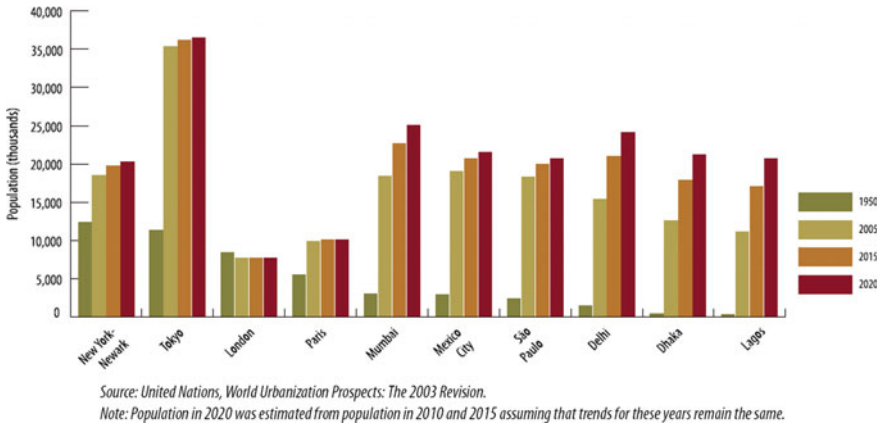

Fig. 1.6 Urban Growth in the World's largest cities 1950–2020

and 10 in Africa. In 2030, 63 cities are projected to have between 5 and 10 million inhabitants. Megacities in 2016 and 2030 are given below.

An overwhelming majority of the world's cities have fewer than 5 million inhabitants. In 2016, there were 436 cities with between 1 and 5 million inhabitants and an additional 551 cities with between 500,000 and 1 million inhabitants.

By 2030, the number of cities with 1 to 5 million inhabitants is projected to grow to 559 and 731 cities will have between 500,000 and 1 million inhabitants.

Megacities population was projected from 2016 to 2030 is given below. It can be seen again that Tokyo is declining while Delhi is growing faster and may overtake Jakarta approaching the second position. Many of the Asian cities and one African city are growing at a much faster rate than European and American cities.

If megacities represent the economic hub of the future, it is shifting towards Asia from America and Europe. This is reflected in the ranking of countries by GDP which shows upward mobility of ranks of China and Asia two large Asian countries. Integrated spatial and economic strategies can help this transition and an integrated megacities development approach across many continents. This is the subject matter of this book. As per the current trend GDP growth rate in Asia is much higher than in Europe and the Americas and it is likely to continue for a few decades. It looks like an Asian and African era is emerging (Fig. 1.7).

4 Pattern of City Development 1995, 2015 and 2025 as Per Urban Percent Population

The global urbanisation and cities development is given in these two maps. It shows levels of urbanisation and settlement development 1995 and 2015 of metro cities and mega-cities (Figs. 1.8. and 1.9.).

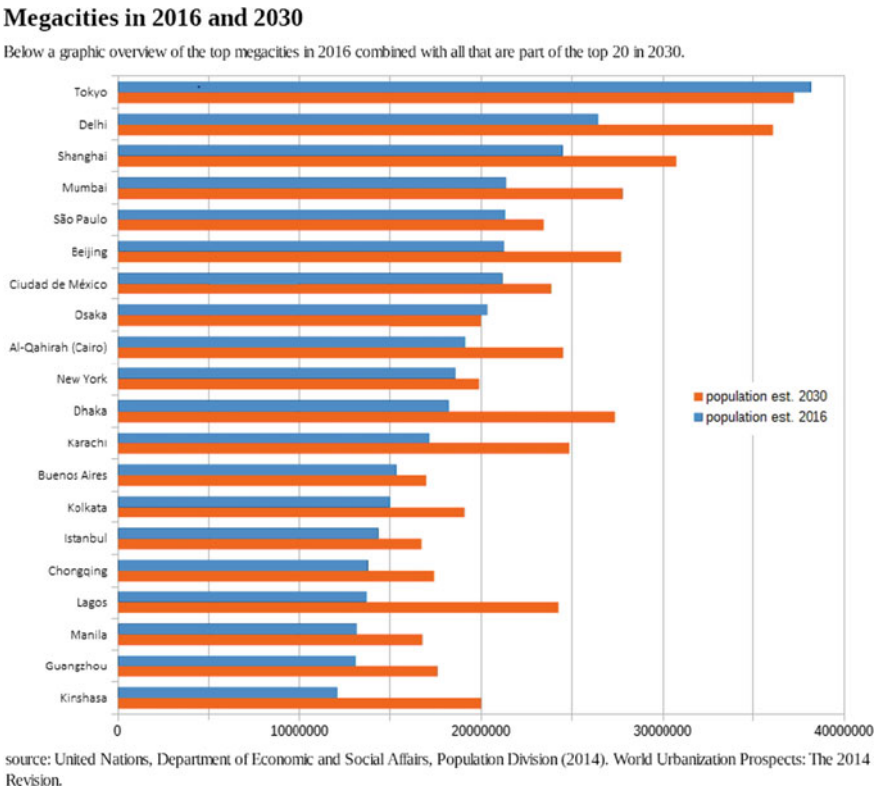

Fig. 1.7 Megacities population 2016 and 2030

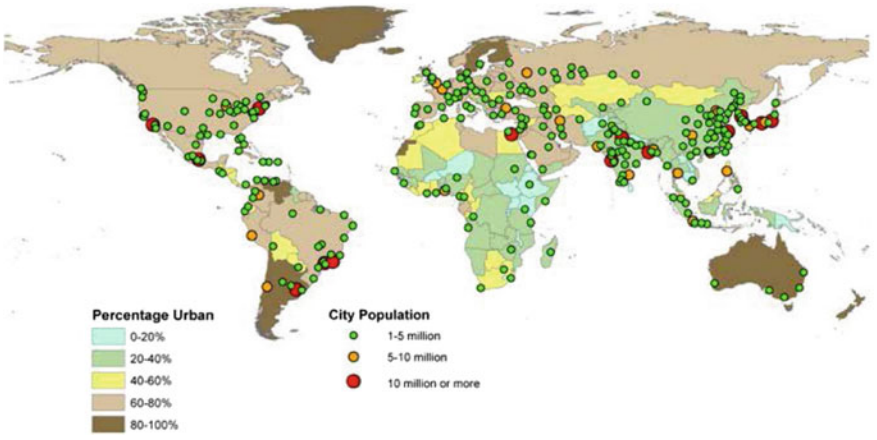

Fig. 1.8 Global Pattern of Urbanisation and large cities development in 1995. *Source* United Nations, 2016 "World Cities in 2016 Data Booklet New York. United Nations, 2016 "World Cities Report 2016, New York

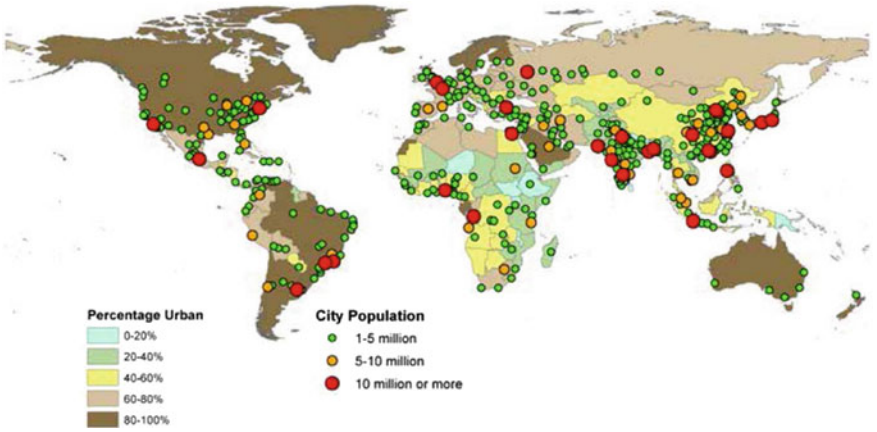

Fig. 1.9 Global patterns of urbanisation and large cities development in 2015. *Source* United Nations, 2016 "World Cities in 2016 Data Booklet New York. United Nations, 2016 "World Cities Report 2016, New York

Megacities show more growth in Asia than Europe, the Americas and Africa. These megacities can generate more per capita GDP. The rate of the projected growth of Urban Agglomeration by size in the world is given below for the period 2011–2025 which substantiate the earlier statement.

Figure 1.10 gives the spatial pattern of one million cities and above in 2015.

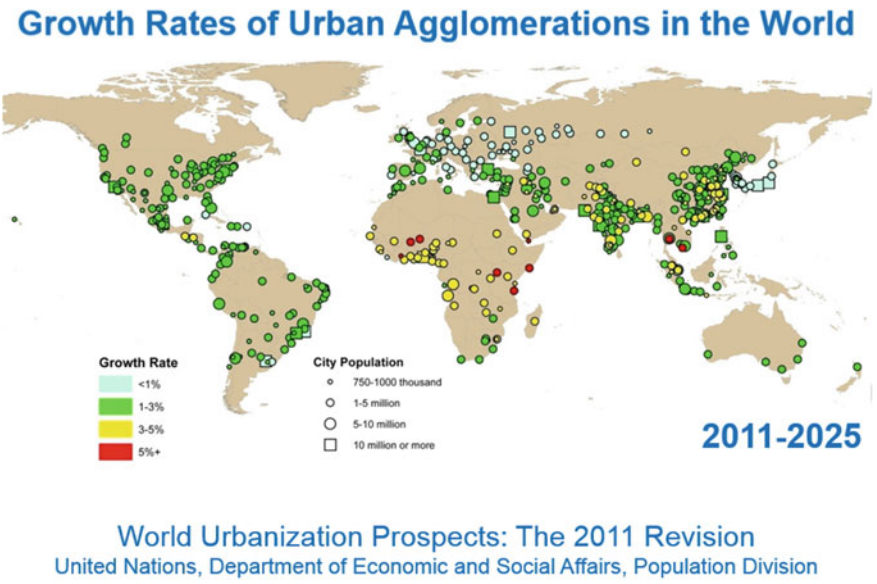

Fig. 1.10 Growth rates of urban agglomerations in 2011–2025

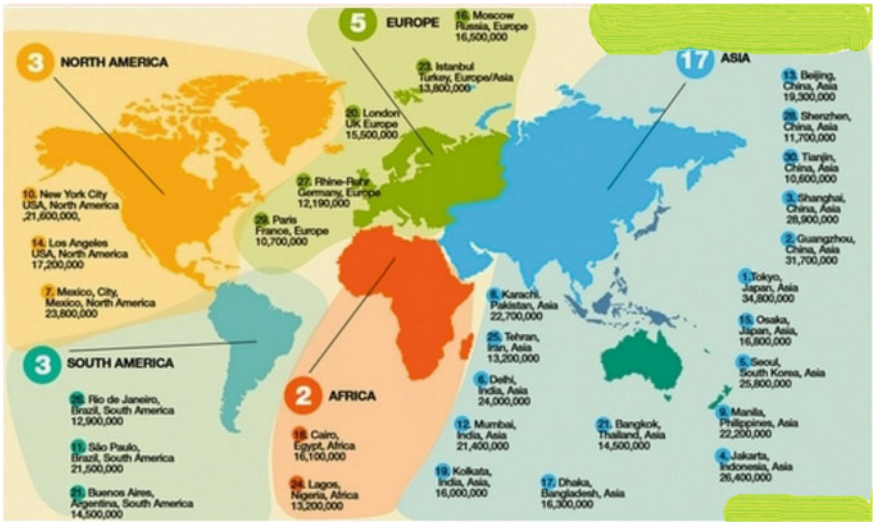

Fig. 1.11 Distribution of 30 megacities by continents 2014

The distribution of megacities is as given below in Fig. 1.11 and metropolitan and megacities scenario of Indian is given in Fig. 1.12.

Among the urban population, the largest percentage of people in India live in megacities. Table 1.3 computes these figures for states. With an extremely high share of the megacity and metropolitan population of urban Kerala, it is important to concentrate on megacity and metropolitan development in Kerala to reap the harvest of rapid economic development. Five of these metropolises will form one megacity. There is a chapter in the book devoted to this megacity.

Figure 1.13 gives the spatial distribution of urban settlement in 1991 and metropolitan and megacities in 2011. The western half of India is having more mega and metro cities than the eastern part.

The above figure represents the towns and cities in 1991 and several metropolitan areas in 2011. It can be seen unlike China the western part of India has more megacities and metropolitan cities than the eastern part. There is also near equitable distribution of mega and metro cities all around the Indian Union, unlike China (Fig. 1.14).

Growth rates of selected million-plus cities are as given and the fastest growing cities in India which all are n Kerala (Table 1.4).

Here the two megacities graduating to meta city Mumbai and Delhi of 20 million and above are taking a fast population growth trajectory. Out of 20 fast-growing cities in India in 2011, 9 are in Kerala and one megacity is formed out of 5 metropolitan cities there. There are seven metropolitan cities of one million population and above in Kerala 2011. Industrialisation is not the cause of this urban growth here since Kerala is least industrialised among all south Indian states missing on many industrial revolutions thanks to the colonial rule and the political dispensations after independence

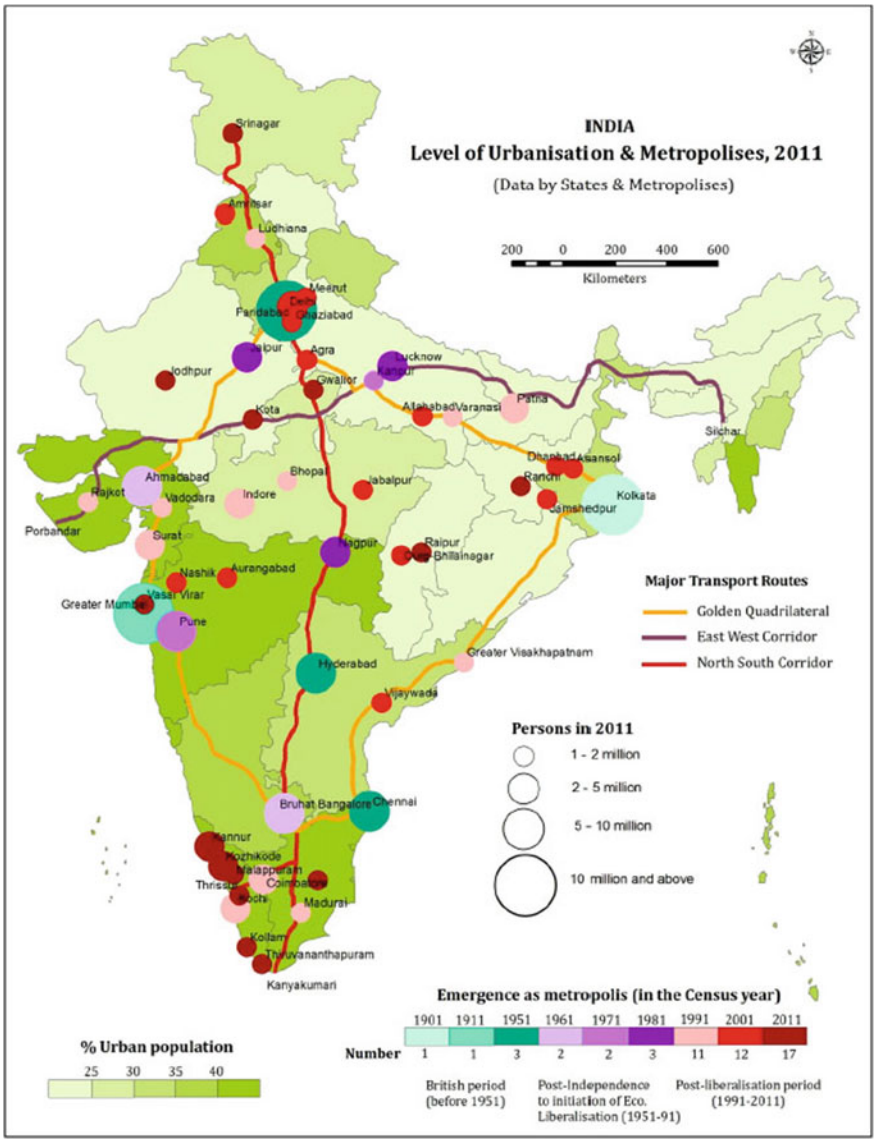

Fig. 1.12 Levels of urbanisation and metropolises in India 2011. *Source* Kumar Jitendra, 2015 "Metropolises in Indian Urban Systems", European Journal of Geography 6–341-51

characterised by strikes and discontent almost every day on trivial issues cloaked in the respectable attire of dissent in a democracy that ruled Kerala as if Berlin wall of Kerala still exists around it. One can conclude here in a positive way from the book title of Thomas Friedman "Thank you for Being Late" and the chapter on Kerala megacity is written in this spirit (Fig. 1.15).

Table 1.3 Configuration of metropolises in 2011

State/Union Territory	Metropolises	No of Metropolises	Population of metropolises	State urban population	State % urban population	% share of metropolises
Kerala	Kochi UA, Kozhikode UA, Thrissur UA, Malappuram UA, Thiruvananthapuram UA, Kannur UA, Kollam UA	7	12,139,860	15,934,926	47.7	76.2
Uttar Pradesh	Kanpur UA, Lucknow UA, Ghaziabad UA, Agra UA, Varanasi UA, Meerut UA, Allahabad UA	7	14,025,098	44,495,063	22.3	31.5
Maharashtra	Greater Mumbai UA, Pune UA, Nagpur UA, Nashik UA, Vasai Virar (Mun.Corp.), Aurangabad UA	6	29,927,857	50,818,259	45.2	58.9
Gujarat	Ahmedabad UA, Surat UA, Vadodara UA, Rajkot UA	4	14,161,800	25,745,083	42.6	55.0
Madhya Pradesh	Indore UA, Bhopal UA, Jabalpur UA, Gwalior UA	4	6,428,127	20,069,405	27.6	32.0

(continued)

Table 1.3 (continued)

State/Union Territory	Metropolises	No of Metropolises	Population of metropolises	State urban population	State % urban population	% share of metropolises
Tamil Nadu	Chennai UA, Coimbatore UA, Madurai UA, Tiruchirappalli UA	4	13,278,580	34,917,440	48.4	38.0
Andhra Pradesh	Hyderabad UA, Vishakhapatnam (M.Corp.), Vijayawada UA	3	10,882,077	28,219,075	33.4	38.6
Jharkhand	Jamshedpur UA, Dhanbad UA, Ranchi UA	3	3,662,372	7,933,061	24.0	46.2
Rajasthan	Jaipur (M.Corp.), Jodhpur UA, Kota (M.Corp.)	3	5,186,157	17,048,085	24.9	30.4
Chhattisgarh	Raipur UA, Bhilainagar UA	2	2,187,780	5,937,237	23.2	36.8
Punjab	Ludhiana (M. Corp) Amritsar UA	2	2,802,428	103,991,346,375	37.5	26.9
West Bengal	Kolkata UA, Asansol UA	2	15,301,405	29,093,002	31.9	52.6
Bihar	Patna UA	1	2,049,156	11,758,016	11.3	17.4
Haryana	Faridabad (M.Corp.)	1	1,412,050	8,842,103	34.9	16.0

Source Census of India 2011, Final Population Total, Registrar General of India, New Delhi. *Note* M. Corp Municipal Corporation

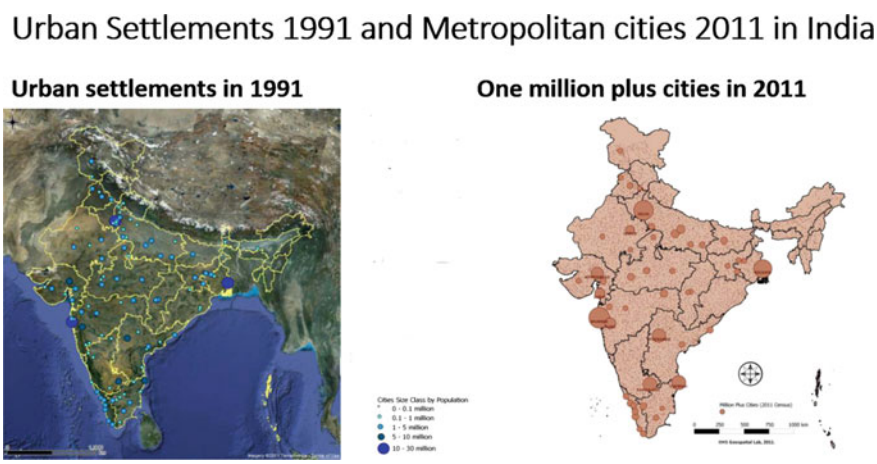

Fig. 1.13 Urban areas in 1951 and million plus urban agglomeration in 2011 in India

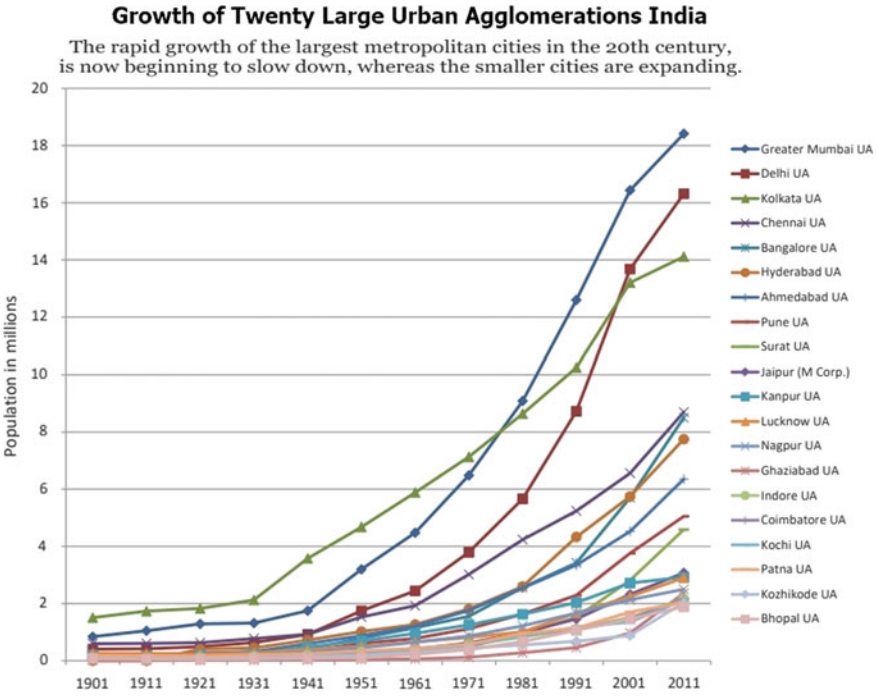

Fig. 1.14 Twenty million plus cities and fast growing cities in India

Table 1.4 Gives the list of Indian million-plus cities and fast-growing cities

Twenty metro cities and twenty fast growing cities India					
	Urban agglomeration	Persons in million	City	State	AEGR
1	Greater Mumbai	18.41	Vasai-Virar City (M Corp.)	Maharashtra	23.30
2	Delhi	16.31	Malappuram (UA)	Kerala	23.00
3	Kolkata	14.11	Fatehpur (NPP)	Uttar Pradesh	18.63
4	Chennai	8.70	Akbarpur (NPP)	Uttar Pradesh	18.58
5	Bengaluru	8.50	Kayamkulam (UA)	Kerala	18.31
6	Hyderabad	7.75	Thrissur (UA)	Kerala	17.30
7	Ahmedabad	6.35	Ottappalam (UA)	Kerala	15.75
8	Pune	5.05	Gurgaon (UA)	Haryana	13.72
9	Surat	4.59	Gangtok (M Corp.)	Sikkim	12.29
10	Kanpur	2.92	Kannur (UA)	Kerala	11.92
11	Lucknow	2.90	Dhulian (UA)	West Bengal	11.88
12	Nagpur	2.50	Cherthala (UA)	Kerala	11.69
13	Ghaziabad	2.36	Bhiwadi (M)	Rajasthan	11.30
14	Indore	2.17	Kothamangalam (UA)	Kerala	11.26
15	Coimbatore	2.15	Raipur (UA)	Chihattisgarh	10.84
16	Kochi	2.12	Hosur (UA)	Tamil Nadu	10.0
17	Patna	2.05	Kasaragod (UA)	Kerala	9.32
18	Kozhikode	2.03	Udhagamandalam (UA)	Tamil Nadu	9.10
19	Bhopal	1.88	Changanassery (UA)	Kerala	9.01
20	Thrissur	1.85	Ghaziabad (UA)	Uttar Pradesh	8.98

Source Census of India 2011. Note: This Includes cities with population above 0.50 million, UA: Urban acclomeration. M. corp, municipal corporation, M, Municipality, NPP, Nagar panchayat, AECR: Annual exponential growth rate. *Source* Census of India, 2011

There are three types of megacities with population decelerating, accelerating, and slow growth. Tokyo is decelerating, and other cities are as shown in the figure above.

The city size distribution of a country that boasts the biggest city in the world is given below (Fig. 1.16).

Figure 1.17 shows the city distribution present and projected India as per the UN.

The projected number by UN of megacity is surpassed by Indian census 2011. UN estimate shows 5 megacities but Indian census 2011 enumerate 7 megacities and it is not the real number of megacities in India because of definitional problem. In the Indian census, most of the megacity must be within one administrative district

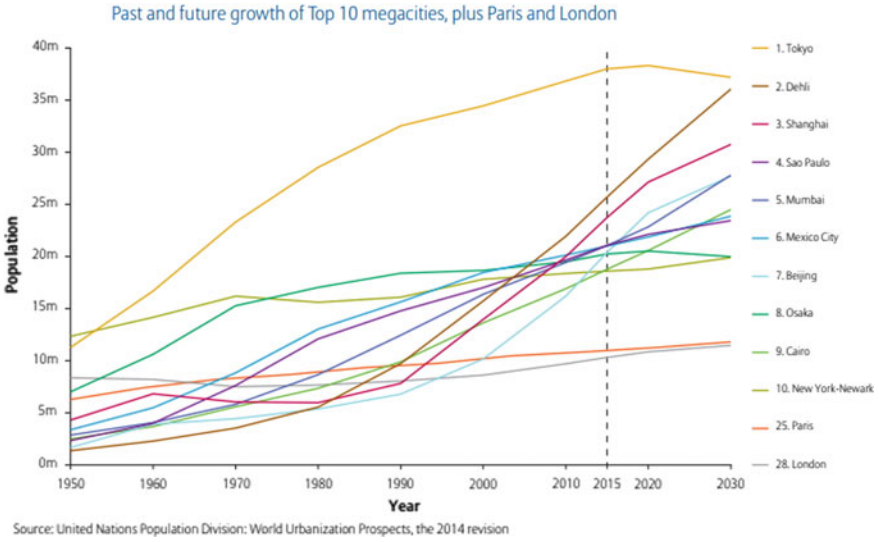

Fig. 1.15 Population growth patterns of selected megacities

boundary. So, five districts of Kerala with 5 metropolitan cities joined to make it a megacity called Kochi-Kannur megacity is not counted in Indian census and UN statistics. Megacity has an economic impact within the country as well as outside the country. Japanese megacities are concentrated but Indian megacities are dispersed and so the economic impact will be more widespread spatially than the Japanese megacity impacts. This itself can trigger the development of megacities to meta cities, for example, Mumbai and Delhi.

In India, there are five megacities as per UN projection, but Indian census showed 7 megacities. The UN projection shows 7 megacities in 2030 and two on the verge of megacity formation which is all underestimations.

As an example of a state, an Indian state Kerala is taken. The Indian census population of 2001 and 2011 is as given below and total megacity that these five-metro cities or million-plus urban agglomeration which is joined is given below in Table 1.5 and Fig. 1.18. This figure is mapped based on the built-up area from satellite imagery. Since the urban definition of India also includes occupational structure, it is likely the area of megacity can be more than that shown by satellite built-up area.

Megacities, meta cities and often metro cities are a key to globalisation, a state of interconnectedness around the globe that transcends and largely ignores national boundaries. There is a division of labour across city regions transcending country boundaries sharing economic responsibilities as per capabilities at relatively lower costs. Global urban economies rely on standardised producer services such as finance, banking, insurance, logistics, law, management consultancy, advertising, and other services. The technology revolution and uniformity of standard practices have made

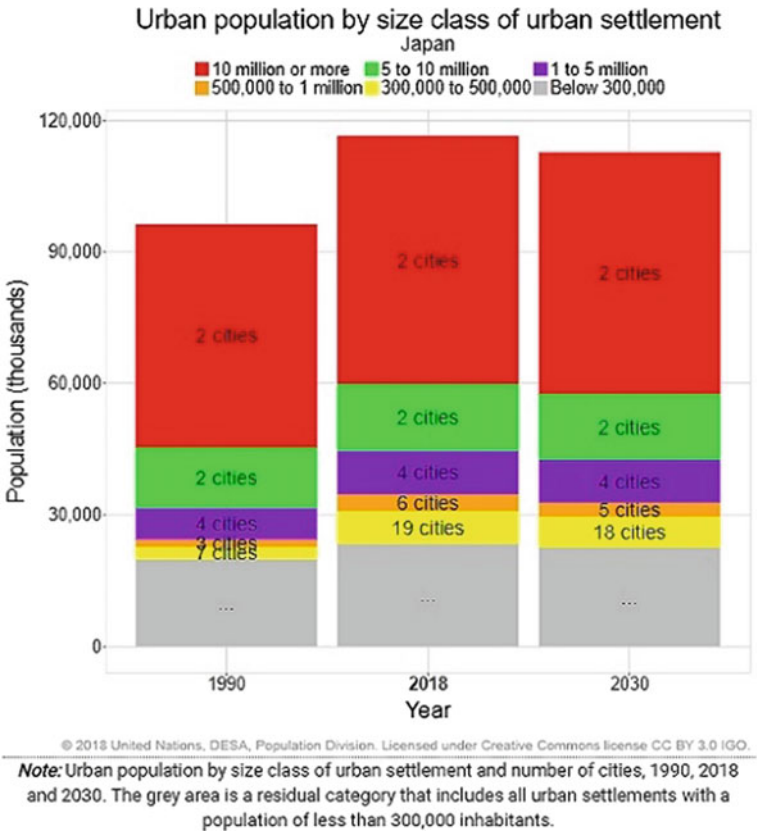

Fig. 1.16 City size distribution 1990 to 2030 Japan (*Source* UN)

it possible for business enterprises to hire these services anywhere in the world. The intense use of ICT in smart cities has an important role.

5 National GDP Share of Mega and Meta Cities

Often the share of GDP in this mega and meta-city are considerable in comparison to total National GDP. The two graphs give how it varies in some selected cities. Figure 1.19 Share of GDP and National Population in Selected Developed Countries Cities. The graphs are self-explanatory (Fig. 1.20).

GDP of selected megacities and its growth rate is as given (Table 1.6).

The share of GDP in selected megacities are as given below (Fig. 1.21),

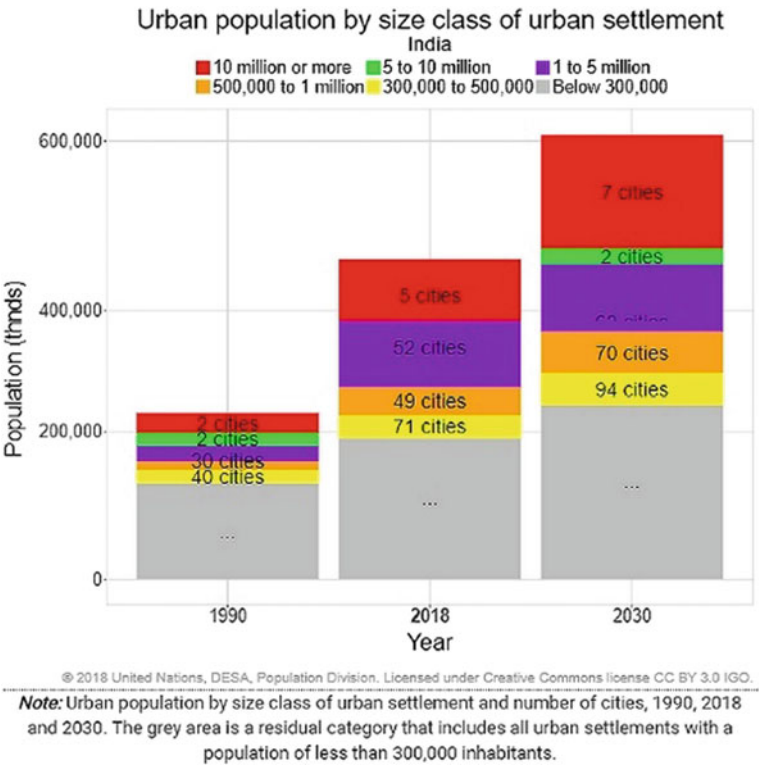

Fig. 1.17 City size distribution 1990 to 2030 India (*Source* UN)

Table 1.5 Kerala megacity 2011(Census of India 2011 and 2001)

S no	Urban agglomeration	Population of 2011	Population of 2001
1	Kochi	2,117,990	1,355,972
2	Kozhikode	2,030,519	1,015,681
3	Thrissur	1,854,783	1,030,122
4	Malappuram	1,698,646	170,409
5	Kannur	1,642,892	498,207
Total	Near Megacity	**9,344,830**	4,070,391

The GDP by the size of Chinese cities are as given in Fig. 1.22.
It is also found poverty is less in megacities as shown in Fig. 1.23.
Functional characteristics of 8 megacities of India is as given below.
Figure 1.24 shows broad specialisation of 8 megacities in India.

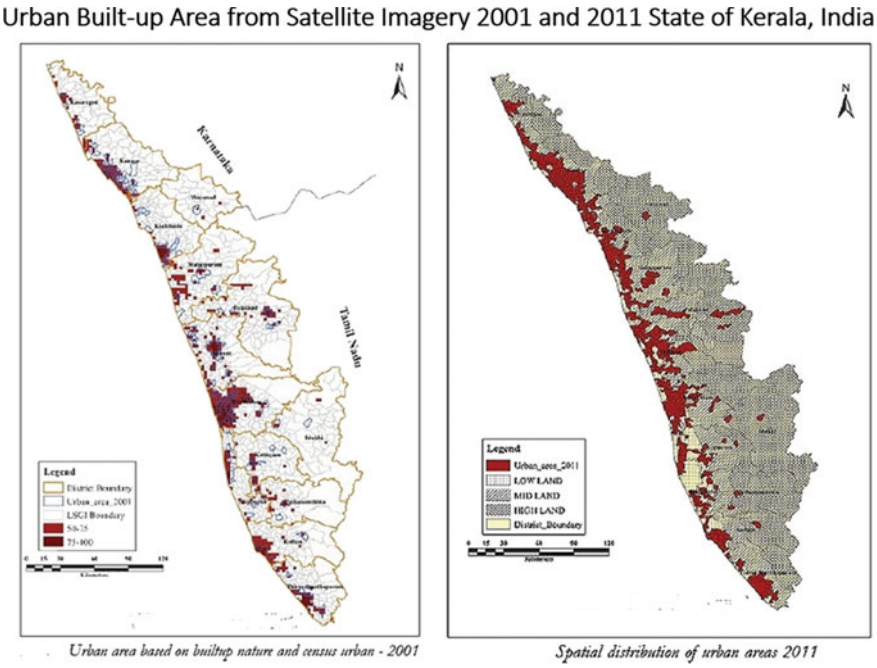

Fig. 1.18 Kerala Urban Built-up area 2001 and 2011 (*Source* Kerala Urbanisation strategy report)

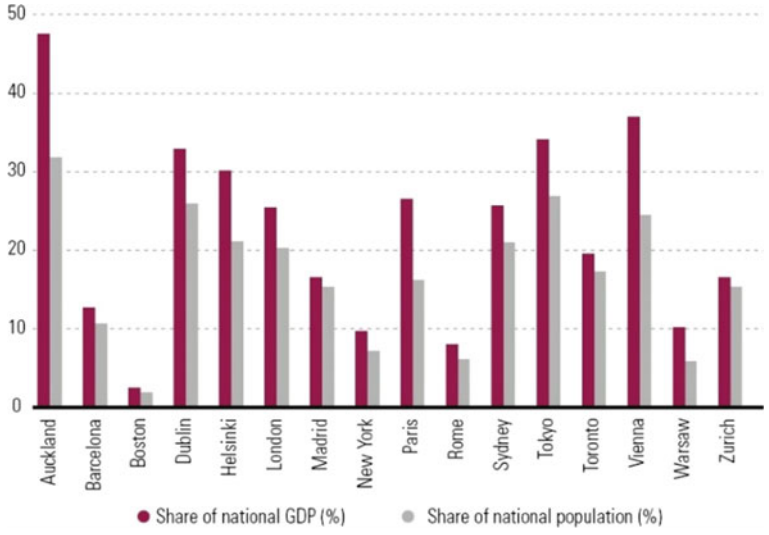

Fig. 1.19 Share of GDP of metropolitan cities in developed countries (*Source* UN)

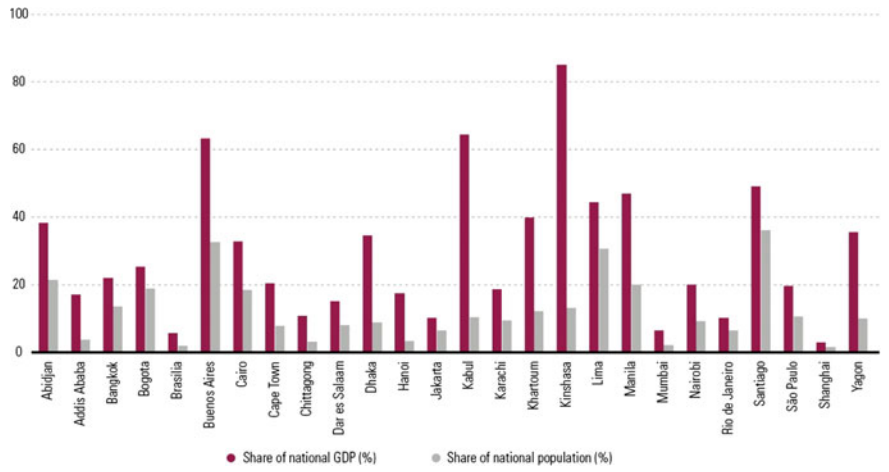

Fig. 1.20 Share of GDP and National Population in Selected Cities in Developing Countries. (*Source* UN)

6 Major Issues of Megacities and Approach to the Solution [18–21]

Examining the spatial, economic, cultural, and environmental sustainability of these megalopolises is therefore highly pertinent. Spatial sustainability involves reaching an optimal land use pattern and creating access to all services and facilities. Economic sustainability involves organising for sustainable products and services. Cultural sustainability is creating cultural spaces for local, regional, and international appreciation. Environment sustainability involves elimination pollution of all kinds and be a watchdog for climatic changes and generating a liveable environment by urban regeneration.

6.1 Examining and Changing Energy Use Pattern for Environmental Conservation

Energy use in this megalopolis traditionally involves high consumption of fossil fuel-related energy, and there is an urgent need to change and reduce the environmental burden of that consumption. An equivalent imperative exists in low consumption countries to create infrastructure systems that meet the social and economic needs of their populations. This is generally community-based renewable energy. However, there is no requirement to replicate to developing countries the carbon-intensive approaches adopted in major urban areas in the west so far. Rather there is scope, particularly at the urban scale, for innovation in infrastructure to deliver low carbon living.

Table 1.6 GDP of selected Megacities and its growth rates

GDP (nominal) and productivity of Asia's Megacities in 2010									
		Megacity GDP	Country GDP	GDP per capita	GDP per KM^2	Share NGDP	Megacity over productivity	Megacity annual growth GDP	
		Billion USD	Billion USD	USD	Million USD	Percent		1993–2007	2007–2011
1	Tokyo	1 340	5 498	40 617	385	24.4	0.9	0.9	−5.6
2	Seoul	758	1 014	31 512	557	74.8	1.5	3.9	0.1
3	Osaka	521	5 498	34 496	180	9.5	0.8	0.7	−5.6
4	Shanghai	294	5 879	11 471	57	5.0	2.7	9.1	4.7
5	Beijing	238	5 879	11 797	165	4.0	2.8	8.7	4.3
6	Guangzhou	196	5 879	15 109	186	3.3	3.6	12.0	10.2
7	Jakarta	160	706	7 102	73	22.7	2.4	1.2	3.2
8	Shenzhen	143	5 879	13 930	346	2.4	3.3	9.9	6.2
9	Tianjin	111	5 879	10 783	284	1.9	1.8	11.9	10.5
10	Bangkok	105	319	9 383	33	32.9	1.6	2.0	−2.4
11	Bombay/Mumbai	98	1 729	5 828	210	5.6	4.5	6.1	3
12	Wuhan	90	5 879	8 405	234	1.5	1.4	12.3	12.1
13	Delhi	68	1 729	3 040	48	3.9	2.1	5.1	8.7
14	Manila	55	199	2 719	50	27.4	1.1	3.5	−1.4
15	Calcutta/Kolkata	53	1 729	3 065	29	3.1	2.2	5.0	4.5
16	Karachi	27	175	1 401	34	15.7	1.4		
17	Dhaka/Dacca	23	100	1 465	21	22.5	2.0		

Sources India. Planning Commission (GDP per district); China Statistical Yearbook (GDP per city), UN (GDP per Country), and National accounts for other countries; Brooking Institute (GDP Growth)

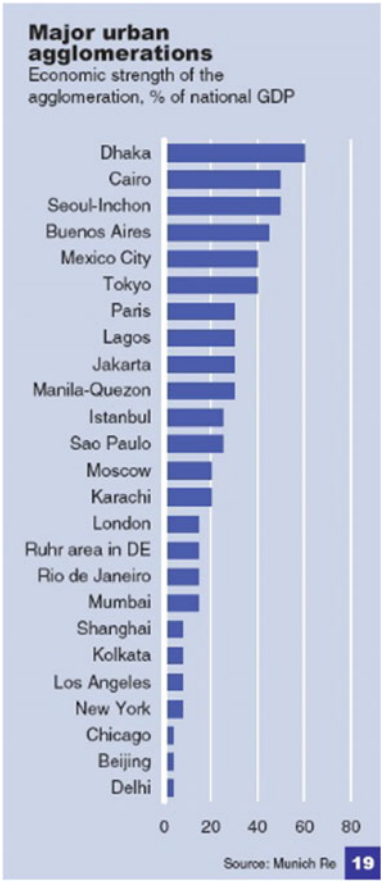

Fig. 1.21 GDP per population of selected megacities

6.2 Development of Internal Transport System

The interaction between urban development and transport is a complex one, influenced by several interconnected factors: industrialization, demand for housing, transport technology, fare levels and structure, strong leadership, national and local politics, economic growth, ownership and regulation and car ownership. History tells us that government involvement and subsidy is essential for delivering sustainable transport systems, although this need not always extend to public ownership and delivery which makes it less competitive and efficient.

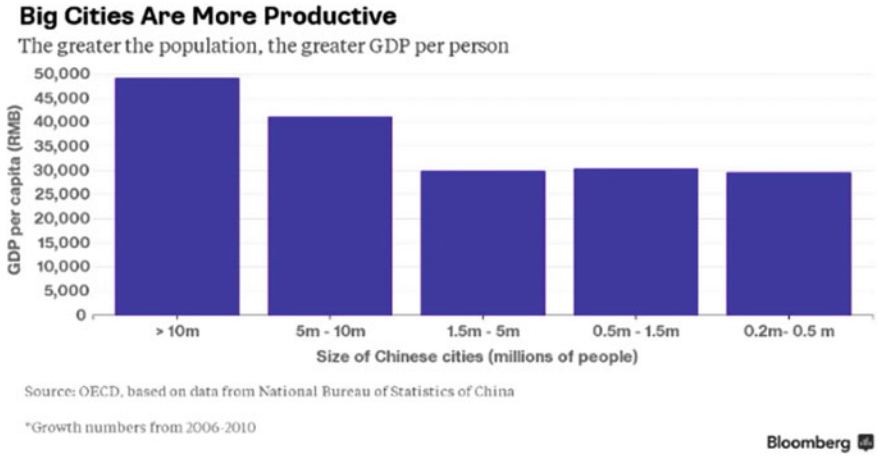

Fig. 1.22 GDP per size of Chinese cities

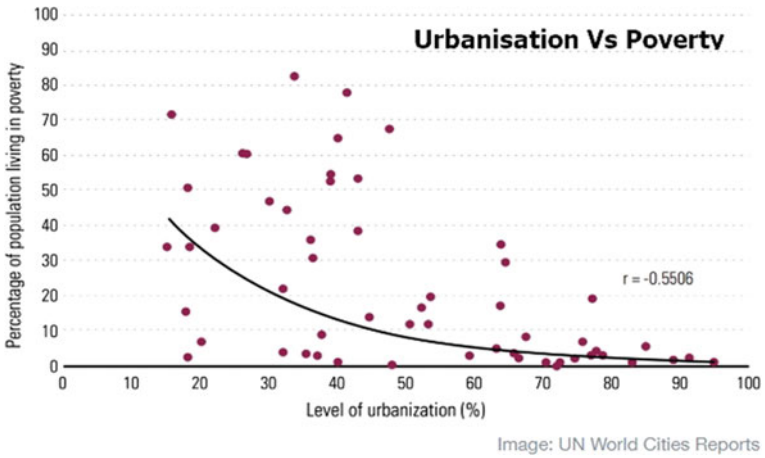

Fig. 1.23 Urbanisation and poverty

6.3 Flooding and Drainage

Flooding—from inundation and sea-level rise—is already a major impact of climate change but its incidence will increase in Coastal megacities like in Kerala. In five-city megalopolises since cities, particularly the largest cities are vulnerable, because of their coastal locations. Kerala experienced in 2018 one of the worst flooding that killed and displaced many people with great loss in houses, people, cattle, and all infrastructure. Most impacts were felt in the megacity. The economic, as well as social costs of flooding, will be immense, but the relative wealthier cities are best

Fig. 1.24 Functional characteristics of megacities in India (*Source* Author)

placed to cope with these threats. It is the already vulnerable communities within cities that are most at risk of a total loss.

6.4 Water Security

While increased water scarcity is a common impact of climate change across many urban areas, there is a significant difference between those megacities with reticulated systems—where the very infrastructure promotes a disregard for the need to conserve water—and those cities (or parts of cities) where private water vendors, illegal connections and communal standpipes dominate. Across these quite different circumstances though, arguments can be made for the value of citizen involvement in policy development and even in co-production schemes through communal water harvesting.

6.5 Disease and Public Health

Much attention has been paid to influenza, now COVID 19, lifestyle pandemics and obesity as aspects of urban health, but the most significant and basic public health issue is the availability of clean water and sanitation facilities to poorer urban communities in megacities. Established infrastructure systems such as reticulated water systems have a place but again the importance of community involvement and local innovation should not be under-estimated.

6.6 Modelling Change in Megacities

There is great potential in building models using the latest techniques to understand the change in urban systems and then develop policy recommendations for the Megacity. Such models can highlight path dependencies in urban change as well as rapid 'phase transitions. However, there remain questions over how far the resources should be devoted to very fine-grained data collection and model-building in a context where there is an urgent need to take policy steps to deliver sustainability, as in lower-income countries and especially vulnerable cities. Involvement of academic institutions in futuristic modelling for megacities can be encouraged.

6.7 Heat Waves

By 2040 average summer temperatures in Europe are expected to be those experienced in the heatwave of 2003 in which between 30,000 and 35,000 people died in Northern Europe, while heatwaves in 2040 will be twice as hot as those we experience now. These impacts of climate change are exacerbated by the Urban Heat Island effect, suggesting the importance of planning new urban development with this enhanced risk in mind. Modelling to protect from a heatwave is an important strategy.

6.8 Governance for Sustainability

Considering the governance of major urban areas such as megalopolises throws up many dilemmas, such as the appropriate scale for governmental units, the allocation of responsibilities across governmental tiers and the different ways of financing governmental action, but the key issue in delivering action for sustainability is the way that this goal intersects with different political interest and priorities and how these conflicts may inhibit collective action. The Governance scope of Megacities is well represented by UN-HABITAT blow (Fig. 1.25).

6.9 Urban Cultural Sustainability

If sustainability is to become part and parcel of the megalopolis then it must have meant within that urban culture and in terms of how people live within the urban area. Sustainability is often couched in culturally conservative terms, drawing on nostalgia. However, this is a choice and the prospect remain of a more progressive cultural engagement with sustainability, opening more options for urban change.

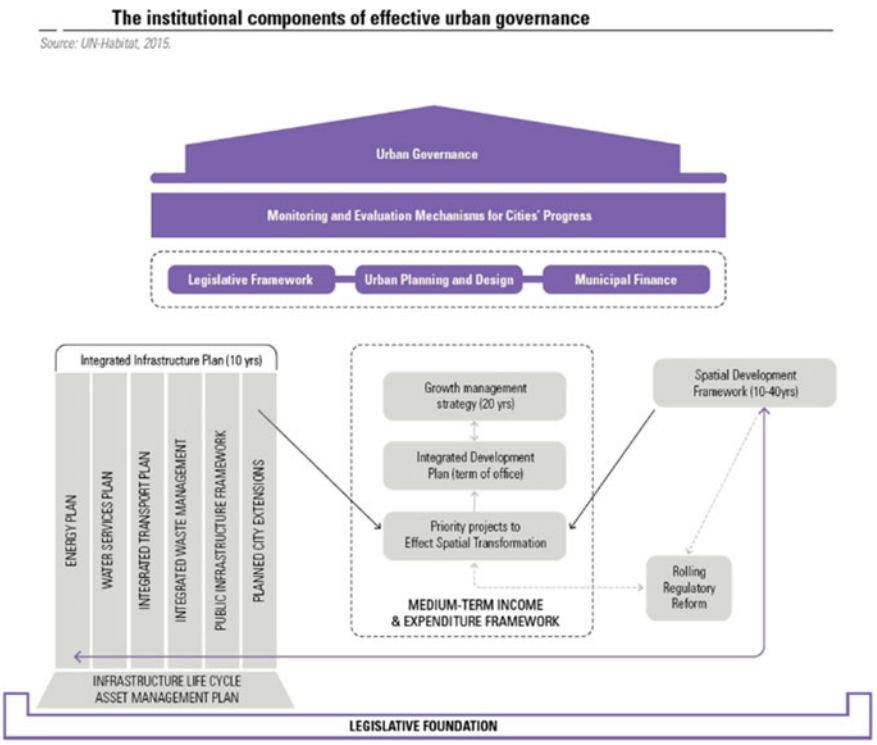

Fig. 1.25 Governance

7 The Metro/Mega/Meta Cities and Globalisation [22–24]

Global cities were there from times immemorial where people congregated from different countries for various purposes. They learned each other's languages and culture and took back to their country the best they felt in addition to commercial products. Global population and population of global cities were small, at that time not to the megacity and meta city scale and the intensity of activities was also small. Thing changed drastically with the emergence of megacities where economic relations with a huge number of people participating came into being only in the last few decades since the 1950s. An emerging application of science and technologies and patterns of Industries 1, 2, 3 and 4 created global cities with differing orientations. In terms of economic, social, and cultural development megacities gained a lot due to massive globalisation with the deployment of ICTs. Industrial products and services delivered to people from cities within one country were replaced by many cities from many cities as if the world of cities is synchronised in a supply chain and fully interconnected and seamlessly integrated. All these happened without a global command structure. No one country can dictate others however powerful it may be. This interconnected production and services indirectly provided world peace since

any war will disrupt the life of people in many cities across the world and dispute shall be settled through diplomacy and dialogue as soon as possible with the help of world bodies and moved towards a rule-based system commonly arrived at. The current Indo China military build-up threatening war in Ladakh with many rounds of diplomatic and military dialogue illustrates the point I have made although one country does not believe in rule-based coexistence but believe in the dream of Mao, the five fingers and palm disregarding sovereignty. Trade war generated by President Trump between US and China affect, directly and indirectly, the rest of the world, but the result is devastating for the global economy as per emerging indicators. There was no revolutions and disruptions any more to happen when many countries practice democracy and not despotism except trade war aberration from time to time despite Word Trade Organisation existing. In the past few people interacted but the intensity of people to people interactions in Megacities, meta cities and often metro cities are immense using ICT which is a key to globalisation, a state of interconnectedness around the globe that transcends and largely ignores national boundaries. With the emergence of global cities, a dual city region emerged for each global city. One city region is within the country the city is located and the second outside the country mainly interacting with global megacities. Often the economic interaction from outside city region will be more dominant, and dynamic in terms of money transacted than from inside the city region. This economic interaction that leads to manufacturing and trading in the highest quality and globally standardised goods and services at the lowest cost to consumers who have the immense choice to shape his quality of living was the result of globalisation. The country-specific regulations that restrict the easy flow of goods and services are discussed and solved mutually by countries involved as can be seen the current negotiating with China and the US still an unfinished business. Such an arrangement creates a division of labour across city regions transcending country boundaries sharing the reciprocal economic responsibilities as per capabilities at lower costs. Global urban economies benefited a great deal on advanced and standardised producer services such as finance, banking, insurance, logistics, law, management consultancy, advertising and other services, thereby generating a variety of local employment opportunities that never existed before globalisation. There was also a demand related to skilling. It further triggers technological development and a higher level of professional service capability. The intranational flow of capital in real-time becomes much easy with research and development in Fintech largely based on internet and fully market-driven. The technology revolution and uniformity of standard practices have made it possible for business enterprises to hire these services anywhere in the world. The intense use of ICT in smart cities has an important role. Cities in the developing world have taken advantage of this to provide customer services at extremely competitive rates by drawing on a large labour force at low rates of pay. This trend, unfortunately, contributes to the creation of divided cities with these professional class earning a higher income with superior skill in comparison to locally employed labour forces from a local source of traditional economic activities. This can create a high standard of living in a gated community of the rich adjacent to slums with inadequate housing and infrastructure provision, another symptom of divided cities. As a reaction, there can

be protectionism emerging as a negative force against globalisation and irrational migration policies which eventually leads to the lower economic and social development of the country practising it and isolation of such countries. Such a situation can be avoided if legislators and policymakers can evolve acceptable solutions acceptable to all beyond vote bank solutions. This is a big political challenge thrown for legislators and policymakers who must be more knowledgeable of globalisation.

Examples of Cities that have become hubs of global economic activity are.

1. Finance—Frankfurt, Hong Kong, Amsterdam, Singapore, Sao Paulo, Shanghai but now Hong Kong is threatened this status by US sanction.
2. Transport—Dubai, Rotterdam.
3. Information technology—Bangalore, Seattle, Silicon Valley. Shenzhen.

Once the sole domain of Europe and North America, world cities are emerging in the developing world to compete with long-established capitals of commerce. Istanbul and Mumbai are culturally influential within their regions through Bollywood and Turkish films, literature, satellite TV networks and other forms of entertainment. These cities boast of an international audience. Nairobi, Addis Ababa, and Bangkok, amongst others, host regional headquarters for international agencies and development partners. Many of the metropolitan and megacities has become the seat of education and research bringing out innovations attracting students and Professors from across the country.

7.1 Emerging Global Functions of Large Cities [25–32]

Large cities are interconnected and influence global spatial structure with economic, financial, physical, communication and cultural linkages at an extremely high intensity than smaller cities. The connection is twofold within its city region and outside the city region as noted earlier transcending other national boundaries. The city is connected to hinterland and outside world simultaneously in a metropolitan region and megacities. In 1950 there was 50% urban and 50% rural population in the world but thereafter the urban population increased as discussed earlier. Urban growth is often confronted with severe problems such as congestion, pollution, social segregation, terrorism, or high crime rates in addition to sustainability issues mentioned earlier which threaten the achievement of sustainable urban development. Consequently, many cities across the globe are engaging in an intense search for strategies which are suitable to address these issues. In several fields, such as public transportation, settlement, and open space development as well as energy or water supply, solutions require a broader approach. Thus, both the megacity-region within the country and megacity region with outside countries are becoming increasingly important for a variety of issues and potentials. The key role cities play in this context is twofold: not only do they represent the centres in which economic and social change occurs, but also function as key ‘actors’ behind these changes. Globalisation and

intense deployment of ICT in cities together result in the increasing importance of megacities at the very top of the hierarchy, the so-called world cities, or global cities.

7.2 Five Phenomena of Global Cities [33–35]

7.2.1. Innovation capacity and the potential for economic development reside in a large part in a megacity or its regions located within the country or outside. Research-intensive industries and knowledge-based services are becoming increasingly concentrated in megacities since there are reputed Universities and Research Institutions there to support.

7.2.2. These locations not only enable innovative companies to exploit opportunities and to establish contacts but also allow them to access information and reduce risks. Besides, these locations also provide access to specialised resources and employees as well as to specific routines, traditions, values, and other local institutions. Furthermore, megacities are characterised by a high degree of economic, social and cultural complexity functionally interconnected and embedded in the global division of labour, they, on the other hand, constitute the nodes of overlapping financial flows as well as trade, production, political, cultural and social networks cutting across national boundaries. Innovation capacity and the potential for economic development reside in a large part in megacities.

7.2.3. The national hierarchy of cities and the spatial division of labour within the economy is superimposed by a global division of labour. Megacities and metropolitan regions become part of an emerging international hierarchy based on a competitive division of labour at the global level by international connections that affect financial flows in the knowledge-intensive service sector. It leads to the emergence of a vertical hierarchy of globalised system of megacities, the relationship between spatial decentralisation and territorial concentration alters the position of peripheral areas in this emerging spatial structure and new ones are created, unbalanced spatial development is reinforced and regions characterised by expansion, stagnation and negative growth co-exist. Highly skilled employment, high-value infrastructure and investment increasingly concentrate in large megacities.

7.2.4. At the same time, these megacities align their specialisation with the global division of labour and forge links with other dynamic megacities. In contrast, interconnections between metropolitan regions, their hinterlands and immediately surrounding (structurally weak) areas may well decrease. Thus, these areas are becoming increasingly disconnected from economic development. Because of the developments described above the lack of suitable institutional structures that extend beyond the city-level in addition to local megacity region becomes evident.

7.2.5. Alongside their effect on the role of megacities as the hubs of economic development, changing spatial patterns are also impacting the level of institutional action within the state hierarchy. State powers are not only being devolved to transnational levels but also newly constituted tiers of the megacity and metropolitan-regional governance. Considering the growing importance of regions, the need for

adequate organisational structures ('for metropolitan governance') in the megacity and metropolitan regions is greater than ever before.

7.3 World Cities and Global Cities

The term "world city" was coined by Patrick Geddes in his 1915 book, Cities in Evolution [1]. Geddes taught biology at the University of Dundee, gave India's rulers advice on how to run their cities. Geddes's comments on world cities were mostly forgotten, however, in part because Geddes became so famous for his work on regional planning.

World cities are characterised by a sum of political power (both national and international) and organisations related to the government; national and international trade, whereby cities function as a gateway for their own and sometimes also neighbouring countries; providing superior banking, insurance and related financial services; advanced professional activities of all kinds; information gathering and diffusion. The form and extent of a city's integration with the world economy and the functions assigned to the city in the new spatial division of labour will be decisive for any structural changes occurring within it. Key cities throughout the world are used by global capital as 'basing points' in the spatial organisation and articulation of production and markets. The resulting linkages make it possible to arrange world cities into a complex spatial hierarchy. The global control functions of world cities are directly reflected in the structure and dynamics of their production sectors and employment. They are major sites for the concentration and accumulation of international capital. They are points of destination for large numbers of both domestic and/or international migrants. World city formation brings into focus the major contradictions of industrial capitalism, among them spatial and class polarisation. World city growth generates social costs at rates that tend to exceed the fiscal capacity of the state. conspicuous consumption: arts, culture and entertainment and the ancillary activities that cater to them. Three main functions of world cities are headquarters function, financial centres function, and articulator' cities that link a national or regional economy to the global economy [32–35].

World Cities hypothesis of Freidman [36] is enumerated below.

1. The nature of a city's integration with the world economy is decisive for any structural changes occurring within it.
2. Key cities throughout the world are used by global capital as 'basing points' for the organization of production and markets.
3. The global control functions of world cities are manifest in the structure of their industrial structure and job markets.
4. World cities are major sites for the concentration and accumulation of capital.
5. World cities are destinations for large numbers of migrants – both domestic and international.

6. World city formation exposes the major contradictions of industrial capitalism, particularly spatial class polarization.
7. World city growth generates social costs that exceed the fiscal capacity of the state.

New technologies, telecommunications and information technology have led to both decentralisation and agglomeration of economic activities. This combination of spatial dispersal and global integration 'has created a new strategic role for major cities', thus leading to a new type of city (essentially different from historical banking and trade centres).

7.4 Global Cities by Saskia Sassen [37–41]

Global cities, for Sassan, form a 'virtual economic cycle' and function in four new ways: the demand for control creates cities as 'command points'; this leads to a demand for finance and business services, whereby cities become the 'key locations' for leading economic sectors; cities become sites of production and innovation for these leading economic sectors; cities constitute markets for main economic sector production.

Saskia Sassen's Global City Hypothesis

1. First, the geographic dispersal of economic activities that marks globalization, along with the simultaneous integration of such geographically dispersed activities, is a key factor in feeding the growth and importance of central corporate functions. The more dispersed a firm's operations across different countries, the more complex and strategic its central functions—that is, the work of managing, coordinating, servicing, financing a firm's network of operations.
2. These central functions become so complex that increasingly the headquarters of large global firms outsource them: they buy a share of their central functions from highly specialized service firms—accounting, legal, public relations, programming, telecommunications, and other such services.
3. Third, those specialized service firms engaged in the most complex and globalized markets are subject to agglomeration economies.
4. The more headquarters outsource their most complex, unstandardized functions, particularly those subject to uncertain and changing markets, the freer they are to opt for any location because less work done in the headquarters is subject to agglomeration economies.
5. These specialized service firms need to provide a global service which has meant a global network of affiliates or some other form of partnership, and as a result, we have seen a strengthening of cross border city-to-city transactions and networks. At the limit, this may well be the beginning of the formation of transnational urban systems. The growth of global markets for finance and specialized services, the need for transnational servicing networks due to sharp increases in

international investment, the reduced role of the government in the regulation of international economic activity, and the corresponding ascendancy of other institutional arenas—notably global markets and corporate headquarters—all point to the existence of a series of transnational networks of cities.

6. A sixth hypothesis is that the growing numbers of high-level professionals and high profit-making specialized service firms have the effect of raising the degree of spatial and socio-economic inequality evident in these cities. The strategic role of these specialized services as inputs raises the value of top-level professionals and their numbers. Further, the fact that talent can matter enormously for the quality of these strategic outputs and given the importance of speed, proven talent is an added value, the structure of rewards is likely to experience rapid increases. Types of activities and workers lacking these attributes, whether manufacturing or industrial services are likely to get caught in the opposite cycle.
7. A seventh hypothesis is that one result of the dynamics described in hypothesis six is the growing informalization of a range of economic activities which find their effective demand in these cities yet have profit rates that do not allow them to compete for various resources with the high-profit making firms at the top of the system. Informalizing part of or all production and distribution activities, including services, is one way.

7.5 Seven Types of Global Cities [41, 42]

The report, "Redefining global cities: The seven types of global metro economies," by Brookings Fellow Joseph Parrilla and former Brookings Research Analyst and Associate Fellow Jesus Leal Trujillo uses a first-of-its-kind database of dozens of indicators to examine global city economic characteristics, industrial structure, and key competitiveness factors: tradable clusters, innovation, talent, and infrastructure connectivity. Their analysis focuses on the 123 largest metropolitan economies in the world, which collectively account for one-third of global GDP despite containing only 13% of the global population [42]. Analysis of these data reveals seven types of global cities—the Global Giants, Asian Anchors, Emerging Gateways, Factory China, Knowledge Capitals, American Middleweights, and International Middleweights—each with its distinctive assets, challenges, and growth trajectories. "This report provides fresh evidence that there is no one way to be a global city," Parrilla said. "Cities that understand their unique niche in the global economy is better positioned to create economic strategies that will be successful in the long-term." The report—and it's accompanying online interactive—uses the typology to help megacity decision-makers understand the local assets that drive economic competitiveness, benchmark their performance against peer cities, and identify the global innovations most relevant for local growth and prosperity.

1. Global Giants: six large, wealthy hubs with concentrations of corporate headquarters; they serve as the command and control centres for the world's largest advanced economies**.**

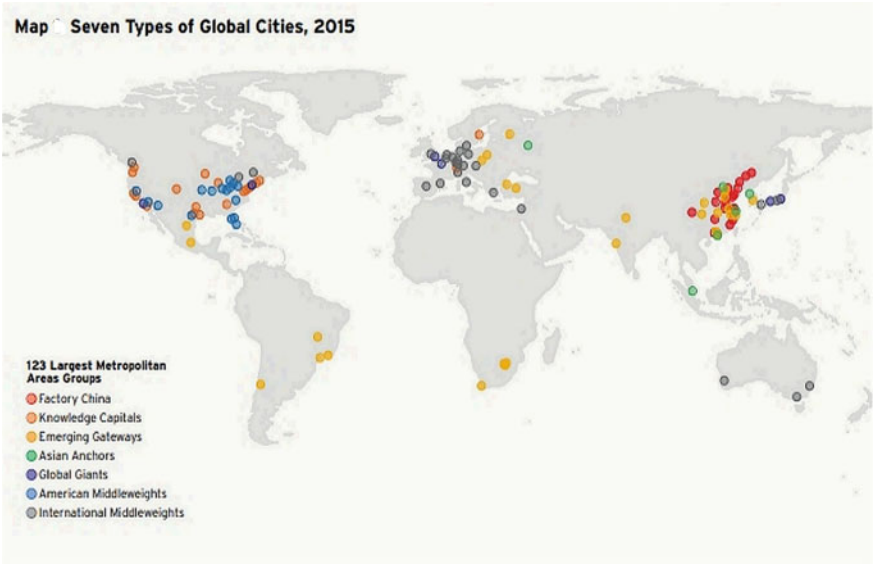

Fig. 1.26 Typology of Global Cities 2015

2. Asian Anchors: five large, business, and financial nodes anchoring inward investment into the Asia Pacific and Russia.
3. Emerging Gateways: 28 large business and the transportation entry points for major national and regional emerging markets in Africa, Asia, Eastern Europe, and Latin America.
4. Factory China: 22 s-and third-tier Chinese cities distinctly reliant on export-intensive manufacturing to power economic growth and global engagement.
5. Knowledge Capitals: 19 mid-sized, highly productive knowledge creation centres in the United States and Europe with talented workforces and elite research universities.
6. American Middleweights: 16 mid-sized U.S. metro areas striving for a post-recession niche in the global economy.
7. International Middleweights: 26 mid-sized cities in Australia, Canada, and Europe globally connected by people and investment flows, but where growth has lagged after the financial crisis (Fig. 1.26).

7.6 Connected Global Cities [43, 44]

With America First Policy of the USA under President Donald Trump and Brexit under process which divorces the United Kingdom from the European Union, migration policy, trade policies, custom union issues, tariff as an economic weapon against saying China for the balance of payment issues have gained considerable attention.

Democrat seems to oppose these what Republican advocates. Germany seems to be more tolerant than some other country in the European Union. Switzerland remains a country with a better immigration policy and then others. Undoubtedly there will be retardation in economic development which will not be limited to a few countries but all countries in a very much connected world. We are all living in a globalised world. "Since 1998 the impact of world cities into globalization has been extensively studied by the Globalization and World Cities (GaWC) Research Network. GaWC provides a geographic and economic-based overview of the world and its evolving configuration. GaWC is a research network based in the Geography Department at Loughborough University (UK), founded by Peter J. Taylor in 1998.

Particularly relevant in this discourse is its categorization of world cities into α, β and γ tiers based upon their international connectedness. If the world is observed for the connectivity of the world cities, a new image emerges, where each city is virtually oriented to other cities of the same level of inter-connectivity. National or continental maps give way to a new world configuration intended as an archipelago, where each city appears utterly separated from its geographical surrounding and closer to other cities of the same level. The leading parameters for the new configuration are based on mutual connections, primarily in the global economic system. The atlas shows the world cities according to the GaWC categorization of 2010. From this, a new configuration emerges, where expected national and local boundaries are presented in their real disposition based upon their international connectedness" (Fig. 1.27).

"Every few years, cities are rated ranked by the Globalization and World Rankings Research http://www.lboro.ac.uk/gawc/Institute. It is considered the leading institute ranking world cities. Cities are ranked into Alpha, Beta and Gamma cities by considering many factors; economic factors are deemed more important than cultural or political factors though in this ranking. Here is a list with the latest data from 2016 (GAWC has not done a study in 2017 or 2018). Spotted by Locals' cities (most of "our" 71 cities are listed) are linked.

Alpha + + world cities: London, New York.

Alpha + world cities: Singapore, Hong Kong, Paris, Beijing, Tokyo, Dubai, Shanghai.

Alpha world cities: Sydney, Sao Paulo, Milan, Chicago, Mexico City, Mumbai, Moscow, Frankfurt, Madrid, Warsaw, Johannesburg, Toronto, Seoul, Istanbul, Kuala Lumpur, Jakarta, Amsterdam, Brussels, Los Angeles.

Alpha − world cities: Dublin, Melbourne, Washington, New Delhi, Bangkok, Zurich, Vienna, Taipei, Buenos Aires, Stockholm, San Francisco, Guangzhou, Manila, Bogotá, Miami, Luxembourg, Riyadh, Santiago, Barcelona, Tel Aviv, Lisbon".

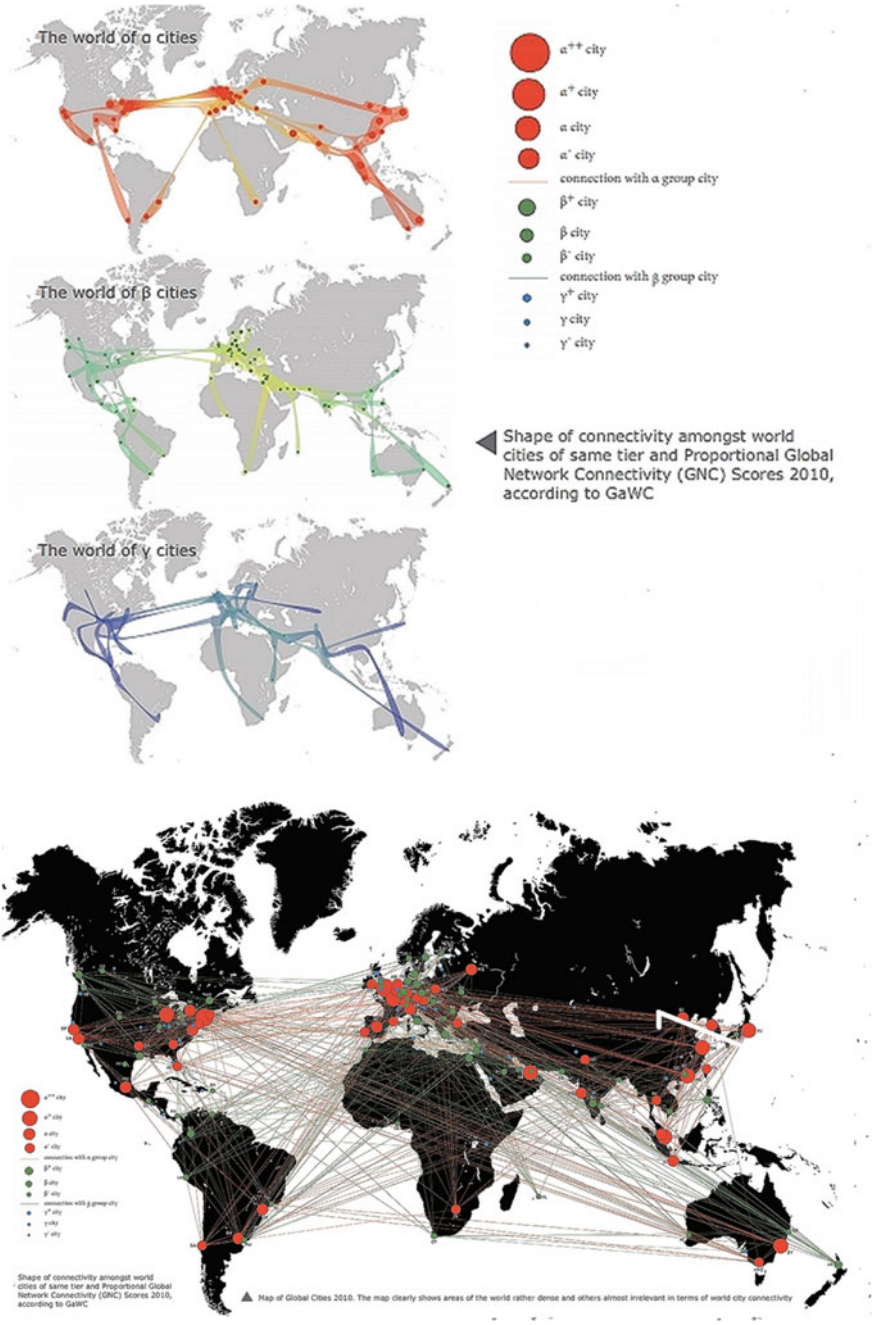

Fig. 1.27 Alpha, Beta and Gama Cities. *Source*—Classification of cities: Classification of GaWC 2010. Geography Department, Loughborough University. http://www.lboro.ac.uk/gawc/world2010t.html—Global network connectivity scores 2010: Geography Department, Loughborough University.—City codes: GaWC Research Bulletin 355. http://www.lboro.ac.uk/gawc/rb/rb355.html

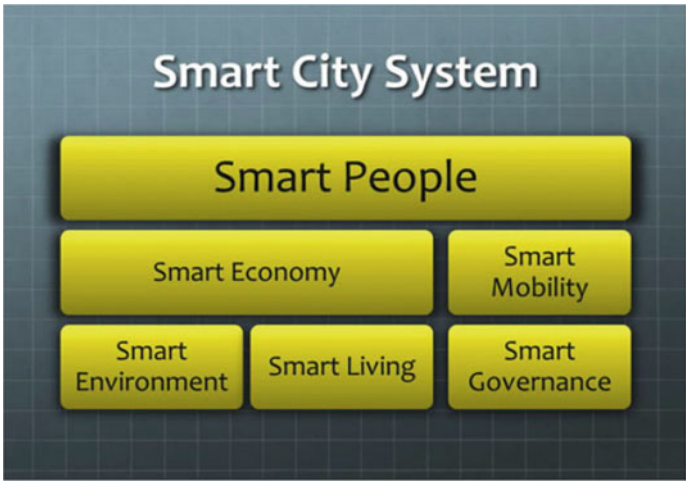

Fig. 1.28 Smart City System

7.7 Thomas Friedman's World is Flat and Thanks for Being Late and Global City [45, 46]

Thomas Friedman's idea of a globalising world is applied here to Global Cities. What follows is a translation of his ideas to the global city. Globalisation he visualises as flattening of the world. I believe Smart Global Megacities are the cities where these actions should take place. According to him flattening of the world is achieved through the convergence often political events, innovations, and companies.

Flatteners 1: 11/9/89 When the Walls Came Down and the Windows Went Up

Friedman refers this to the fall of the Berlin wall which for the global city is merely a symbol. Before this date, there were two ways of planning a global city namely the socialist/communist way and democratic way. Soon after that date, the Soviet Union disintegrated, and China moved closer to following the market economy. In Socialist/Communist way of planning a global city, Communist party manned mostly by a single party system who decides what to produce and what services to be developed in a city with no consideration about what happens outside the city or their country decides everything under the ideology of socialism or Marxism or Maoism. The targets are made as designed by Planning Commission or Board planning and procedures for implementing are formulated subjectively, more tax from the rich was collected and the bureaucracy implements it using tax collected using a licensing system and highly restrictive controls which resulted in inefficiencies, massive corruption of political and administrative bodies and slow economic growth and slower poverty reduction. These have happened in India. The biggest problem of the command economy is that they are prisoners of an ancient theory of Marxism and not represent what is happening today globally in an ever-changing world with

its empirical evidence that is available digitally in smart cities. This has resulted in the breaking of the Berlin wall by people who protested the slow progress of cities and countries under socialism. This symbolises the increasing democratic power to people to decide what they want, how their jobs should evolve and how they will integrate with the world. In a democratic global city, people and communities decide what is good for them based on emerging facts and they interact with the local and international community, they invest their money and run production of goods and services as per their perception and initiative within the rights available under the constitution fully prepared to face any risks. In such a setup, licensing and control of socialist bureaucracy were reduced to minimal regulations to protect all. India practised the socialist way strictly until 1991 and found poverty never came down and the growth rate never went up more than 3% and India was going to be bankrupt in 1991. In 1991 then existing Indian government moved to the democratic way and found growth rates going up to 8 and 9% and poverty is reduced faster just by removing license raj and related bureaucratic controls and planning board designed subjective procedures. Subsequently, the Planning Commission was dissolved by the Union Government of India and they found policy research by a body called Niti Aayog is more useful and productive than administrative rules and target set by the Planning Commission based on some unsubstantiated abstract ideas generated in the past by non-Indians, not supported by empirical research. This means all households in the smart global megacity should be empowered so also local face to face community for economic, social, spatial, environmental and cultural development with not many administrative restrictions and licencing under the constitution of rights enshrined there. The Government, Chamber of Commerce and Industries and Academia can take a leading role to support households and the local community. Under socialism and communist global city information dissemination was restricted and not freely available to all but to a privileged few. With the rise of the internet, information was available freely to people that lead them to decide actions and soon to adjust themselves to global production and services aligning it to common standards globally acceptable. With the advent of TV, enlightened journalism, and mass media; people and household started knowing rapidly what is happening and started communication their views and finding on their opportunities with no dictation of parties or planning boards and commissions and administrators.

Flattener #2 8/9/95 when the Netscape Went Public

The concept of the worldwide web a system for creating, organizing, and linking all types of documents so that they could be easily browsed was first created by a British Computer Scientist Tim Berners-Lee in 1991. It became a reality for public use when Netscape was produced, and the company tried to market as a commercial web browser by Netscape. The immense possibility of WWW triggered development in fibre optic network across the world at a speed unimaginable which can carry a huge amount of data connecting the whole universe. Then PC and Mac computer started its accelerated path with increasing capabilities and reducing cost incorporating web browsers which were independent of the operating system. These were free and triggered by the thought that more users mean more commercial gains, and investment

in the network infrastructure of fibre optic cables by entrepreneurs that created the infrastructure of WWW which was meant for increasing business activities globally. Every office needed to interact with workers through the computer using a local area network. With the internet, this office expands globally to the whole world transferring all types of data voice, music, images, movies, and messages with almost zero cost. It was widely used for emails and information sharing across the world. This development was significant to smart global megacities. The city can be developed and managed and monitored through the internet and all global economic activities scattered all over the world can use the internet for the global economic development of megacity by all citizens and communities. Here the size of the city does not matter whether it is megacities or meta cities; the amount of information movement does not matter and what matter is global economic development using megacity which is also digital city intensively using ICT in emerging smart or digital city. This flattening gave rise to the foundation of the smart global megacity. This movement was done in an amazingly fast way because all that is required were available free or almost free to all. The Berlin wall we discussed above need to be broken down before Netscape and both cannot co-exist.

Flattener #3 Workflow Software

Workflow software is internet-based Using this software, work can be shared from multiple locations globally. GIS and CAD that is used in megacity digitisation, monitoring and production of a spatial decision support system can be used and implemented from multiple locations for many purposes. Product and services can also be designed, and prototypes generated at multiple locations using web-based workflow programs. Many GIS Venders and open-source Linux have their brands of such free software which can be used for industrial production. This became the backbone of the global supply chain in a field like culture, visual art, movie making and so on. Workflow software soon moved to automation using artificial intelligence. Global collaboration and sharing economy two pillars of Smart Global megacity got institutionalised with workflow software based on the digitisation of everything. Microsoft Office used the world over is now called Microsoft 365 and now includes workflow software like Microsoft teams and Microsoft Fluid. There are similar offering from other companies. Multi megacity city workflow is enabled by such development and accessible to millions of Microsoft 365 subscriber's world over.

Flattener #4 Open-Sourcing Self Organizing Collaborative Communities

Self-Organizing smart and collaborative community is the building block of Smart Global megacities. Open-source software movement made use of the world wide web and professionals who wanted to freely contribute their capabilities to make software and web browsers which can be freely used and whose source code is available to all for modification and improvement and this self-organizing smart community had their unique management system to organise it. It produced the most outstanding software for a variety of tasks. This software along with using Fab Lab can be used to produce outstanding innovative products that may not exist today. Often private company shared its software and joined with open source movement accepting their

code of conduct. Thus, Samsung Smart Things which provide a hub for smart thing IoT smart home automation which is very much used in the smart global city is progressing much faster in software development than other commercial software who are not using Open-sourcing. Amazon's Alexa is also another example whose SDK is freely available for anyone to design and use Alexa for their use. The result is cheaper product and services and more access to people who need not be rich. Often the same company gives out such software free of cost like web browsers. The marginal cost of production near zero is one of the approaches to smart city economy and open source movement is the first practitioner of this philosophy and it can be considered as the first post-capitalist and post-socialist model of shared community products and services. The governing structure of the open-source movement is self-governance, and it is a model for megacity governance. For Smart Global Megacities, Open sourcing and the self-organising communities are the foundation for smart global megacity economic development and smart living.

Flattener #5 Outsourcing Y2K

According to Thomas Friedmann India is the second buyer who buys a hotel, a mall, or golf course or industry at 10% the cost when the first owner grows bankrupt. Here the first owner is those fibre-optic cable company which produced a giant global, network undersea to carry digital information of unimaginable quantity assuming the Netscape going commercial can reap gigantic profit unimaginable before, but all the web browsers that subsequently came up wanted it to be free so that it can attract more information traffic for fibre optic that helps other commercial ventures and this created a situation where the whole WWW industry became free which necessitated selling the fibre-optic network cheap or for at no cost since there is no possibility of web browser going commercial. Indians did not purchase the share of fibre optic companies, but they and their American clients benefited from the overcapacity creation and used it almost free. They were able to use these resources because of the English educated Science, technology, engineering, and mathematical graduates (STEM) they produced in abundance at a cheaper cost. So American, in turn, became the second buyer of Indian capability at the much lower cost of University education than available in their own country. Many educated in India could not find suitable jobs under the "Berlin Wall " type socialist mixed- up economy in India and this helped. In addition to fibre optic, the Y2K crisis which the computer industry faced was a blessing for India to start in the knowledge economy. The early start of many knowledge-based companies gave Indian educated an alternative future in their own country which the Soviet Russia model of command economy practised before 1991 could not provide for rapid economic development and consequent reduction in poverty but gave way to the so-called the Hindu GDP Growth rate of 2 to 3%. The hardships felt by the population of India resulted in outmigration. These companies established in India escaped licence raj temporarily since IT was a very new sector for the Government and there were not even ministries of IT then. The alternative for educated unemployed was a migration to another country which they did, but which is now being opposed by the USA with America First, Brexit and the right-wing Nationalism wave in other countries and other policies of migration

that was prevented. While colonial rule created the use of universal languages of colonial masters helped this migration a great deal. In Kerala, the socialist parties like Communist Party of India came out with land reforms that fragmented the agricultural land to so uneconomically small, agriculture vanished with land reforms in Kerala along with agricultural employment opportunities and ever since depends on the vegetable and grocery items from other states and countries in a large money order economy created by blue-collar workers migrated abroad. With the oil-based economy in the middle east and ancient commercial and cultural relationship of Kerala and the middle east resulted in the export of blue-collar workers and artisans to the middle east from almost every household. Since industrialisation under Communist rule in Kerala democracy did not happen in Kerala since no investment in the industry took place in a state that witnessed everyday disruption on work in commerce, transport and industries because of call of strikes almost daily often for trivial causes which gave employment for strike organisers. triggered by political parties. These political parties in Kerala attach low value to hard work that brings prosperity that increases tax base unlike in other Asian countries like Japan, South Korea, and China. This did not result in investment in industries in Kerala in comparison to its neighbouring states like Karnataka and Tamil Nadu, that created wealth and employment and a better living. The start-up culture as a novelty with shared infrastructure owned by the community became another building block a positive development of the smart economy of smart global megacity from this flattener for Kerala but less in numbers. This also gave to the smart global megacity the art of becoming a knowledge-based industry entrepreneur breaking free from the Berlin Wall, socialism, or capitalism and embraced community sharing of work.

Flattener #5 Offshoring. Running with Gazelles. Eating with Lions

On December 11, 2001, China joined the World Trading Organisation which means China accepted world trade as a rule-based activity and eventually became the factory of the world. The spirit behind such transformation was summarised in a saying written in a Chinese factory as reported by Friedman.

> Every morning in Africa, a gazelle wakes up.
>
> It knows it must run faster than the fastest lion or it will be killed.
>
> Every morning a lion wakes up
>
> It knows it must outrun the slowest gazelle or it will starve to death
>
> It does not matter whether you are a lion or a gazelle
>
> When the sun comes up you better start running

This is the spirit behind China becoming a factory of the world. You cannot see here the Berlin wall discussed above and Marxism, Leninism and Maoism and no Planning Commission.

Offshoring is a process in which a foreign company moves stock and barrel the entire factory production to another country to take advantage of lower factors of production such as labour, water, energy, space and infrastructure cost for example and produce the product much cheaper than produced at home and reap the benefit

in the world market. China came forward as a destination for offshoring. It made itself suitable when it joined the World Trade Organisation and accepted a rule-based system from a communist system where party decide what is good often in an arbitrary manner with so-called superior knowledge of the party. It had about 160 million-plus population in metro and megacities cities in the east coast near harbours to accommodate with necessary infrastructure. The leadership of Deng who proclaimed it does not matter the colour of the cat and what matter is the capacity to catch a mouse made China more accommodative, easy to do business, and adaptable to offshoring by removing bureaucratic controls characteristic of the socialist economy but supporting most efficiently all such attempts in offshoring. These attracted major offshoring to China from the USA, Europe, and Japan. Instead of China making itself statuesque it became more dynamic. Vast Chinese population became students in western universities and became innovators themselves. The existing managerial class who were passive in the past under communist target keeping system became more innovative in management and started thinking out of the box solutions and made themselves more than efficient Japanese and western managers. Quality of output, non-failing infrastructure, and efficiency moved to China to become a factory for the world. The underlying fact is the Chinese capacity to work hard and worshipped hard work unlike in Indian communism and socialism. We also found a role reversal here to make it more confusing to know who a lion is and who is a gazelle in Offshoring. After leaders like Deng, the later Chinese supreme leaders became more arrogant with increasing GDP, less accommodative, neo-colonist, and expansionist with palm and five finger policy, not rule-based. Only the future will tell what is in store for China and the status of Deng's China that made modern China. Further, we have a reality of wealthy China, but we do not know whether we have wealthy Chinese population when we see ghost malls and ghost towns, and these can go bad if the economic relationship of the current world order decides to change. Only the unfolding of recent history may say the future pattern of megacities development in China despite excess urban infrastructure built up in China. The prosperous Megacities in China can be depopulated into metropolises or less in no time when work vanishes and supply chains migrate.

Flattener #7 Supply Chaining. Eating Sushi in Arkansas

The world has said goodbye to a situation where every part of a product is produced under one roof in one location, one country and then sold from there worldwide. The concept of self-reliance is no more valid and is replaced by the least cost, reliability, and efficiency of supply chains from selected competent countries who may hold the patent for technologies used in industries. The frequency of market demand by location in the world marketplaces determines the assembly location of final products in any country while parts and components are produced in many countries and many locations based on its efficiency of production and cost factors. The final assembly destination has a series of supply warehouses around it. When the order for example at a website is made, the e-commerce firm sends information of purchase with the time required to fulfil the order to -e-commerce seller. A computer algorithm for reduced cost and efficiency allows the message to be transmitted to

the best location of assembly of the product. The assembly order all component required from different warehouses and then assemble and courier it to the consumer. Another algorithm based on real-time supply statistics allows the warehouse to stock an optimum number of parts so that there is no loss due to excess inventory unsold. In this situation, we have a global city operating a business where the nationality of the participant supply chain does not matter but what matter is cost reduction and reduced time for delivery to the customer. All these activities can be synchronised using the artificial intelligence which guides the production, assembly, dispatch, and logistics using facts and algorithm and not Capitalism, Marxism, Socialism or Maoism. None of these isms knows how Industry 4 under 5 G works seamlessly integrated into global production. If they know that there would not be Capitalism, Marxism, socialism, and Maoism. Indirectly it helps in world peace since war is likely to disrupt the economic activity of many nations involved because of the disruption of the supply chain which nobody wants. The supply chain resulted in a series of technological innovation to further strengthen the supply chains and created a whole set of jobs which were not there earlier. Sushi in Arkansas is an expression of global co-existence of an interconnected smart mega global city.

Flattening # 8 Insourcing What the Guys in Funny Brown Shorts are Doing

Outsourcing is an activity in which certain corporate function sends out to another country based on efficiency, cost and other factors of production, marketing and services. Here, for example, an accounting firm hired for filing income tax outsource his job from the USA to an Indian firm at 5 pm and the Indian firm works on it giving all precautions of secrecy of data and then send back to the Accounting firm before 9 am when the firm opens its shop in the USA. There is no change in the working hours of US and Indian firms and no overtime allowances since when it is night in the US it is a day in India. This is an example of outsourcing. Insourcing is another form of outsourcing in which job remains within the county but formal office space for this activity is no more required. The job is given to housewife, retired personals and like who is competent to do the work at home or shared workspaces and they may be scattered in many states within the country. A good example is ticketing airway travel involving receiving instruction, discussing, finally ticketing, using electronic payment, ticket prepared and emailed and further the traveller print his boarding pass based on the instruction for a particular seat in aircraft and then travel to the airport where face recognition admits him into his aircraft. However, there exists an imaginary or virtual corporate office there which is based on telecommunication connection or web connection. When you phone for an air ticket or apply on the website for air ticket one of the in-shoring households receives the call based on an algorithm for maximising objective functions and answer it and ticket it. An algorithm which fixes who should receive the call and execute the job direct the phone call to this individual in real-time automatically. Here the company no more require a brick and motor office to do the function. He can hire the activity dispersed through the country at a much cheaper cost. I have used here another example, but Thomas Friedman gave an example of how a courier company UPS doubled up as a computer service company for Toshiba. Imagine what happens to a physical city

when we are in shoring all Administration of Government of India and all State Governments in India and to the brick and motor collectorates and secretariat, these buildings transform to recreation areas of the local population. They are not required and so also Government servants, but administrative services are performed much efficiently and cost-effective by households scattered all over. Imagine also, what happens to land use planning of urban planners under these flatters?

Flattener # 9 In-forming Google, Yahoo, MSN Web Search

According to Friedman In-forming through web search is a form of collaboration which is a foundation of globalisation and global cities. In-forming is the individual personal analogue to open sourcing, outsourcing, supply-chaining, and offshoring. In-forming is the ability to build and deploy your supply chains, a chain of information, knowledge, and entertainment that will make you part of the global economy. In-forming is about self-collaboration, your researcher, and editor, without having to go to the library. It is about seeking like-minded people and communicates is using social media. It has more functions than you can imagine. Web search can also act as a personal and free detective when you are searching for a bridegroom to your daughter.

Flattener # 10 The Steroid Digital, Mobile, Personal and Virtual

The tenth Flattener is the digital information and its access to all through smartphones in your pocket. The world is digitizing all information continuously and available in WWW. You have access to it through smartphone even if you are travelling in a bullet train 150 miles per hour. You can do all 9 flatteners discussed above through the smartphone. The smartphone is your biggest library in the world, it is the biggest multiplex in the world with the choicest cinema, it is the biggest music concert hall in the world and so on. Many of these digital resources are free of cost. So, the smart mobile phone should be part and parcel of smart global megacities.

The many study cities of this book were global city before the colonial period like cities in China, India, and many other countries. The city was global and has even tradition such as the City of Truth for Kozhikode before the colonial era a few hundred years. The rediscovery of the ancient cultural system of the global city is the first step in creating Global City. With more than 100% smartphone ownership in the study area, the world is already interconnected to study city, but actions are required to make it global city leveraging opportunities in the global workplace scattered in the study megacity. Globally operable workflow applications are already available but not learned and used in the study area for global interconnectedness and collaborative economic development. The study city is yet to develop a self-organizing collaborative community for international services, trade, app development and production by designing appropriate smart communities. Study city is yet to practice as part of outsourcing. Study city is yet to practice and reap the benefit of offshoring of foreign manufacturing and services by making factors competitive and cheaper elsewhere. Study city is yet to practice and reap the benefit of being part of global supply chains. Study city is yet to practice and reap the benefit of being part of insourcing. Study

city is yet to practice and reap the benefit of being part of In-forming. Study city is yet to practice and reap the benefit of being part of personal and virtual computing.

Here Thomas Friedman's book gives direction to how a megacity can become a global city which will be worked out in the case study of Kochi-Kannur Megacity along with others. He did not talk about megacities in his book.

7.8 Charter Cities [47–53] as Smart and Global Cities

A charter city functions based on the city's charter document which fully take into account all stakeholders of the proposed city whether they are foreigners or locals who want to invest and live in these cities and protect all their interest. It will not follow the general law based on the constitution of the country. In this general law the Central Government, State Government and City Government share the Governing and management function based on what are the state, central and city function they should perform. They will have a schedule called state, central and city schemes with specific powers and responsibility. The charter can be designed in such a way the city can function as an effective global city meeting the needs and fears of foreign as well as local participants. It is designed to attract international capital and institution to cooperate with this charter and participate in global providers of products and services at the least cost. This charter provides for autonomy unlike city laws under a constitution of the country with less autonomy and limited power delegated to the city by the state. Many countries had special economic zones with a limited delegation of freedom to participants. "A charter city is a new type of special zone, one that can serve as an incubator for reform. In partnership with credible allies, who can be from as many countries as possible, a developing country can pursue reforms in a special zone large enough to one day accommodate a city with millions of residents". It is generally a greenfield project and not a brownfield. The formal rules in a charter city and the norms that these rules encourage can differ markedly from the ones that prevail elsewhere in the country. These rules can nevertheless be legitimate in the eyes of the migrants to the zone, just as the rules in high-income countries are legitimate in the eyes of the few immigrants that manage to move from less developed countries. Economist Paul Romer proposes founding many new charter cities in developing countries especially in South America which supplies lots of migrants to the USA. This can stop or control to a limited extent the immigration to the USA. Romer suggests that a developing country pass a law that sets aside a tract of land for a new charter city. This charter city would be administered by a developed third-party guarantor government, and citizens from the host country (and maybe other countries) could move in and out as they please. The point of the charter cities idea is to give citizens the choice about where they want to live and to provide the basic rules and amenities required for economic growth. Ideally, by establishing a city with highly developed rules and governance in an underdeveloped region, living and working in a charter city may provide a closer and more attractive alternative to moving far away to more developed countries.

A city charter is a unique document that, in many ways, acts as a constitution for the city adopting it. It can only be adopted, amended, or repealed by a majority vote of a city's voters. The primary advantage of a charter is that it allows greater authority for a city's governance than that provided by state law.

A charter transfers the power to adopt legislation affecting municipal affairs from the state legislature to the city adopting it. A city operating under a charter can acquire full control over its municipal affairs. These affairs are unaffected by the general laws passed by the state legislature on the same subject matters. This, in effect, gives the local voters more control over their local government and the affairs of the city. However, a city operating under a charter is still subject to the general laws, as passed by the state legislature, on affairs that are not municipal, and are of state-wide concern.

All indices of easy to do business are fully honoured in a chartered city since it is open to reforms and the city decides on it and not the legislative assembly of the state where the city is located or Central Government. The threshold issue is whether there is a conflict between state law and a charter city enactment. The court examines the rules and regulations laid down by the Charter to see whether it conforms to the constitution and if not, generally the charter laws are discarded.

There are rules which monopolise some urban services like electric generation and supply as a sole domain of the public sector where private enterprises are not allowed. "As a result, the citizens of poor countries often end up paying the most for basic goods such as electricity, if they have access to it at all. The places where rules are weak and inefficient are also the places where job-creating investment could offer the highest returns. Yet firms build new factories, not in the parts of the world where people are most eager for formal-sector jobs, but in places where electricity is inexpensive, people and property are safe, and the rules for doing business are straightforward, predictable, and reasonably efficient. Though better rules should be easy to replicate, experience shows that social groups at all scales, from firms to cities to nations, have great difficulty achieving the consensus that is required to change their rules and norms. In this setting, competition between different jurisdictions—with each trying to attract new members by implementing better rules—can be a powerful source of human progress. This competition is particularly powerful if new entrants, new start-up jurisdictions, can challenge incumbents".

Structure of a Charter City.

A charter city's governance structure could vary significantly not necesesserly following what is laid down in the constitution of the country for the city depending on where it is established, "but all charter cities would share four common elements. The first is an undeveloped piece of land that is large enough to eventually host an entire city. Good target size is 1,000 square kilometres, roughly the size of Hong Kong and Singapore. The second common element is a charter that pre-specifies the broad rules that would apply there. The third element is a commitment to choose, backed by both voluntary entry and free exit for all residents, employers, and investors. The fourth is a commitment to the equal treatment of all residents under the law".

"The broad commitment to choose means that only a country that wants to create a charter city will offer the land. It also means that only people and firms who make an

affirmative decision to move to the new city will live under its rules—staying only if those rules are as good as those offered by competing cities. A charter or constitution should outline general principles and describe the process whereby the detailed rules and regulations will be established and enforced in a city. It should provide a foundation for a legal system that will let the city grow and prosper. This legal system, which might be given instant credibility of enforcement by a partner country, will be particularly important for attracting foreign direct investment in long-lived urban infrastructure. Of course, a charter should not specify a centralized economic plan. It should not contain rules for a detailed spatial plan for the city, one that specifies what people can do in every specific location. The rules that will encourage economic opportunities and vibrant city life will be those that leave broad scope for experiments and let competition and choice determine which experiments persist. Moreover, in a city where population and income per capita will both grow rapidly, the rules should allow much more flexibility and change that would be required in a less dynamic environment. There are three distinct roles for participating nations: host, source, and partner. The host country provides the land. The source country supplies the people who move to the new city. The partner country helps to ensure that the charter will be respected and enforced for decades into the future. Because these roles can be played by a single nation or by several countries working together as partners, there are many potential charter city arrangements. One possibility is for one country to assume all three roles, much as China did in establishing the special economic zone where the new city of Shenzhen emerged, with the central government acting as "partner" to the local authorities. India is considering such a path, using innovative governance structures and public–private partnerships to create new cities on greenfield sites. The key to going it alone is the ability of the central government to credibly commit to would-be residents and investors that the special rules in a new reform zone will be upheld.

> In practice, some countries have been receptive to Romer's idea. After a meeting of Romer with President Marc Ravalomanana, Madagascar considered creating two charter cities, but the plan was scrapped when the political leadership that supported the idea was removed from power. More recently, the government of Honduras has considered creating a charter city, though without the oversight of a third-party government. In 2011 Honduras made the necessary legal changes. Romer served as chair of a "transparency committee" but resigned in September 2012 when the Honduran government agency responsible for the project signed agreements with international developers without knowledge of the committee. In October 2012, the Honduran Supreme Court declared charter cities to be unconstitutional because the laws of Honduras would not be applicable here.

In conclusion, it can be said that Chattered global megacities are possible if the charter is deeply rooted in the local culture since local culture dictate the constitution of the country in addition to all value systems the foundation of the chartered city discussed.

8 Smart Global Megacities [54–61]

Smart global megacities will have 100% smartphone ownership with higher broadband connectivity's in every building whether it is a house or factory or hospital or airport. There shall be a broadband bandwidth below which it is not allowed to operate in a megacity. Economic, social, political, and cultural activities and environmental resources management functions will be conducted by a strategically located system of functional IOTs that is connected to an ICT system. This general connectivity by ICT and IOT system is articulated by smartphone apps with voice interfaces like Alexa or Google assistant or hub. Local universities will be involved in producing relevant E-Democracy and E-Governance Apps for use by inhabitants for various day to day activities and functions. Spatial Decision Support System using GIS in smartphone apps will be used extensively as part of E-Governance and E-Democracy. The IoT and ICT network will not make any distinction between the private and public network and the market will decide the network. An attempt will be made to use every available network cost-effectively and efficiently. Smart communities, University located in the megacities and Chamber of Commerce and Industry will be given an all-important role in the Megacity for its futures.

8.1 Smart Global Megacity 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. 1.28. Some authors treat the six elements of a smart city system equally [62]. However, following Vinod Kumar [14, 63], 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.

8.2 Smart Mega Global People

We define smart people of the global megacity as a part of a smart community of people. The sum of smart households which promotes global/international city activities by relating and connecting local economic and cultural activities to the world is a smart community which can interact face to face in a walkable space of 1.5 to 2 km radius around a major activity centre. Here smart household cannot be an isolated entity but an integral part of smart local society. Local Institutions such as academic institutions and business institutions takes part along with regulator

government to make people smart. People, households, and community become smarter with one step at a time.

Since it is not possible to generalise the smart community, what follows here is the potential of creating a smart community in Kerala a state in only one of its megacities in India. The smart community consisting of several households in a walkable area say about roughly 1.5 km radius starts with the following community assessment.

(1) Kerala is the first 100% computer literate state in India under the Akshaya project. The community will assess what additional skill that can be acquired over and above what is available by the community by households to be part of global insourcing, outsourcing etc. discussed earlier as part of Flattening of the World. This smart community provides for the global city professional services like accounting, financial services, legal services, and IT services. Global jobs for the community can be discovered based on local resource both human, natural, and cultural resources or invented through association with academic centres in the locality for new products and services global and local use. This smart community links up all related community for innovation and knowledge-based economy This smart community showcase the local culture to the world. This smart community organises and shows case local tourism activities and even local cinema.
(2) Renewable energy and rainwater harvesting will be undertaken, and the electric energy and water grid will be developed and managed its issue by the smart community.
(3) Solid and liquid waste produced by the household will be evaluated by the household by the community and find technological up-gradation in the disposal at the household level by the smart community.
(4) The drainage system will be subjected to community study to find ways and means it can be stored in retention and retention ponds in the area and identify its possible uses.
(5) A major qualitative change in the community infrastructure and spatial urban regeneration will be eventually planned for creating a smart community design which uses IoT and ICT and eventually makes every house a smart house. This may involve well known and successful models of urban land management approach panned and implemented by the community itself and not Government. In the process, we develop various standards for smart communities in different circumstances. International Standard Organisations are already started working out Various standards for smart communities [ISO Code smart community 3750:2014]. A series of spatial development exercise based on the above will be used for a stand of smart community in the megacity of Kerala.

The ‘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 [14].
(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 a 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, 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 efficiency.

8.3 Smart Megacity Economy

Smart Economy of each megacity and each smart community will be different from others. It is the cultural and ecological system of the city that gives shape to the smart city. So, the Chinese experience of global cities of converting cities to the factory by offshoring for the world may not apply to another country and New York and Tokyo models, the oldest of global cities but there are lessons to be lean so that we do not make the same mistakes these cities had made and demonstrated to the world. What society gives priority will be reflected in the smart economy. Indian value is reflected in the caste hierarchy present from the Vedic period to today. In the top of the Caste hierarchy we have Brahmin caste the men of knowledge, followed by the Kshatriya the worrier/soldier, then Vaishya the businesspeople and then Sudras the working class or service people. So much so Indians moves all over the world today as students wherever there are good universities and give leadership to knowledge-based firms like Google, Microsoft and so on and many companies in Silicon Valley. The material and financial value additions of the third caste Vaishyas was more than any caste and still, they were consigned to the third caste in the hierarchy much lower which proclaims to the world money is not that important in Indian culture. British colonialist in India reversed the hierarchy and Indian Civil Service and later Indian Administrative Service after independence were given leadership for economic development who belongs to the sudra caste the service caste of the hierarchy the lowest. Sudras do not make appreciable value addition to the economy just like the administrators who took charge of the economy through public sector undertakings which ran in massive debt like Air India which the Government of India is unable to disinvest. So ever since it happened economic development of India went down the hill with till 1991 before liberalisation the Sudra lead in economic development was pitiable and reached a point of bankruptcy in the 1990s. Still, India requires many more reforms in the economy when we do away with a deceleration in the economy. The Berlin wall of Thomas Friedman talked in the earlier part of

this chapter was about a negative force for global cities and India it was the imported Marxism and Fabian Socialism of Harold Laski of the London School of Economics and now-defunct Soviet Union model with the command economy which further strengthened Sudras to run economy was found unsuitable to India which kept people under poverty for a long time from 1947 to 1991. Thereafter poverty receded but still miles to go for economic reforms in India.

Smart megacity economic activities convert households to a mixed-use knowledge-based production, or service centre unit (engaging in international legal, financial, IT or accounting services from home using ICT) and the urban area around households largely a mixed-use urban space largely shared than owned catering to the needs of local and global consumers by providing global services. There are many more scenarios of global engagement of cities from households and urban areas in a megacity using ICT which smart global megacities should explore.

There are many paths for instituting smart economy in a megacity. Higher-level facilities for services and production shall be provided for by community workspaces of the knowledge-based economy with shared infrastructure at the neighbourhood. Conventional economic activities shall be converted to smart economic activities using ICT, IoT, Artificial Intelligence and E-Democracy apps. The marginal cost of production shall be made near zero by being a producer of renewable energy or even water harvesting by producing more than domestic use and cultural practices of community living and sharing what we have for smart economic developed as discussed in the book Smart Metropolitan Regional Development: Economic and Spatial Design Strategies for Kozhikode chapter.

'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
(8) globalization.
(9) Smart City experiments, supports and promotes the sharing economy.
(10) A Smart City thinks locally, acts regionally, and competes globally.
(11) A Smart City makes strategic investments in its strategic assets.
(12) A Smart City develops and supports compelling national brand/s.
(13) Smart City insists on balanced and sustainable economic development (growth).
(14) A Smart City is a destination that people want to visit (tourism).
(15) A Smart City is nationally competitive on selected and significant factors.

(16) A Smart City is resourceful, making the most of its assets while finding solutions to problems.
(17) A Smart City excels in productivity.
(18) A Smart City has high flexibility in the labour market.
(19) A Smart City welcomes human resources that enhance its wealth.
(20) A Smart City's inhabitants strive for sustainable natural resource management and understand that without this its economy will not function indefinitely.

8.4 Smart Megacity Mobility

Megacities have 10 million-plus population living in a vast area. There are innumerable geographic locations which act as a point of interest for work, recreation, shopping, and many other activities within a megacity. The mobility of these 10 million populations is ensured earlier by a basket of model-based transportation models such as traffic projection, model splits, traffic assignment, speed, and delay and so on which guided the city. These models help the city to increased mobility. Like population projections of many cities, these models can fail. Alternate to these modelling exercises is using real-time data and make an appropriate decision then and there to increase mobility efficiencies. This involves real-time data collections using sensors which transmit these data to cloud and cloud compute traffic assignment and cloud also intervene using management algorithms then and there which is transmitted to traffic signals which regulate movement. Here we have an example of smart mobility. Here we can use deterministic models instead of probability eliminating the margin of errors.

For increasing mobility, the entire movement pattern of megacity needs to be changed. Walking and Cycling shall be promoted by redesigning local roads from households to community workspaces and other points of interest suitably relocated. Such a design approach also meets other goals of using fewer petroleum products and thereby eliminating environmental pollution and noise pollution.

Employment can be generated by community business ventures like local Courier services shall be formed to connect to higher-order logistic centres for household delivery by locals using cycles instead of polluting motorcycles used nowadays.

Renewable Electricity operated goods traffic shall be provided to connect to major centres of interest to the local community using shuttle services of battery-operated vehicles which moves the nearest point of interest of the local population and come back and during waiting period they can be recharged their batteries using chargers in waiting places. The charger can be drawn from renewable energy grid of the local community.

Major destinations for daily and weekly use shall be benchmarked for current time distance and shall be planned to shorten the time of travel by future benchmark years by using suitable mobility technologies that use renewable technologies.

'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 [65, 66].
(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 a mass rapid transit system, such as metro rail, light metro, monorail, or 'sky train' for high-speed mobility.
(8) A smart city will have integrated high-mobility system linking residential areas, workplaces, recreational areas, and transport notes (e.g. bus/railway station/s and airport).
(9) A smart city will practice high-density living, such that the benefit of high-speed mobility is uniformly available.
(10) A smart city has seamless mobility for differently-abled (often incorrectly called, disabled) people.

8.5 Smart Megacity Environment

The smart megacity environment is generated using ICT is aimed at developing the Design and Practice of Smart Environmental Resources Management for Smart Cities. Environment Resources are common proprieties where an active role of Government and People are required and hence its management is a joint and synchronous effort of E-Democracy, E-Governance and IoT system in a 24 h 7-day framework on any environment resource in any smart cities. The smart environmental resources management is a practice that uses information and communication technologies, Internet of Things, Internet of Governance (E-Governance) and Internet of People (E-Democracy) along with conventional resource management tools to realise the coordinated, effective and efficient management, development, and conservation that equitably improves ecological and economic welfare without compromising the sustainability of development ecosystems and stakeholders.

The environment of a megacity is ever-changing, and no environmental regulator-administrator can effectively monitor and intervene conventionally practised these years. IOTs and ICT can be utilised to monitor Coastal regulation zones, river regulation zones, the water level in dams, special environmentally sensitive zones, and zones of biodiversity whenever some disturbances or changes impact the ecosystem. An ICT-IoT, E-Democracy and E-Governance solution using Spatial decision Support System shall be designed and implemented by all stakeholders.

Major touristic and cultural activity centres shall be promoted for international use by proving user-friendly apps and supporting service provision by local stakeholders. A smart environment efficiently and effectively manages its natural resource base. A smart environment is a green and blue city. 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. A smart city can create a low-carbon environment with a focus on energy efficiency, renewable energy, and the like.

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

(1) A smart city lives and protects 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 the 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 because 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 a 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 airsheds 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 a focus on energy efficiency, renewable energy, and the like.

8.6 Smart Megacity Living

The smart megacity living is a concept aimed at developing state of the art design of "Smart Living" for megacities and meta cities as well as a community and neighbourhood level. Smart living is one of six components for Smart Cities; the others being smart people, smart economy, smart environment, smart mobility, and smart Governance and all of them are integrated concepts. The smart living in any smart city can only be designed and executed by active roles of Smart People and Smart City Government and is a joint and synchronous effort of E-Democracy, E-Governance and ICT-IoT system in a 24 h 7-day framework on all activities. In addition to uses of information and communication technologies, Internet of Things, Internet of Governance (E-Governance) and Internet of People (E-Democracy) the design of smart living utilizes domain-specific tools of many aspects of living by age cohorts to realise the coordinated, effective and efficient management, development, and conservation that improves ecological, social, biophysical, psychological and economic wellbeing equitably without compromising the sustainability of development ecosystems and stakeholders.

A smart city has strong and shared values. A smart city records and celebrates local history, culture, and nature. A smart city has a vibrant downtown, 24 h and 7 days a week. A smart city improves the urban way of life. A smart city has high-quality public services and amenities. A smart city is an ideal place of living, especially for women, children, and senior citizens. A smart city engages artists to improve and enrich the aesthetics of daily life of the city.

'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 the 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.

8.7 Smart Megacity Governance

In India as well as in many countries there is no Governing institution for megacity in their constitutions. One reason is the number of megacities in a large country like India is limited to seven or eight megacities. However, there is a provision for a Metropolitan Planning Committee only if it is within one state and one district. Census of India also do not delineate megacities and it stops at urban agglomeration and define one million-plus population urban agglomeration in a district as metropolitan cities. A bottom-up approach where megacity governance and development are visualised from households to the community will be the ideal approach. This community needs to be self-organised than organised by administrators of the Government. This community themselves can have their E-Governance framework based on existing legislation as well as E-Democracy apps that execute all aspects of the work of this community. The local academic institutions shall skill them as per their needs through extensions and make them smart. The future of smart global megacities is therefore left to the local communities and households to develop at their initiates.

Smart Megacity Governance highlights electronic governance in a smart city. "E-Government" refers to the use by government agencies of information technologies (such as Wide Area Networks, the Internet, and mobile computing) that can transform relations with citizens, businesses, and other arms of government. These technologies can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management. The resulting benefits are less corruption, increased transparency, greater convenience, revenue growth, and/or cost reductions.

Smart Megacity Governance can be studied in three parts.

- E-Governance State of the Art Study
- E-Governance Domains Studies
- E-Governance Tools and Issues.

'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
(5) and effectively.
(6) A smart city practices participatory policymaking, planning, budgeting, implementation, and monitoring.
(7) A smart city has a clear sustainable urban development strategy and perspectives known to all.
(8) A smart city utilizes creative urban and regional planning with a focus on the integration of economic, social, and environmental dimensions of urban development.
(9) A smart city features an effective, efficient, and people-friendly urban management.
(10) A smart city practices E-Democracy to achieve better development outcomes for all.
(11) A smart city embraces a Triple Helix Model in which government, Academia and Business/Industry practice-changing roles in Governance.

9 Configuration of Megacities: Configuration Basics

1. No megacity is like any other megacity in all aspect except that the size of the population is equal or above 10 million. Delhi is not Mumbai and Tokyo is not New York. They are unique. They have a unique cultural system and ecological system. Their unique history has shaped them, and their configuration shall follow a unique path which cannot be cloned.
2. No megacity has got a constitutionally valid administrative boundary. For example, the largest administrative boundary in Mumbai cannot cover the whole megacity Mumbai. Tokyo Metropolitan Government does not cover the whole of megacity Tokyo.
3. While it is possible to keep a track of expanding megacities through Remote Sensing and GIS technologies, it is never used and kept track of possible megacity expansion. There are well tested predictive models of spatial megacities expansion it is never tried and updated in these megacities. [10]
4. The GDP share of countries is mostly generated in the urban area than in a rural area. In India, it is 7 to 3 proportion although India is a country of villages. Megacities generate generally the maximum GDP in any country because of the consumption and production income flows of 10 million-plus population.

5. Majority of the counties do not compute GDP of megacities although India has 7 to 10 megacities no GDP statistics of megacities is available, they do not compute GDP of megacities instead they compute district GDP.
6. Although Indian census computes occupational structure, male and female workforce participation, main and marginal workforces, they do not account for the diversity of urban employment.
7. Megacities have got two service areas unlike small cities like market Towns (Mandi) with one service area consisting of supply villages of agricultural commodities and the market town. One service area is within the country and the other outside country. The service areas are defined by intense interaction with communication and flow of money, goods, and service. The outside service areas are generally megacities and metropolitan cities which will have their service areas. These three levels of service area connection allow the flow of goods, services and communication and money flows uninterrupted if world trade is rule-based under, the World Trade Organisation and counties do not arbitrarily and independently make trade rules.
8. Megacity interactions and flows generate two types of income the basic income from outside and non-basic income within the country.
9. Megacities can be broadly classified into mature megacities and emerging megacities. Mature megacities are those who had attained 10-million-mark population decades back and graduating towards meta city of 20 million population. Some of them may lose absolute population and some may have less of growth rate. Emerging megacities are those who graduated from metro cities to megacities in the last decades. Many of them may have faster population growth than meta cities.
10. Megacities involve vast geographical area and diverse ecosystem, and positive and negative impact will have far more consequence than other smaller settlements. Same exists with the successful environment resources management.

9.1 Building Information System for just in Time Decision Making for Smart Global Megacities

There are two sets of decisions people of smart global megacities wants to make. They relate to smart living and start working. Before the Berlin Wall was broken in Germany and now the barrier that separates North Korea with South Korea, the communist/socialist system of Governance the Communist party and bureaucracy decides on living and working, there but in democratic countries, people have right to decide as per the constitution. Majority of the countries participating in this project are democracies and will continue to the path of democratic smart global megacities.

1. The household and community around household about walking distance from the household support each other in achieving smart living and working. They also collectively develop and use information system for these purposes.

2. All community decisions shall be based on correct and new information collected to make decisions.
3. This is achieved by human and non-human sensors.
4. Non-human sensors are a set of appropriate IOT sensors located within the households and community.
5. These IOTs are interconnected and the information is stored in the cloud within learned institutions selected within the megacities or selectively commercial cloud storages such as Amazon, Microsoft, and others.
6. The digitisation of information including Geographical Information System for the megacities will be developed by the community and households and updated from time to time.
7. The skilling for GIS database creation by local households and communities will be conducted by selected learned institutions within the megacity.
8. The spatial decision support system as smartphone apps required making decisions will be developed by community and institutions selected for the purpose as part of extensions.
9. They can also share similar decision support systems from other communities outside the megacities.
10. The community will have a middle range and long-range plan of action to strengthen community IOT-ICT based information system based on perceived needs of the community.

9.2 Homestead and Households as the Building Block of Smart Global Megacities

1. Household has a piece of land, a house to live in and household infrastructure which will be assessed and digitised in the information system of the community.
2. Existing land information system if any of the land revenue department of the Government will be used as the basis for updating information or developed from the actual measurement and digitizing by a smart community.
3. The skilling for the task for the community to digitize this information will be conducted by competent institutions nearby.
4. Solid waste disposal system of the household will be assessed, and possible improvement will be discussed by the community with the household.
5. Sewerage system such as a septic tank of the household will be assessed, and possible improvement will be discussed by the community with the household.
6. Drinking water sources such as well household will be assessed, and possible improvement will be discussed by the community with the household.
7. Community and households will discuss the maximum use of rooftop for a generation of surplus electricity using photovoltaic systems connected to a community microgrid.

8. Drainage system within the household will be evaluated and Community and households will discuss redesign.
9. Rooftop harvesting of rainwater will be designed by the community which will eventually be connected to rainwater-harvesting-community grid.
10. Based on E-Urban Land Management as Business for Umami developed in Chapter 19 of the book "Smart Economy for Smart Cities" the household will be educated on how they can prosper using the various land management system [14].

9.3 Analysis of Existing Employment and Potential for Employment in the Smart Community

1. Employment in the smart community cannot be a uniform and the same pattern in every community in the megacity. There can be a specialisation of employment pattern.
2. Employment pattern need not be all in the formal sector. There can be formal and informal employment types, and both can be global if required.
3. Employment in the Smart Community depends upon many factors. Dominant institutions nearby determine the possibility and types of employment.
4. Employment in a smart community can be of two types; discoverable and those that can be invented through new products and service that do not exist.
5. Discoverable employment is that employment which meets the existing as well as projected demand for services based on population, income, and expenditure pattern of the population.
6. Invented products and services are arising out of the institutions nearby the smart community by the production of new products and services.
7. The smart community shall be skilled by competent institutions to assess employment potentials, employment budgeting and employment projection for the smart community
8. Using household statistics, the supply side of employment statistics of working age, as well as a senior citizen, shall be assessed by male and female and their skills, the employment potential can be assessed by the smart community.
9. 6. The community shall assess newer skill required to participate in inventible jobs and training programs may be organised.
10. Emerging jobs like e-commerce seller, logistic services and electric vehicle shuttle services and many others may be investigated.
11. The smart community shall decide the strategy of balancing supply-side employment with demand-side jobs and find gaps to fill in through proactive inviting of immigrants with skill sets to settle within the community.
12. All global jobs can be identified, and it can be located by GIS-based suitability analysis.
13. The household shall be designated as a workplace. For shared employment activities as well as shared essential infrastructure for working the community

shall identify shared workspaces for a differing mix of employment activities suitable for the community and developed as part of urban land management for the business indicated as above.

9.4 Making Megacity Global and Locating Global Employment

1. Making a Megacity, Global city is like telling the obvious that as a human being you have two eyes which are taken for granted since megacity is endowed with a higher level of ICT, global physical connectivity with multiple international airports, harbours and road and rail connectivity, innovative Knowledgebase and globally standardised skill sets in IT, Finance, Accounting, and legal affairs with clusters of interrelated institutions of higher knowledge base and highest quantum of income, expenditure and savings of 10 million people and above taking place in a small geographic area. The only issue is the smart communities of megacity shall realise these facts and change their lifestyles and employment pattern to global and higher levels.
2. Every megacity has a service area within the country and outside. The certainty of the flow of goods and services from the megacity outwards within the country is faced with less uncertainty than outside. The potential of developing global flows of goods and services and local flows generates basic and non-basic employment respectively within households and the smart community. What remains is household and community decision making and enterprise.
3. The ability of smart individuals and smart community with special orientations on providing specialised and often innovative goods and services largely depends upon the possible skilling in facing these uncertainties in the flows of goods and services.
4. To uncover a global aspect of megacity one must systematically identify which community has higher potential to increase the type of activity in the global service area and develop it.
5. A multi-criteria locational decision need to be rationally executed preferably with GIS and SDSS to identify the potential specialisation for global service areas of goods and services of the smart community.
6. Then these smart communities need to be functionally related to university system located nearby that space with the capability to extend skills and upgrade these skills continuously of the smart community based on the generation of new knowledge on the product and services.
7. The current system of manufacturing such as Fab Lab of MIT makes it easy for any smart community to produce any new and innovative knowledge-based products, for example, a new electric vehicle or aeroplanes or drones in any smart community workspace. Such production is not depending on Henry Fords or Toyota motors factory space or big capital.

8. E-marketing can take over the marketing from the smart community where the smart community can be e sellers. E-Logistics and E-electric mobility can intelligently support it.
9. Venture Capitalist or Government policies are there to provide capital for any ventures having the potential for a higher level of success. The smart community need not be rich by inheritance to run an enterprise.
10. E-Governance, Spatial Decision Support System and E-Democracy and use of artificial intelligence and blockchain in all aspects of Governance and regulations can replace expensive, often partisan and least efficient bureaucracy with high potential of corruption and nepotism to make smart community corruption-free at the same time a community that self-regulate and 100% law-abiding using electronic means.

9.5 Smart Community Design

1. Smart Community in the megacity shall mutually support institutions nearby by providing suitable goods and services. It also allows productions related to the institute's specialisation. A good example of such a relationship is the relationship of Stanford University and Silicon Valley and MIT and Boston Corridor where many innovative industries came up. The institutions need not be university alone but can be related to health, recreation, tourism, or any aspect of megacity institutions.
2. How the human resources in the community can create jobs from all these opportunities and how the income derived from the job can be increased by skilling process the smart community shall consider.
3. The smart community shall start with major resources the community have and how it can be utilised to reap the best returns to the inhabitant. The urban land management coupled with urban management can be used. The landholding of the community can be pooled using well-known land management tools likes Land pooling and plot reconstitutions, etc. can be used to increase the income of the community if you make urban land management business of the community.
4. Renewable energy such as electricity from photovoltaic shall be executed in a phased manner in a smart community such as maximum rooftop is utilised for this purpose eventually. The excess of energy can be channelized into a microgrid and the smart community can use it for local social and economic development and smart mobility using electric vehicles.
5. Rooftop rain harvesting system for the community shall be channelized into a water grid which can be managed by the community using IOTs and smartphone apps.
6. The drainage pattern of the community shall be planned, and water can be stored in retention and detention ponds to be used for livelihood and recreation in addition to managing the groundwater table.

7. The main sewerage system is a septic tank based and the main source of water supply is well water in Kerala. The septic tank can contaminate well water. A program of restructuring septic tanks for small-bore sewer system using water lagoon can be considered as a workable alternative by the smart community.
8. Every household will be a producer and consumer at the same time.
9. Mixed-use shall be propagated for all uses so that work and stay are adjacent to each other.
10. Public Realm shall be created in the community for all age group.

9.6 The Smart New Urbanism Principles

1. In this book, we propose to add smart as a prefix to well-accepted new urbanism principles which we call smart new urbanism.
2. The genesis of a smart community is the nexus of smart community infrastructure, related Analytics and Communication system which can even be voice-enable like Amazon Alexa in Echo for daily community life. Energy grid and water grid can be developed in a smart community using ICT and IOT and necessary scope for instant diagnosis and malady remedy systems using speech-enabled Alexa type speaker system by the housewife.
3. The smart infrastructure, devices and sensors and embedded processing can be used to measure; wide-area communication connectivity and data management can be used for management control requirements, preventing leaks, regulating flow to households and all leading towards Optimisation control and management.
4. What follows is new urbanism principles which will be adopted in the community design and can be made smart using ICT smartphone enabling.

    (1) Design for pleasurable walkability within the community
    (2) Design for maximising all types of connectivity
    (3) Increasing density using various urban compaction tools.
    (4) Design for diversity and use of mixed-use as an important element of diversity
    (5) Mixed housing was rich, middle income and low income live together using the same common services and facilities.
    (6) Adopting quality architecture as related to cultural symbols, a way of life and climate and quality urban design to create a culturally acceptable public realm.
    (7) Reinventing the traditional neighbourhood in the smart community which can be a mad intelligent neighbourhood.
    (8) Modifying the transport system using ICT so that we have just in the information that guides movements of goods and people with different modes of travel.

(9) Sustainable consideration is used to evaluate all aspects of the smart community.
(10) Benching marking of quality of life using robust indicators present and future.

9.7 Smart Community Vision that Integrates Zoning, Urban Compaction, Urban Land Management, and Form-Based Codes

Hybrid Form-Based Code (HFBC) is advocated for Smart Community spatial urban design. Elements of HFBC is tabulated below (Table 1.7).

1. The Smart Community Shall Have a Vision of the Smart Community to Collectively Evolve.
2. This vision needs to be formulated as a five-year zonal plan prepared by the community which indicates broad land uses using a detailed GIS database of plots which the smart community shall be skilled to make. The vision plans

Table 1.7 Elements of form based codes

Element	Description
Regulating plan	A plan or map of the regulated area designating the locations where different building form standards apply, based on dear community intentions regarding the physical character of the area being coded
Building form standards	Regulations controlling the configuration, features, and functions of buildings that define and shape the public realm
Public space/street standards	Specifications for the elements within the public realm (e.g., sidewalks, travel lanes, street trees, street furniture, etc.)
Administration	A clearly defined application and project review process
Architectural standards	Regulations controlling external architectural materials and quality
Landscaping standards	Regulations controlling landscape design and plant materials on private property as they impact public spaces (e.g. regulations about parking lot screening and shading, maintaining sight lines, insuring unobstructed pedestrian movements, etc.)
Signage standards	Regulations controlling allowable signage sizes, materials, illumination, and placement
Environmental Resource Standards	Regulations controlling issues such as storm water drainage and infiltration, development on slopes, tree protection, solar access, etc

Source [64]

shall have a community involvement strategy, Market demand analysis, infrastructure development and financing strategy, development incentives and finally consensus adoption by the smart community.

3. Various urban compaction approaches shall be evaluated for adoption to increase the household stocks for the future as well as providing a quality of life for the smart community. The smart community shall be skilled to adopt urban compaction involving their homesteads.
4. Various approaches available for urban land management shall be evaluated for adoption to increase the household stocks for the future as well as providing a quality of life for the smart community. The smart community shall be skilled to adopt urban land management tools involving their homesteads.
5. Various Form-Based Codes can be evaluated by the smart community evaluated for adoption to increase the household stocks for the future as well as providing a quality of life for the smart community. A regulation Plan based on community designed zonal plan which gives broad placement of standards discussed below and administrative process shall be detailed out at the start of community-based form-based coding which is an additional skill the community shall learn from competent professionals. They are summarised below and selected few are discussed further.

    (1) **Building Form Standards**: It consists of an overview of the zonal plan including the use of space and placement of buildings, building form regulation, parking regulations, frontage types, allowed building types and allowed encroachments of public spaces.
    (2) **Public Space Standards**: It consists of identifying public spaces within zonal plans and classifying by areal extent and use, specifying locational principles, general character, and potential use. It includes neighbourhood parks, playground by age group and open spaces for senior citizen and women group.
    (3) **Architectural Standards**: It consists of specifying by community facade composition, door and windows types, material use, details of a porch, balcony, and galleries
    (4) **Landscape standards**: Specification of landscape standards for pedestrian paths, cycle tracks, public space landscape, playground landscape by types, selection of point location for trees and other landscape elements, tree line along roads of different types, commercial area landscape, parking area landscape and irrigation plans and facilities.
    (5) **Environment Standards**: Hierarchy of drainage system standards, stormwater system standards, rainwater harvesting standards, Retention and detention ponds standards, garbage disposal standards, solar panel standards and sewerage standards including retrofitting of septic tanks.

9.8 Configuring Mega City for Smart Mobility

1. A vast megacity area with 10 million-plus population and widely dispersed employment centres and many activities centres spread around requires a high level of mobility for people as well as goods. Sustainable mobility is ensured if this mobility is based on renewable energy and progressively reduce dependency on fossil fuels to near zero which is getting costlier and about to vanish.
2. A restructuring of the neighbourhood which makes walking and cycling a good experience shall be created using urban design, Form-Based Codes, Urban land management and site planning techniques and tools.
3. Household and institutional level renewable energy harvested from roof photovoltaic microgrid system shall be used to power e vehicle mobility managed by the smart community.
4. This renewable energy-based mobility shall take care of all regular work, school, and shopping trips/movement of the community.
5. Waterways and coastal shipping shall be explored and developed for less costly mobility.
6. Low-cost taxi system connecting airports may be explored for feasibility.
7. Renewable energy operated mobility using electric vehicle shall gradually replace in a phased manner all fossil fuel vehicles within the smart community. These e vehicles can be shared and owned by many households or total smart community
8. An integrated mobility plan with other modes of travel shall be designed for a megacity.
9. If the community produced a rooftop micro electric grid of the community shall be used for Vehicle mobility, then the community can plan to exempt payment to travel for a certain category of regular travellers like school children and senior citizen. Metro rail and light metro shall be encouraged and constructed to eliminate dependency on self-owned vehicles. The e-vehicles shall connect to metro rails and light metros transportation system.
10. All mobility of goods and people in the megacities shall have assistive smartphone apps to guide movement in the most efficient manner integrating all modes and types of movement.

9.9 Configuring Mega City for Smart Environment

1. Megacity provides for large-area smart environment management.
2. Floodwater that is designed to connect large watersheds makes it easy to manage floods with collaborative institutions using a watershed-based ICT system.

3. Megacity generally has long seashores since most of the megacities located along seashores. Coastal zone protection shall be managed by the smart community.
4. Megacities generally have many river systems having vulnerable zones.
5. Using IOTs, sensors including human sensors these vulnerable areas can be monitored by all concerned including smart communities.
6. There are many legislations connected with coastal zones and river zones.
7. These laws can be codified as smartphone applications by local institutions and managed by the smart community.
8. Monitored environmental data can be used in spatial decision support system apps using smartphones or Alexa enabled smart speakers on environmental regulations can be utilised by smart communities affected by the calamity to get necessary administrative and policy supports.
9. These applications can be developed by competent institutions in collaboration with local smart communities.
10. The same approach developed for sale erosion and riverbank conservation can be extended to many other common megacity's environmental issues.

9.10 Configuring Mega City for Smart Economy

1. Both Industry and services in megacities are important in creating local and global jobs.
2. The industry tends to create more jobs in megacities than services barring a few sectors such as health care.
3. Factors of production and services and its comparative cost advantage and high international quality and reliability standards for industrial products determine the generation of employment in a megacity.
4. Surplus production of renewable energy in megacities can generate the lower cost of production and services if these employment sectors have access to community decided free renewable energy grids.
5. The above principles can be utilised for social welfare activities.
6. A balance of the cultural and ecological system of the megacity shall determine the industrial and services mix that can create employment.
7. There is no universal model such as China the world factory to dictate smart economic development.
8. The digitisation of all economic activities can be used to make economic activities more cost-effective and globally competitive.
9. Traditional extension of welfare measures as per religious practice and caste practice is more efficient and less corrupt than the bureaucratic delivery of welfare functions. This activity shall be outsourced by Government to them and further strengthen with Government help.
10. The smart economy shall be configured within the ecosystem of smart mobility, smart people, smart environment, smart living, smart and smart government.

9.11 Configuring Smart Megacity for Smart Governance

1. Megacities shall learn governance of megacities from the governance of the internet. It works despite not having a visible governing system existing with taxpayer's money. There is no systematic governance with administrative officers and brick and motor institutions, but it works effectively and never let you down in any of your activities.
2. The Smart Community will take a supportive role in all aspects of rule-based governance.
3. The smart communities will use ICT and IOTs and human sensors to monitor rule-based governance parameters. For example, If Coastal Regulation Zone is violated or river bed is encroached d upon, these violations will be geocoded in a GIS-based rule-based decision support system and brought to the concerned administrators for administrative action in addition to community applying social pressure.
4. Direct value addition to the smart economy by governance is zero or negative expenditure on Governance should be reduced using minimum government officers and maximum governance using electronic means and artificial intelligence.
5. Most of the administrative activities can be outsourced like passport issue in India by Government using Tata Consultancy Services has made an issue of passport more efficient and expenditure on Governance less. Such experience shall be continued in all walks of administration.
6. The existing E-Governance application accessible to internet and smartphone-only constitutes less than 25% which needs to be made at least 75% in the megacities.
7. Cash transaction in the economy shall be progressively reduced. The achievement of Reserve Bank of India in propagating core banking facilities, Unified Payment Infrastructure UPI to all banks and people and Income Tax and Goods and Service Tax moving towards electronic payment system is a notable achievement and policy tweaks can reduce the cash transaction in economy considerably.
8. Amazon Echo the talking interface has an open SDK and therefore many more smart speakers for definite Governance functions can be made by local academic institutions managed by housewives. Such devices shall be used widely by human sensors in the household for governance purpose.
9. There is the widespread use of websites by Government but most of them provide information and, but it is not enough. These websites should perform governing functions and shall be interactive. There shall be an evaluation of the website and award for best Government website which will help in improving the delivery of Governance a great deal.

9.12 Configuring Smart Megacity for Smart Living

1. The foundation of smart living is the physical, mental, and social health of a people.
2. Since humans being are part of the ecology, ecological health is equally important. This means living and non-living entity connected to an individual in megacity affect the foundation of living. If you decrease the migratory bird's arrival in some part of the city if you pollute the air, water and land and if you deliberatively change the climate by disrespecting ecology, you are doing a disservice to your very foundation of life.
3. The biological system of a human being if functioning abnormally it may be partly genetical or because of the four components discussed above. Remedial action needs to be taken which can be curative or preventive.
4. The megacity can be configured to achieve the preventive aspect of health considerably.
5. This configuration can be based on Regeneration of smart spaces for smart living in any megacity
6. The regeneration of megacity shall use urban land management tools enriched by ICT applications that benefit financially local population and aim at maximising the human physical and electronic contacts by opening public realm for all age groups, sex and income group in a locality at walkable distance.
7. These public realms shall be endowed with suitable infrastructure to make it most sought-after locations in a city for human interaction which can remove depression and suicidal tendencies and can make your health with playgrounds and enrich local culture and provides opportunities to have ethnic exotic food and view music, drama and dances along with a cinema.
8. To augment a healthy living the access to this public realm shall be by walking or cycling and shall be creatively designed and landscaped that gives the most memorable experience of the megacity.
9. The security of these open spaces shall be ensured by e-Governance apps in the smartphone by easily pressing the button of panic there.
10. E-Democracy apps related to open spaces can be used for the easy gathering of the people and enact various activities there in the public realm.

10 Conclusion

1. The configuring of a smart global megacity may vary depending upon the cultural and ecosystem of the city. This aspect ensures the diversity of smart global megacities.
2. Sharing and not owning is the fundamental philosophy of smart cities. Airbnb, Uber, and all aspects of smart are sharing.

3. Open sourcing of Spatial Decision Support for smart city decision making is yet another speeder option for the smart community and linked institutions. Smartphone apps are developed by competent persons in a common platform and shared not only within megacities but also outside.
4. The Smart community is on a continuous path of skilling. The skill themselves in developing E-Urban Land Management, Form-Based Codes for the smart communities, and gets skilled in smart economic activities such as an e- seller or innovative product developments and commercialisations.
5. A balanced view of six systems of a smart city will be executed and for example, smart economic goals of wealth creation need not diminish natural capitals and smart environmental goals.
6. Under the rights to livelihood given in the constitution, Government or its set procedures of planning board will not dictate what smart community shall do. They decide themselves what is good for themselves.
7. The smart community shall collaborate with traditional religious or caste-based community programs which were in existence in many centuries.
8. The renewable resource-based smart city will be attempted which are sustainable. Therefore, in community design, there shall be rainwater harvesting and community use and harvesting of solar energy for electric generation, grid management and common use.
9. Megacity shall aim at the complete transition from fossil-based fuel to renewable energy for all types of mobility in a phased manner.
10. The smart community shall not be only concerned about smart people but also trees, animal and birds and all non-living things like river coastal zones and so on.
11. What follows Sect. 1 of the book is a series of studies which will discuss these aspects in length.

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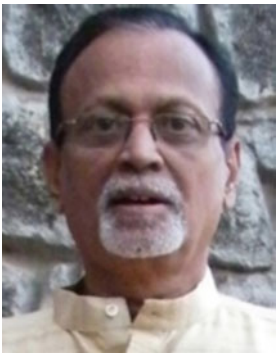

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E-Commerce and the City: Vignettes from Kozhikode, India

Althaf Shajahan and Fawaz Kareem

Abstract E-commerce has been making rapid inroads into Indian markets. Historically, markets have been central to the configuration of the city. When e-commerce is changing these markets, we need to assess what digital market platforms will mean for the future of the city's markets and the traditional brick and mortar sellers. The current research focuses on hyperlocal e-commerce initiatives emerging as alternatives to dominant e-commerce players. Using the city context of Kozhikode, the chapter explores how hyperlocal e-commerce responses are being led by young entrepreneurs from the traditional business communities of the city and how their growth is catalyzed by the Kozhikode's ethos of solidarity and mutual support. We would like to make use of qualitative research methods adopting a case-study approach with in-depth interviews with different stakeholders in conjunction with timeline methods to unveil this transformation. We focus on four hyperlocal e-commerce initiatives in the city. We find that there is still room for smaller 'hyperlocal' players from the city in the emerging digital markets and they would play a pivotal role in the 'smartening' of the city bottom-up. In cities where commerce thrived for centuries owing to centuries old trust and informal social control, 'hyperlocal' e-commerce platforms are here to stay.

Keywords E-commerce · Digital economy · Platform business models · Urban commerce · Markets · Hyperlocal

1 Introduction

India is among the fastest growing economies in the world, with a significantly large percentage of young and internet-savvy consumers. The Indian economy is driven mainly by a young demographic market segment, with around 75% of internet users in the 15–34 age band [7]. Favorable government policy which allows 100%

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FDI in business to business (B2B) e-commerce and investments and innovations in supply chain management, logistics infrastructure, warehouses and storage, Indian e-commerce industry is anticipated to grow even more rapidly. The fast-growing e-commerce market in the country will touch $84 billion in 2021 from $24 billion in 2017 on account of healthy growth in organised retail sector making India the third largest retail market in Asia and fourth largest in the world. The retail market in India is expected to grow to $1.2 trillion by 2021 from $795 billion in 2017 [3]. E-commerce and this rapid digitization is changing the way buyers and sellers interact in our economy and also the way cities and its commerce is evolving. Historically, markets have been central to the configuration of the city. When e-commerce is changing these markets, we need to assess what virtual markets will mean for the future of our urban spaces. And for this, it is essential to grasp the realities of current situation.

This study is an attempt to understand the influences of expanding reach of e-commerce in the city, the changing configurations of the city and its impact on the city's traditional brick and mortar retailers. We take the case of the historic city of Kozhikode to illustrate how e-commerce is changing the commercial landscape of Tier-II cities. Using the unique context of Kozhikode, we see how hyperlocal e-commerce responses are being led by young entrepreneurs from the traditional business communities of the city and how their growth is catalyzed by Kozhikode's ethos of solidarity and mutual support. We would like to make use of qualitative research methods to unveil these undercurrents. The study employs a case-study approach involving in-depth interviews with different stakeholders. We focus on four hyperlocal e-commerce initiatives in the city—*Masalakada.com*, an online venture initiated by a traditional seller in Valyangadi (Big Bazaar) of Kozhikode; *Potafo,* an indigenous online food delivery website/app; *Slash*, an info-mediational platform for local retailers and *FixSo*, a horizontal gig marketplace which later extended to an online 'shommerce' platform for the SM Street retailers.

Current research recognizes that the mushrooming of e-commerce businesses across the country is an unstoppable process. E-Commerce being adopted is not unexpected in urban markets that always search for avenues to widen the market. But what e-commerce disrupts is the element of trust in business engagements. Seller interaction and pre purchase inspection is a crucial element in building trust in traditional markets which are characterized by a more complex consumer behavior [1]. A more inclusive view is that e-commerce could be deemed complementary to traditional commerce as it is incapable of discarding market places. Market places have been the centers of urban life for centuries and vital spaces for social interaction [4]

2 Methodology

We adopted a qualitative research route for pursuing our curiosities regarding this theme. Following [5] and the positivist school, we adopted a case study research focusing on select firms using in-depth interviews, archives and user interface and experience(UI/UX) studies of their mobile applications/websites and evidence being mostly qualitative. We interacted with the business historians of the city and observed the changes in the city's commerce scene and this took us to the developments around the newly emerging hyperlocal e-commerce platforms. We made in-depth interviews of different stakeholders while focusing on the entrepreneurs behind these initiatives. We particularly documented the experiences of the 'hyperlocal' entrepreneurs behind the e-commerce initiatives indicating the different stages of their 'startup' journey and their experiences with the sellers, buyers and major competitors. We also focus on the sellers who were influenced by the transition from conventional commerce to e-commerce and played a key role in the growth of these 'hyperlocal' initiatives. With focus on such changes in centuries-old Kozhikode city, we expected to witness how e-commerce activity is disrupting or impacting the lives of retailers and businessmen with generations of their ancestors intricately embedded to the markets of city. To figure in these temporal aspects, we employed timeline (or lifeline) methods in conjunction with the in-depth interviews. Timelines are a visual depiction of a life history, where events are displayed in chronological order with relative importance of the events also indicated. Timelines facilitate recollection and sequencing of personal events and they are useful in placing a particular research construct in the context of other events [6].

3 E-Commerce in the City: Kozhikode City

Kozhikode city, also called **Calicut**, is situated on the Malabar Coast in the state of Kerala in south-western India. Kozhikode was once a famous cotton-weaving centre, and it is remembered as the place of origin of calico, to which it gave its name (i.e., Calicut). The place was an early focus for Arab traders, who first settled there in the 7th century. Vasco da Gama, the Portuguese discoverer of the sea route to India, reached Kozhikode in 1498. The Portuguese built a fortified trading post there in 1511, but it was abandoned and not until 1664 did the British East India Company find a trading post there. Kozhikode's port used to be active, although virtually closed during the summer monsoon season, and ships must lie 3 miles (5 km) offshore at other times of the year and the city exported pepper, ginger, coffee, tea, and other crops trading in coconut products, Its industries include sawmills and tile making, coffee curing, and hosiery works [2]. Figure 1 locates Kozhikode city within the map of local bodies in Kozhikode District. Figure 2 is the raster image of VIIRS Stray Light Corrected Nighttime Day/Night Band Composites (May, 2020) which proxy

Fig. 1 Kozhikode City corporation in Kozhikode district-map of urban and rural local bodies in Kozhikode district

economic activities and night-time market activities which peaks in Kozhikode city limits and other urban centres in the district.

Kozhikode's markets boast of a long business history and trading heritage with vibrant trade relations with trading nations around the world. These urban markets bear remnants to this past and the scions of the trading communities which controlled these markets are instrumental in the ensuring that the city's commerce stay on. The biggest of the Kozhikode city's traditional markets, the 'Valya-angadi' or the big bazaar is the living testimonial to the historical maritime trade relationships of Kozhikode with the world. The warehouses (*Pandikasala*) or godowns to store spices and hill produce to be shipped from Kozhikode port are still found here. Valyangadi market grew into Valya (Big) 'Angadi' (Bazaar) due to its suitability as the collection centre of export goods and its proximity to the now non-existent Kozhikode sea port and the Kozhikode railway station (the busiest station in the erstwhile Malabar district). Valyangadi could be rightly called as the heart of central business district of the city and was positioned on the direct road between the second

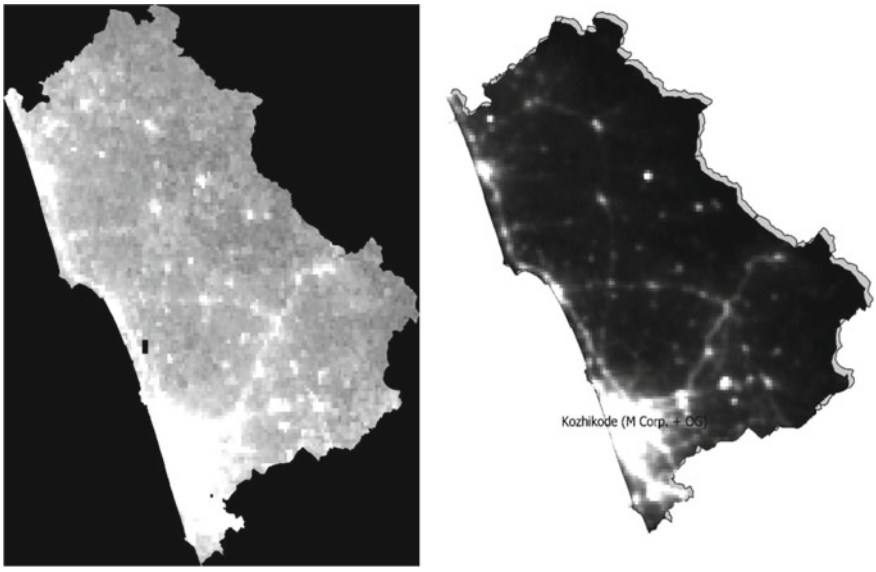

Fig. 2 Left: VIIRS stray light corrected nighttime day/night band composites (May, 2020) Right: VIIRS raster image averaged between 2015 and 2020

largest market—'Palayam' and the sea bridge to the trading ships. The Gunny street which collected the used sacks from the trade, the Gujarathi Street, the Silk street with remnants of the trade relations with Chinese and the Goods shed circumscribing the Valyangadi bear witness for trade and commerce activities centred around this heritage urban market. The Sweet Meat Street (SM Street) aptly named due to the prominent 'halwa' shops there and the Palayam Market are the again part of the network of urban markets and its paraphernalia of one of the oldest trading towns on the Indian coasts. South to Valyangadi is the southern trading quarters of the city—'Thekkepuram' where the descendants of the Arab traders created a settlement around Kuttichira. This settlement was home to an active business community comprising of commission agents and traders mediating the trade between Kozhikode and parts of the world. The maps in Fig. 2 indicates the location of Valyangadi, Palayam and Kuttichira(Thekkepuram) in Kozhikode city ward-level map and the Open-street map further focus on Valyangadi(Big Bazaar), Palayam, SM Street and Thekkepuram (Kuttichira) (Fig. 3).

Kozhikode city remained an important node on the international trade network till its port lost its prominence in maritime trade (with no good alternative in the natural harbor in Beypore). From then, city's commerce could not adapt or innovate to stay afloat. The business community in the city could clearly witness the gradual stagnation of the markets of this heritage port city and a fall in overall business activity. The latest threat was the coming of e-commerce giants and the unorganized retailers of the city found themselves most vulnerable. Despite being a

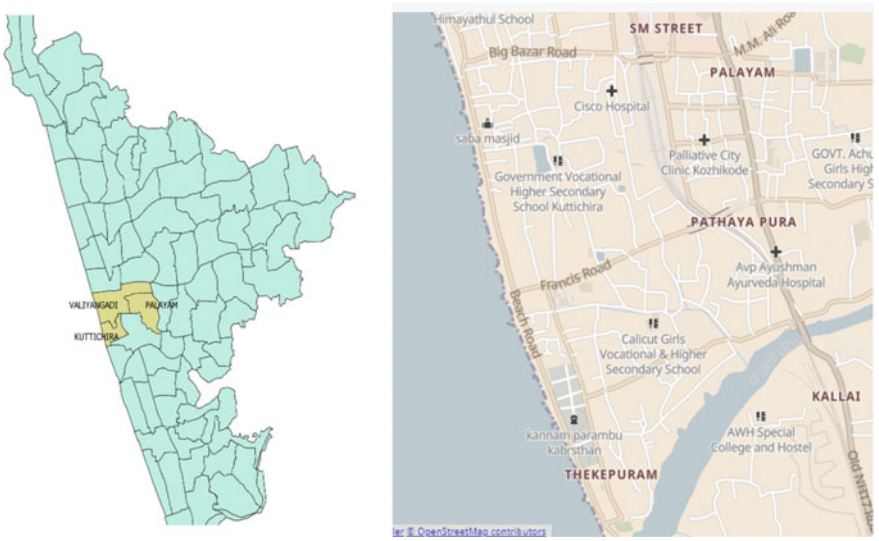

Fig. 3 (Left) Map indicating the location of Valyangadi, Palayam and Kuttichira in Kozhikode city ward-level map. (Right) Openstreet map focusing on Valyangadi(Big Bazaar)-its Pathayapura, Palayam, SM Street and Thekkepuram (Kuttichira) (Creative Commons Attribution-ShareAlike 2.0 licence (CC BY-SA 2.0).)

mid-tier city, Kozhikode city's commerce was trust based. According to a respondent, "in 1970s, everybody in the city knew each other". Like any urban market, the city's commerce depended on the local retail sellers till 2010s. Each retailer desisted from selling under-quality goods for the fear of loss of reputation. Informal social control ensured that a seller dreaded the possibility of a complaining customer at their door step. But when e-commerce started making inroads into the city with high internet penetration, the local retailer found footfalls in their shops drastically coming down. Targeted digital marketing and popularity of the e-commerce Apps had already hooked the local customer, especially in the younger age groups, onto the e-commerce platforms. Their offers, discounts and the festival seasons were more than enough for the online purchases from the leading e-commerce giants to skyrocket. Again, this phenomenon was observed in the cities and towns all over India. The local retailer vehemently fought back, albeit in vain, against the distortionary effects of the entry of e-commerce giants into their home markets. They alleged that there are multiple instances of buyers duped by low quality goods through these e-commerce platforms. Retailers mobilized themselves through their trade unions (quite active in the traditionally communist-inclined state) and frequently used anti-capitalist and anti-imperialist rhetoric against the largely foreign-based online platform businesses. They allege that these foreign firms have been gradually 'draining' Indian markets and usurping the surpluses of Indian consumers. In this onslaught of e-commerce giants, the local retailer finds himself pushed to the walls. What seems to be violated is an age-old economic truism. In the retail markets, the demand for the local retailers

have to be created by the local buyer. This would ensure that there is a local circular flow of money resulting in local economic development and creation of employment opportunities. The predatory growth of e-commerce giants has clearly jeopardized this and endangered local markets. Local based e-commerce does have certain clear-cut advantages over e-commerce giants. They can deliver in short time that multi-national e-commerce firms can't afford to do now. Customers can get any product related service from the seller. Sellers' trustworthiness is ensured. Thus hyperlocal e-commerce is a key to tomorrow's sustainable cities.

Kozhikode city is no exception. The associations of the local retailers from the Kozhikode city have woken up to this reality. One of the first responses came from the local industrialist and retailer with left leanings. The VKC's app, from a leading footwear retail brand, was one of the first such e-commerce responses from the city. VKC led by an active communist legislator and leading industrialist VKC Mammad Koya sensed the need to expand its retail business digitally way before the other local hyperlocal initiatives. But whether this was a rule or exception needs to be further probed into. Businesses in Calicut, according to the respondents, belong to three types. The traditional businessmen are happy with their existing business model, which is well-established and time tested for them, and find no reason to even consider the e-commerce route as an alternate expansion path. They are dogmatic to the extent that they believe that bringing in technology to their businesses would dilute the traditional modes of operating their businesses. There do exist few traditional merchants who are adaptable and are willing to bring in some innovation in the hereditary businesses. They view e-commerce as additional sources of revenue. Rest are the unorganized sellers which include small retailers, home-producers and others who are in constant search for finding buyers for their products. Most of the city's hyperlocal e-commerce initiatives target the latter two groups who are willing to partner with them. Kozhikode's response to e-commerce has been mixed in this fashion (Fig. 4).

4 The Hyperlocal E-Commerce Initiatives—Case Studies

4.1 Slash

Slash was one such initiative. With a vision to empower the local retailer, Slash App started out as a start-up of 6 youngsters who wanted to bring together the small retailers into a single platform. The business model of Slash is of info-mediational platform. Slash plans to enroll maximum small and medium retailers in the city into the platform on a nominal fee as low as Rs. 500. The retailers are trained to use the App's dashboard where the retailer list out all active offers and discounts on their products. A prospective buyer-user who browse through the interface of Slash could view all the products and associated offers of these retail outlets. The buyer-user makes an informed decision before the actual purchase and can proceed

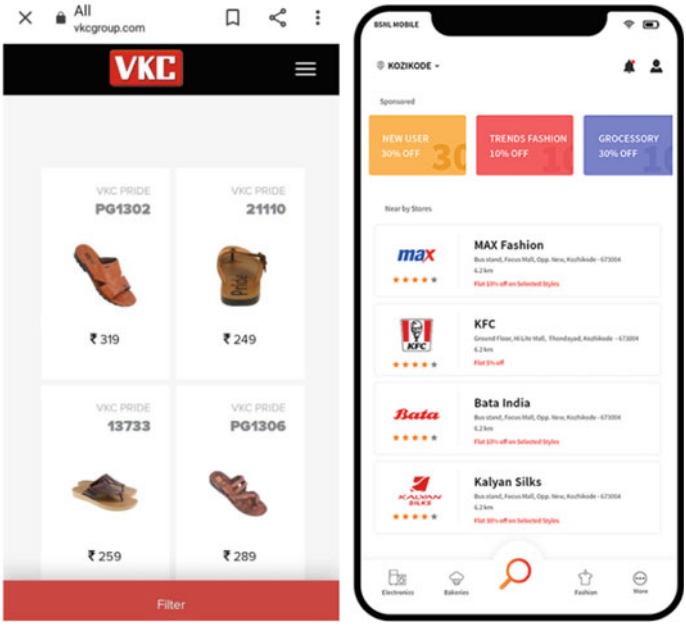

Fig. 4 Mobile applications (User interfaces mobile applications (Apps) of VKC and Slash)

to the physical store for making the sale. As a location based dealers listing app and deals listing app, Slash helps the buyer find the best deals for buyers and increases the store visits for the vendors on the platform. They have modeled themselves to grow in the future into a large loyalty/rewards program maintaining its focus on physical stores vendors. Slash thus becomes the app support for the local retailers to disseminate information on their prices and offers to the local buyers. The local buyer is thus encouraged to know the local market, its products, offers and discounts before checking out the online commerce platforms of the leading giants.

Slash makes the case for such an e-commerce initiative using the example of the furniture business in Kuttikatoor in the outskirts of Kozhikode city. This centuries old furniture business centred around Kuttikattoor can rightfully pitch for a Geographic Indicator status due to its reputation in Malabar. It is quite recognized that Kuttikattoor's furniture products have relatively lower prices and superior quality compared to major brands. But there are no avenues for these businesses to expand its business beyond the local clientele. Potential buyers who depend only on the interfaces of major e-commerce giants and are influenced by the targeted advertising by search engines and social media, misses the local commerce scene and the benefits of reliable markets such as Kuttikattoor. Slash, thus, claims itself to be a locally rooted e-commerce response to save the local businesses from these negative externalities of e-commerce.

4.2 Masalakada.Com

Masalakada.com is one of the early e-commerce ventures which emerged out of Valyangadi, the central business district of Kozhikode city. Masalakada.com had its origins in M/s Varish traders, a leading wholesaler based out of Valyangadi dealing in cereals, pulses and spices. Their dealer network extended all across Kerala and even to the neighboring states. Varish, the entrepreneur behind *Masalakada.com*, belongs to the trading community of Thekkepuram and descends from a trading lineage which was intricately linked to the wholesale markets in Valyangadi. Varish belong to a traditional merchant family in Kuttichira. They proudly introduce themselves as the household where the first ever income tax raid happened in erstwhile Malabar district in British India, thanks to their participation in the Quit India and Swadeshi movements. His ancestors were keen in creating their own 'Swadeshi' brands when Lever & Co. company largely dominated the branded retail space then and were also known for their own brands in common salt (Salt laws banned such attempts).

Masalakada.com places itself in the highly competitive Kozhikode market with retail groceries operating as hypermarkets or supermarkets, but the most popular form being low budget outlets. It was this rationale that made him think about an online commerce model for the retail expansion. But the flipside is that Masalakada.com, in spite of having sizeable number of app downloads, still continue getting frequent purchase requests via telephone and WhatsApp. Thus its e-commerce model finds itself ineffective due to the interface design issues. This failure in giving due importance to aspects related to the design of its interface and its digital platform has hampered the e-commerce platform. Despite his enthusiastic entrepreneurial efforts to expand his firm digitally, the entrepreneur underestimated these crucial investments required in the creation of an e-commerce platform.

Nevertheless, Varish does exploit his wholesaler advantage in propelling the growth of Masalakada.com. For an age-old wholesale seller like Varish ('Varish' and 'Imax Gold' are registered brand names), Masalakada.com is just a selling App. It is his wholesale background and his extensive supplies network makes it work. Also he makes the best use of the e-commerce platforms to overcome the wholesaler's disadvantage of the longer receivable collection periods, most of the sales being on credit and the apparent wrong market signals associated with a wholesaler moving to the retail segment. Masalakada.com claims to serve an estimated 8–10% of the grocery retail needs of the Kozhikode city. They plan to expand their business using a franchisee model. Masalakada.com remains an interesting case of an entrepreneurial innovation of a traditional wholesaler who caught on the early signs of digital adoption in the retail markets, despite the failures with the interface (Fig. 5).

Fig. 5 The advertisements of 'Masalakada.com'-(Left) Masalakada.com's own brands of Dry fruits claimed to be selling at prices lower than of Gulf(Middle East) and (Right) Masalakada.com selling bottled cow milk sourced from cattle farmers in and around Kozhikode city

4.3 FixSo

FixSo (Fixing Solutions) started out as an indigenous e-commerce platform functioning as a horizontal gig marketplace providing services categories such as home repairs and maintenance (on the lines of the Urban Company, erstwhile Urban-clap). The ideations started in 2017 and FixSo was launched in 2018 by four friends who have got diverse expertise but believe e-commerce's potential as a sustainable business. They started out as an app for the maintenance services and chose to start with Kochi city. FixSo found characteristics of metro city in Kochi and suitable for launching their e-commerce offering providing gig maintenance solutions, particularly for the city's non-native population. After having tasted success in Kochi, they decided to expand its services to their home city despite the apprehensions that Kozhikode is found to be very unattractive for their business when compared to other metro cities like Kochi, Bangalore, and Mumbai etc. The entrepreneurs behind FixSo had its origins in the traditional trading and commission agent families in Thekkepuram of Kozhikode with sentiments attached to the business heritage of the city.

FixSo offer their services under two heads—E-tailing and E-services. Their E-tailing segment is named *FixSo shommerce* which is the portmanteau word for shop and e-commerce. Both segments are online platform based businesses. Their maintenance services include electrical, plumbing, carpentry, painting, cleaning, home appliances service and installation and maintenance of electric appliances such as Air Conditioners, refrigerators, washing machine, microwave oven, water purifier, CCTV, TV, Solar panel and inverters. Their associated offering *FixSo daily* helps

clients with ironing, laundry, plucking coconuts and home cleaning, property services like home & office renovation, property management, facility management, E-tailing support and much more. *FixSo daily* even offers helping hand to the citizens of the city in connecting with their municipal ward representatives, thus playing their own part in the grass-root level city administration. In this manner, FixSo plans to rope in the elected councilors onto their platforms to attend to the civic requirements of the citizens of the city and to synchronize these activities. Fixso created a market which never existed but had a potential group of customers. Every urban customer face day to day issues such as getting an AC repaired on time or getting car repaired on site. FixSo connects customers with independent service providers (like carpenters, mechanics, plumbers, etc.) on its ecommerce platform and addresses these pain-points effectively and efficiently. And the independent service providers get regular demand for their services and are paid wages on a regular basis. It creates a hyper local empowerment.

It was when Fixso was dabbling with the expansion of Fixso Daily and e-services into the city that the entrepreneurs intricately linked with Kozhikode city's business history realized the undercurrents in the retail space of the city. Fixso found the local retailers helpless in fighting the e-commerce giants. The idea of FixSo Shommerce as their e-tailing support is built on this resolve to use the same technology (e-commerce) which threatens the existence of the local retailer in fighting the e-commerce giants. FixSo offers its resource base and expertise with online platform businesses for the local retailers to reach out to the local customer more effectively than before and face the unequal competition in the retail space. FixSo strongly believes that ecommerce giants should not be allowed to siphon off the remittances of the Middle East based expatriates, which dominates the demography of Kozhikode and Malappuram districts who have been historically supporting the retail markets of Kozhikode city and its businesses. They join them in their vision to empower the small and medium local retailers in holding onto their traditional customer base in Kozhikode city. Again what motivates is their belief that the local money should create demand for the local enterprises and sustain the local economy. But the serious limitation in their pursuit of this objective is that most of the key players in the city's retail markets are reluctant to change. They are myopic to the changes to the extent that they are unable to foresee the impending danger to their existence with the e-commerce giants and adversarial policy changes with regard to Foreign Direct Investment(FDI) and Foreign Institutional Investment(FII) in retail sector, not to speak about the major national conglomerates in multibrand retail tightening their grip and moving to the Tier II and Tier III markets. So FixSo plans to overcome this first hurdle by creating awareness among the retailers of the city about the need to leverage the e-commerce options. FixSo also aims to bring small and unorganized retailers and home based producers on board. They are currently targeting women entrepreneurs with home based production (Fig. 6).

Fixso Shommerce started its operations in early 2020 well before the Covid lock-down and onset of regulations on commerce. With its retailers based in the city, *Fixso Shommerce* assures delivery within 2 h. Most of the retailers listed on the App are from the SM Street (Sweet Meet Street) who faced a stalemate when the city

Fig. 6 (Left) SM Street, the heritage retail street in Kozhikode and (Right) Flyer of ***FixSo Shommerce*** which brings online retailers in the SM Street online (*Source* https://images.app.goo.gl/86ApAGFurjtVPM4R6)

corporation council decided to convert the street to a Walking Street thus affecting the business. For a city whose citizens hardly walk and depend on motorized vehicles for even short trips, the regulation was a serious blow to the sellers on its heritage street. This ban on vehicles into SM Street was based on the arguments of havoc caused by moving vehicles (on the line of bans on commercial streets such as Sarojini Market in New Delhi). City merchants lobbied against the ban voicing their dissent through the opposition members in the corporation council. SM Street retailers and their association backed the App after the ban. Apparently the retailer association was approached by another e-commerce firm earlier. But the deliberations did not progress as the builders of the App were new to the city. The mutual symbiotic association of Fixso and the SM Street retailers which led to Fixso Shommerce was founded on the ties and acquaintances among the entrepreneurs and most of retailers who knew each other for generations. The walking street regulation also created a sense of urgency among the retailers who were initially hesitant to adopt e-commerce. Now FixSo plans to bring the whole SM Street on to e-commerce platform as a part of *'shommerce'*. Fixso is founded on the local Kozhikodan ethos of mutual support and solidarity and envisages to use in the favor of the local retailer against the threat of the e-commerce giants annihilating their livelihoods.

4.4 Potafo

Potafo is an online food ordering and delivery platform based out of Kozhikode which started operating from 2017 May in the Kozhikode urban agglomeration.

They named themselves after the French beef stew 'Pot-au-feu'. Potafo envisions to be a Super-App and expanded itself to online grocery delivery service through Potafo Mart and plans to enter the horizontal gig marketplace through the Potafo assist. Its expansion plans also include Potafo Caterers wherein individuals can make party/bulk orders for events and this step is supposed to increase the revenue for restaurants on their clientele. Potafo was founded by four student-turned entrepreneur friends who built their start-up idea on the lines of Uber eats and Swiggy while exploring the possibilities offered by the food culture of Kozhikode which is often termed as the food capital of Kerala. When it started out, residents of the city were not yet introduced to the digital platforms. Choosing the right user interface for the Mobile Application was an initial challenge and Potafo chose to go for a minimum viable product—a basic mobile App model and Cash-On-Delivery (COD) mode. The second challenge was convincing restaurants to partner with the e-commerce platform. The leading restaurants of the city were quick to join as they found a new avenue of revenue in this and the contracts were on commission basis. This simplified its marketing challenges.

But the response from the customers was very low in initial days, given the formidable marketing costs to introduce a relatively new platform to a city unused to such apps. But again Kozhikode's ethos helped Potafo in this struggling stage. There was already a customer segment who regularly ordered food from select restaurants (whose contacts were listed in the internet search engines or their websites or social media site pages). Potafo tapped into this segment. These restaurants helped Potafo in getting them these customers onboard and they were keen to sign up on the App. Initially entrepreneurs themselves got to the ground and dealt order handling and delivery directly, so as to set the startup on track. One of the major e-commerce food delivery giants entered the city in 2018, but Potafo stayed afloat. Potafo believes that restaurants would eventually find partnering with these major players as less profitable as they push too much of deep offers and demand higher commissions thus driving the restaurants to losses in long run. Potafo focusses on maintaining the cart size, charges only reasonable commissions from their exclusive (the leading ones) and non-exclusive restaurants and stays away from deep offers. Potafo is planning to increase their footprints and would be expanding to seven cities of Kerala.

As a hyperlocal player, Potafo wants to develop an informal relationship with restaurants. They insist on quick and mostly personalized response to customer queries and every customer query is directed to call center executives to avoid hassles of chat-bots. Currently they have around 400 restaurants of the city and 1,20,000 users in their network. An anecdotal evidence for their rapport relationships with the restaurant-partners emerged during the Covid-19 national lockdown and quarantines. The city and district administration entrusted Potafo for online food delivery within the city during the period, heeding to the recommendation from the umbrella association of restaurants—Kerala Hotels and Restaurants association. This has led to its considerable take up in Kozhikode due to COVID-19. Testifying to the Kozhikodan ethos and solidarity, the associations and restaurants decided to chose the local e-commerce platform over the more endowed major players with significant initial offers. Potafo has grown into a Private Limited Company from an LLP. It is hesitant

Fig. 7 Potafo's online food delivery app

towards a franchising model as they want to stick to their core organizational goals of retaining a human touch in their customer interactions and providing additional revenue options for the restaurants. They don't fear the entry of bigger players into their city because they find more chances to learn and grow (Fig. 7).

5 The Business Models

E-commerce initiatives are, in general, platform business models offering three kinds of intermediation—matching platforms, transaction platforms, and info-mediation platforms [9]. The four hyperlocal e-commerce initiatives from Kozhikode, under study, are either a transaction platform or an info-mediation platform or a mix of both. Slash and FixSo are info-mediation platforms (like Justdial). These platform businesses gather a database of information about one side of sellers and provides it to the other side. Any info-mediation platform thrives upon the interactions between the two sides of the markets, information providers and the information seekers. Slash and FixSo started getting small and medium business(es) (SMBs) on their platforms by listing them on a nominal charge (or sometimes free of charge) with the promise of augmenting their customer bases. Potafo and FixSo aim to be the

Super-Apps and have characteristics of both info-mediation and transaction platforms. And for these hyperlocal e-commerce platforms, the local businesses and the search users make up the two sides. The more the number of search users on the platforms, the more the number of local businesses would be willing to associate with and pay for the platform. Similarly, the more the number of local businesses on the platform, the more the users willing to search on these Apps to get comprehensive results. Potafo leverages by charging them for premium listings—what they call as exclusive restaurants in their parlance. Slash and Fixso aims to be comprehensive info-mediation platforms offering information on a wide range of services and products [10]. Potafo and Fixso, in its resolve to be Super Apps, believe that local businesses won't be requiring more than one App for their online presence. They want to assure that they would not have to pay additional subscription fee for other such platforms and there won't be no multi-homing costs for the buyer side [8]. Fixso and Potafo has most of the characteristics of a *transaction platform which* facilitates transactions between two sides of the platform, e.g., the buyers and the sellers. They connect the provider of a product/service to the consumer of said product/service. A good example of a transaction platform is FixSo, where households can find independent service providers relevant to all kinds of house maintenance requirements and book appointments. with them on the platform. A transaction platform needs to have acquired a database of one side, i.e., service providers which should be valued by the other side [9].

6 Conclusions

Electronic Commerce has made rapid inroads into even deeper pockets of the Indian markets, thanks to the advancements in logistics, infrastructure and technology. The new 'digital markets' have different mechanisms of price discovery, patterns of competition and types of intermediation when compared to the conventional markets. Intense competitive rivalries among the e-commerce giants have led to substantial gains for the customer and in reducing search costs for both buyers and sellers. The current research focuses on one particular externality of these competitive online commerce markets—its impact on the local retailer in the cities and their coping strategies. Focusing on a south Indian Tier-II city, we see how the local retailer feels the heat of the growth of e-tailing and intense competition in the e-commerce market. We also see how the local initiatives harness the internet/mobile based technology and mobilize the solidarity and the empathy for the 'local' of the local retailer and the buyer. We understand these underlying patterns through the elaborate case-studies of four 'local' e-commerce initiatives from the Kozhikode city, namely, *Masalakada.com*, *Fixso shommerce*, *Potafo* and *Slash*. These indigenous e-commerce platforms arose as 'hyperlocal' entrepreneurial efforts of individuals from the Kozhikode city most of whom belong to the lineage of the traditional trading communities in this erstwhile vibrant port-city on the Western coast. They were directly or indirectly affected by the onslaught of online commerce and they

believed in the viability of a hyperlocal initiative in these markets despite the presence of global giants. Their entrepreneurial journeys are eventful with their learning experiences and struggles to adapt and survive while facing hurdles such as the non-existence of markets and the need to create a new market for their venture to operate and the predatory onslaught of the national and global players to the same markets. Their experiences testify that it is not always 'advantage global'. There is still room for smaller 'hyperlocal' players from the city in the emerging digital markets and they would play a pivotal role in the 'smartening' of the city bottom-up. In cities where commerce thrived for centuries owing to centuries old trust and informal social control, 'hyperlocal' e-commerce platforms are here to stay.

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Territorial Intelligence Project: Governance for Megalopolis Urban-Rural Linkage Pattern: Comparative Study Between Po River Valley Megalopolis Region, Italy & Chennai and Kolkata, India

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Abstract Megalopolis or Mega-city is a new scale that should not be defined by population numbers. We are in a new dimension, a new DNA. In the context of Megalopolis and regions where the scale of the urbanization goes beyond the traditional definition of a Metropolis, defining an effective governance structure and strategies is a challenging yet fundamental goal. Information technology plays a vital role in

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building the global Megalopolis, as the virtual infrastructure and data allow a city to be strategic at the international scale while advancing inhabitants' daily life at the local scale. In this chapter we attempt to define the governance strategies in the mega global cities in two steps: first, to trace the dynamics between the various stakeholders in the mega-project that is often complex and less hierarchical and provide a framework where the genome of a Metropolis is evident. The second step emphasizes the importance of the direct relationship between the governance structure and the territorial contexts and intelligences.

Keywords Megalopolis · Cartography · Smart city · Metropolitan Milanese area · Governance

I. Megalopolis

Megalopolis is a crucial word and the concepts related to it were defined by Gottmann in 1961 in the book: Megalopolis: the urbanised North-eastern Seaboard of the United States.

In the coming years, several scholars such as J. Jacobs 1961, The Death and Life of Great American Cities, K. Lynch, 1964 The view from the road, R. Venturi 1972, Learning from Las Vegas: The Forgotten Symbolism of Architectural Form, and finally K. Frampton 1999, Megaform as Urban Landscape, formulated a theoretical criticism to the immeasurable growth model which was unable to produce urbanity. At that time, a new set of methodological rules, interpretative hypothesis, explanatory models, and defined practices took place that initiated a revolutionary breakdown facing the rise of a generic city.

In today's context, we would like to frame the Megalopolitan issues as something that is much more linked to the need for a shared vision regarding today's infrastructural, mega trans-national and regional projects. Nevertheless, these projects due to the lack of a metropolitan and megalopolitan political culture are usually defined by following the management rules which deal with the geopolitical needs and the needs of global companies only, thereby ignoring the participation from local communities.

II. EU Mega-region and Data

The national quantitative figures alone, are incapable of depicting the whole and complex picture of what is happening at a more detailed level, especially in the European Union. This incapability of quantitative data constitutes to be one of the major reasons behind why Metropolises can never be defined by population numbers alone.

In this regard, statistical information at a subnational level is an essential tool for highlighting specific regional and territorial aspects (NUT Region). It helps in analysing the changing patterns and the impacts that policy decisions can have on

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the daily life of citizens. In order to provide a detailed picture of the diverse EU territories and to monitor EU regional policy targets, Eurostat has developed a range of statistics based on different classifications and typologies. These include data for regions, cities and greater cities, metropolitan regions, rural areas and regions. Specific geographies such as coastal regions, mountain regions, border regions or island regions are also covered [1].

For the EU, 'NUTS' stands for Nomenclature of Territorial Units for Statistics. EU is categorised in:

NUTS 1: 3–7 million

NUTS 2: 800,000–3 million

NUTS 3: 150,000–800,000

North-West Italy falls under NUT 1, Lombardy Region in NUT2 and the Milan Province NUT3.

The European Union (Eurostat and EC-DG Region), in collaboration with the OECD, has developed a harmonised definition of urban areas as functional economic units, in order to overcome the previous administrative limitations and build functional urban areas. This vision, linked to economic areas and functional areas, although closely linked to a geography as the main element for the definition of a mega European region, remains the fundamental one.

We think that it is sensible to state that neither the Metropolis nor the Megalopolis can be conceived as the fulfilment of a new hierarchy between cities following a pure quantitative datum.

Metropolis and Megalopolis are not the results of a dual paradigm that extracts, from the induced void of intermediate territories, the metropolitan entity and the idea of functional macro-regions. The paradigm thus risks having totalising connotations [2].

It erases the differences between habitats; homogenises and unifies the cities, by making them interchangeable, thereby moving in the direction which is difficult for the survival of the human being on the planet. In one sense, we are dealing only with the asphyxiated horizon of the Metropolises and mega-regions that, unlike the Greek poleis and Renaissance cities, have expelled from their urban space both the animal life of the oikos and the political life of the agora. Today, Metropolis and Megalopolis are nothing more than the space of alienated production and consumption in which oikos and agora disappear and become confused [2].

This opens the discussion on whether the democracy can be exercised and whether a political culture on the mega scale is possible. Where the relationship between those who are ruling and those who are getting ruled is physically closer, it becomes possible to erode the verticality of Governance by conditioning political power with control from bottom or even self-government from bottom. Bookchin distinguished statehood, within which individuals have little influence on political issues given the limits of representative government, from politics where citizens have direct and participatory control over their governments and municipalities.

The Po Valley is made up of a network of towns (a considerable thickening of small and large towns, where the density of inhabitants is higher than the average of the megalopolitan region). The demographic dimension alone (we do not reach

Gottmann's 25 million inhabitants) in a territory like the Po Valley is not entirely relevant. On the contrary, it can even become secondary, considering the level of economic interconnection (in addition to labour issues, linked to commuting, made evident by the number of industrial districts concentrated in the area–70 out of 141 in Italy as of 2011, with unparalleled density also in Europe), infrastructural (it is one of the most highly infrastructural areas in southern Europe, with 9 airports in a few km, including the technological networks of the future, such as fibre) and social (supported by the wide variety in land use, population, occupations and interests), but also environmental, landscape, ecological and biological [3]. Moreover, according to urban geography, a Megalopolis concentrates, on a small area, at least one fifth of the population of its own country. The area of the Po plain concentrates 22,000,000 inhabitants, 36% in Italy, for 47,820 km, 15.83% of the national surface area, for about 460 ab/skm, much more than the 250 planned for the Megalopolis.

III. A thought on the global governance dimension of Megalopolis

Generally, the issue of governance of Megalopolis cannot be solved by nation alone within which it is located. The solutions depend on several factors beyond the nation and Megalopolis as the megaregions change organically with their context (physical, social, economic, cultural). Governance must not be limited to following the spirit of the times. Rather, it must anticipate it, like a visionary who promotes forms of life beyond the future.

In Europe, Transnational metro-regions are dealing with transnational megaprojects. To be able to manage them in a shared way, first thing that might be necessary is to create a transnational confederation (like the Hanseatic league from the Renaissance). Even before the requirement of being a single administrative union, the EU would have become the United States of Europe [4]. Nevertheless, we can start dealing with an agreement regarding the management of shared megaprojects but beyond a severe cultural, political debate regarding the European shared values.

Before theorising on the legal instruments which can regulate the relations between the megaregions and their national States, it is, therefore, necessary to approach the problem from a semantic point of view.

There are different ideas of subjects involved: the megaregions, the different states, but also the cities interested in the construction of the mega infrastructure and the local territories on which the work has an impact. Thus, there are different roles played by different actors. Hence, there are also different visions of subjectivity, different processes and different result indicators. Here, we deal with a structuralist vision of an essentialist type and a pragmatic vision of a performative type. In the first case, especially at the metropolitan scale, the administrations must interpret the essential characteristics of its territory even when it is not aware of it as it is completely immersed in a social, territorial context that changes it with expectations. They prefer to look at what always remains the same rather than at what changes. In the second case, on the other hand, no structure always remains the same concerning changing secondary characters.

IV. Governance and Management

Every metropolitan city needs a tool to help politicians define objectives based on SDGs and their impact indicators in order to be able to make decisions at the scale of the megaregion. We will have global and local goals that must find a sustainable balance to transform the vertical colonial Governance to parallel and globally good Governance. That is the challenge of Megalopolis governance; we propose to start finding an agreement regarding the management of the transnational territorial projects.

The agreement between such different actors with different competences does not require a ready recipe, but a time for dialogue and observation, in the first phase of agreement between Metropolises that are part of mega transnational regions. The agreement is built on the opportunity to have common result indicators: what kind of common result indicators (IR) do we want to achieve?

We start from the analysis of the constraints on which result indicators depend for those who manage a process on a global scale according to a geopolitical strategy and must be able to measure if they have done their job well in social (quality of life), economic (budget), governance, physical space. (Qualitative Indicators, instead, are measured according to the concept of on-off).

There are also result indicators for the beneficiaries (Citizens) of the local territories. They must be consistent with the IR of the global goals because the global and local projects must coincide. That is a process, and obviously, it is necessary to establish who is responsible for making the decisions and at which political level, because not everything is shared.

There are also process indicators (IP) more related to the management of the organisation of large transnational projects.

These are the indicators that go in parallel with the result indicators and are the first ones to tell whether the path followed is correct or not. However, first, what must be shared politically, is the same values that must be recognised and shared at different scales. The question to ask then will be related to what kind of critical processes to produce to build this value (a sustainable project) and in how long and short time.

Therefore, regarding the transnational project, when the focus of economic and political power is evidently on one side, the importance of participation and consensus is as much as the project itself. Many topics require different groups of stakeholders due to the very nature of the subject. Moreover, Governance cannot be separated from management. For example, water governance is a sensitive and challenging issue around the world where there is freshwater scarcity, and the infrastructure inadequacy for serving the growing population. Many Metropolises have water authorities that control the quality and quantity of water. However, in practice, it became an issue because the water authority does not define the land use around the watershed–the same at the Global scale. Due to the green, blue and grey infrastructure continuity, an international agreement on water management and protection is required. Flexibility and cooperation in dealing with such an issue are mandatory, advancing from the current situation of working in silos.

In our methodology, therefore, we try to address the issue of Governance by creating a stakeholder map that reflects the core value and the issue of the subject matter and balances the participation amongst the local and global metropolitan actors, and the metropolitan experts. The stakeholders bring the relevant topics on the table to discuss following the Metropolitan Metro-dology [5] and provide a strong case for the matter. However, the decision-making of a metropolitan project is always done at the political level.

V. Physical territory towards territoriality with international common laws

Many Metropolises and Megalopolis lie outside the nations where the Megalopolis is located. However, to deal with this phenomenon, so that the physical territory becomes territoriality with common laws internationally, requires a cultural leap in scale, even before the legal framework.

The phenomenon of the contemporary Metropolis, however, differs from the modern industrial *big city*. The unrestricted urban growth we are experiencing presently, has exceeded the timeframe of planning. Moreover, the main drivers of urban development in the past two centuries were not the physical shape of the city but external logics such as economic models, political agenda, and technological optimisation. These growth models focusing on the efficiency of growth demonstrated their limits in addressing the quality of the well-being of the citizens. The existing urbanised spaces have not been able to accommodate the incoming population and unplanned occupancy in areas. For example, the main water basins that serve the entire city and flood-prone area become a risk for all inhabitants, only exacerbated by the effect of global climate change. The colonial past has cast long shadows over many of the developing countries to struggle with not only the physical, social, and economic difficulties but also with the cultural identity of the population. Moreover, the prevailing inequality has only escalated the conflict amongst groups of people.

These backgrounds of extreme urbanisation leave us with a big question of how to deal with the metropolitan complexity to realise the goal of sustainable growth to reach the well-being of the population in the post-colonial, Anthropocene era. These issues cannot be addressed with a single, static, and traditional disciplinary approach, but need a comprehensive and multidisciplinary vision to understand them [5].

The Metropolis and Megalopolis thus must be conceived as trans-scalar arenas. It is necessary claiming for a link among local processes and necessity of inter-metropolitan cooperation, hollowing out of the state and interstate coordination. Global issues, global competitiveness must be balanced within local goals looking for territorial cohesion.

However, we must investigate whether Megalopolises are also an arena of collective actors, like the Metropolises. Since the Metropolis is conceived as multiple actions arena, newly emerging spatial actors at metropolitan scale arise. Investigating if Megalopolis can advocate the metropolitan collective actors such as enterprises that need a frame defining a possible direct relationship within the different National State authorities, could be the theoretical effort.

VI. Megalopolis territory as an intelligent global territory

The Megalopolis as a space of innovation in public policies and citizenship is meant to deal with citizenships and rights. Hence, in the context of Megalopolis, addressing the questions on climate change, natural hazard and emerging policy, demands for social innovation as answers to new policy and public goods demands.

These are the principles that critically introduce a discussion on the main institutional settings responsible for Megalopolis government, in a public policy perspective with the aim at describing some relevant policy tools. In the fast changing urban and metropolitan environments which characterise the contemporary age, the roles that government institutions play in planning and policymaking varies significantly according to several variables (political, legal, administrative context, urban dimension, sectorial vs cross-sectorial approach). Through literature overview and primarily through case study introduction and discussion, it is mandatory to define the competences and skills needed for analysing the institutional environment, in which the Mega trans-regional project experts operate to identify the main actors and policy networks. This approach is needed for being able to use a variety of policy tools, choosing the most appropriate ones according to the context and the role of different actors, in particular government and non-government institutes.

Every institutional and Governance arrangement rises into different legal and administrative systems at global level. Hence, we would like to analyse the basic principles and to enable Mega Project Experts to reflect about the most common institutional settings and policy mechanisms that deal with the metropolitan dimension.

We think that it is mandatory to analyse the legal, administrative and planning systems from an international perspective, introducing the most relevant principles and differences, identifying actors and policy networks at the global and metropolitan level, the local institutions and policy tools (activation, orchestration, modulation). The law can establish the responsibilities of a possible Megaregion administrative level. The principle applied in the law (EU and USA) is that of subsidiarity. It is the principle that social and political issues should be dealt with at the most immediate (or local) level that is consistent with their resolution. Anyone who has to perform the service of defining the sustainability requirements for the trans-regional mega project can be assigned by law to a supra-metropolitan authority.

VII. The Megalopolis D.N.A

We do not have yet an acceptable standard definition of Megalopolis.[1] As we have discussed above, size or the population of megalopolis is not the right approach to define it. Consequently, it is difficult to make the list of those multi-metropolitan groups that will pass the definition and can be incorporated to the list of Megapolises.

Actual standard definition of Megapolis is based on the concept of ‘very large cities’ and thus defined by population size. The size adopted is the 10-million threshold. 47 cities across the globe comply with this figure. The last one is Lima,

[1]Megalopolis and Megapolis are equivalent terms. Many authors use Megalopolis. As in mathematics and Linguistics, the shorter, the more elegant.

which is actually a Metropolis, and not a Megapolis. If the categorization is not supposed to be based on size but on structure, it is possible to reduce the number of these cities to a range of 25–30. This is the number that could form a practical group for horizontal exchange and experience sharing.

VIII. The Governance Challenges

In the management of Metropolises and megalopolises the need for coordination, for complex responses to complex problems is necessary. The problems of the Metropolis are not the addition of the problems of the municipalities. The problems of the megapolises are not the aggregation of the problems of the Metropolises. They might have a municipal effect, like the symptoms in a disease. But it is not from healing the symptoms that we are going to address the disease. Metropolitan problems must be addressed in a comprehensive approach at the metropolitan level, and not by the summation of municipal policies.

Megapolises as Metropolises, in the territorial-physical realm, apart from the economic, social or institutional one, have 5 sectors: Environment, Transport, Housing, Productive-activities and Social-facilities. Each of these sectors are a system within and should be addressed at a metropolitan level. The location of economic activities or large metropolitan facilities has an influence on all the municipalities in the Metropolis although they might be in one specific municipality. It is not a municipal issue. It is a metropolitan issue.

Among these five sectors, two of them are continuous systems. They are, namely, the Environmental one (Green Infrastructure) and the Transport one (Grey Infrastructure). The other three sectors are discontinuous systems. By continuous systems, we mean the systems which have the physical assets linked continuously. We cannot have a discontinuous train track, or we cannot, on arrival to the intermodal station have the connection with the other modes of transport of a more urban scale as metro, BRT, buses, bicycles, etc. The parks and protected areas must be linked as well to allow the biodiversity transfer. Due to the scarcity of the resources and the climate change issues the continuity of the green/blue infrastructure must be secured. The green/blue systems are obviously metropolitan and not municipal or urban. We cannot have a river clean just in a municipality if it is polluted upstream. Even if we can, we should not have the burden of pollution externalities produced by others. The same is for the water management and the land uses: we need a share vision at all scales. Hence, a higher-level institution, that will enforce a comprehensive policy for the Metropolis is necessary.

So, we need a metropolitan institution that will address at least environmental and transport issues. The same reasoning has to be made for the three other dis-continuous systems, systems altogether, but we are not going to go into it. The argument is set up. Thus, we could argue for the economy; on economic terms, the single market the Metropolis is built on, and takes its strength from, as it is the result and one that benefits from the agglomeration phenomena. Nevertheless, we can argue on the Social component even if social exclusion works hard to seclude the lower-income groups in the worst located municipalities-no need to mention the institutional setup (Fig. 1).

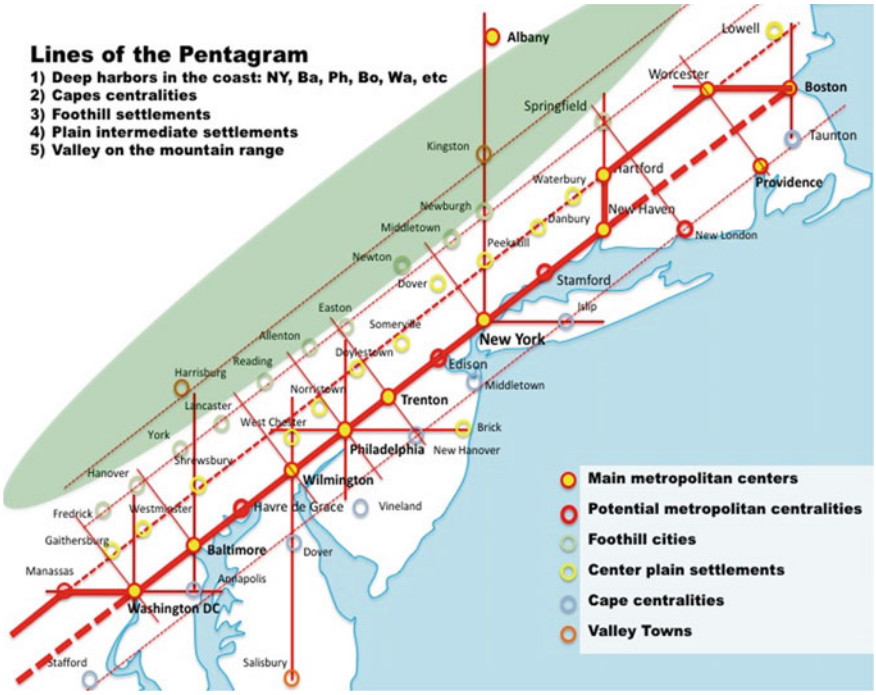

Fig. 1 Mega-York metro-matrix structure *Credit* P. Ortiz

IX. Megalopolis Governance: New scale, new challenge, cautious solutions

The phenomenon of Megalopolises is however a new scale detected already in the 60's, but that goes beyond Metropolises. A scale and that we have not yet addressed, nor comprehensively understood.

Megalopolises are defined not by numbers, but by their inner structure, their DNA. Megalopolises are sets of interactive Metropolises. Just the way Metropolises are sets of interactive cities. Megalopolises are not Metropolises over 10 million inhabitants, as Metropolises can neither be defined by population numbers. Metropolises are not conurbations as the conurbation phenomenon is a metastasis of unmanaged urban expansions.

X. The recent Beijing Megalopolis

We are looking at a new DNA and not just in a new dimension. Mega-York runs from Washington DC to Boston incorporating several Metropolises within its system. Delhi Megalopolis (Mega-Delhi) runs from Meerut to Rewari and from Rohtak to Aligarh, if not Agra. Probably in the future we will have to address the Delhi-Mumbai Megalopolis (now just call it a Corridor), including Jaipur, Udaipur, Ahmedabad and Surat among others. Beijing is another good example, where Chinese authorities have already defined a Megalopolitan area of 250 million inhabitants.

XI. Confederations, national or transnational

Metropolitan and Megalopolitan governance structures need to be distinguished from the municipal or regional structure due to the decentralization of power. Each institution involved in the decision-making process has its own legitimation, its own assignation of competences. This condition requires the governance structure to be horizontal and interrelated, rather than vertical and hierarchical. A matrix system of the stakeholders of the metropolitan genome allows a more democratic dialogue where each actor can express one's concern and negotiate to achieve a common goal.

Can megalopolises, a set of Metropolises, address their governance systems in the same framework of Metropolises or nations? Can they look for a solution on the frame of the three alternatives of Unitary, Federal or Confederal structures applicable to nations and Metropolises?

A Unitary system would be impossible, and inadvisable, as the metropolitan system is already a federal one, and it would be incompatible. A Federal system of a higher magnitude integrating the federal systems of the Metropolises could be conceptually envisaged. It would be the subtle extrapolation of the subsidiarity principle already applied in the European Union and the USA for their institutional inter-government management of tiers and competence's assignment.

A safe first step to Megalopolitan governance, instead, would be a Confederal system, where the diverse Metropolises that on joining will keep their own sovereignty within their own federal system. A confederation is a very loose system approach that we already know it does not work for Metropolises, but it is the first step that can give time and room to think about what the best would be, in the long term, for megalopolitan governance.

A Transnational Confederation of cities already has existed in history and it worked relatively well in for a 300-year span. The Confederation of Metropolises in a Megalopolis does not confront, nor jeopardizes, the national existence. That will just provide a framework to address megalopolitan issues now unaddressed, and the time to build the metropolitan federal system in view of what would be the best for megalopolises to address their institutional governance in the long term, in 40 years' time.

XII. Introduction: A Comprehensive Approach towards the Megalopolis governance, management, and new ICT tools

Starting from the Metropolitan and Megalopolitan concern as background, the chapter aims to investigate not only on governance as an architecture of relations between different institutions but also preferers to aim at a description of a method of regional governance that can structure context-based practices.

Governance cannot be separated from the vast and diverse territory that a Megalopolis stretches over. One of the challenges of overcoming contemporary urban issues is to overcome the dichotomy of urban and rural. The arbitrary division, based on little evidence, does not consider the reality of endless fluxes of people and goods, yet impact the lives of inhabitants in various levels [6]. Based on the general acceptance, in both theoretical and practical circles, the urbanization takes diverse form in

different contexts, in a rather dispersed manner [7] and that it could be considered as a net-city of various scales of urban centres [8] the governance strategies on the territory recognize and reflect the urban-rural continuum. Therefore, it is essential to recognize both the material and immaterial values of territory and develop tools that allow the territorial actors to elaborate, to manage and to evaluate partnership and participative projects of territories' sustainable development at all scales. What kind of governance strategies do we need for a smart territory?

In particular, the chapter analyses the relationship between Lombardy and Po River Valley water system Governance and territory.

For this reason, the final comparison with the Indian desakota region is relevant for us. Moreover, what we wanted to highlight is the position. By now, all European cities are moving towards the concept of Smart City. Our region has always built its wealth from the effective management of its waters. Management entrusted to a very refined technique used by industry since the 18th century. We can say that through this technique, an agreement was signed between the territory and its manufacturing and agricultural production realities. It was an intelligent territory.

Today, to manage the complexity of the Metropolis, we no longer rely only on technique, but on technology too. Nevertheless, firm in our tradition, even now, technology must be located and adapted to the territory. That is why we have presented an example of metropolitan cartography that works with open-source data. This intelligent and cognitive approach to complexity is fundamental for the interpretation and enhancement of the intelligence of a tricky territory. Then, we present a system of mapping through big-data, necessary for the definition of the size of metropolitan cities and Megalopolises (linked more to virtual than physical relations), as well as needed to make the territory more porous through the identification of its values. That is our Smart City Approach to develop key factors stimulating the growth of Italian desakota regions during the urbanization process.

Regarding the architectural and urban disciplines, the question about the relationship between science and technology arose through the distinction between the conscience of the engineer and the conscience of the architect. The problem of technology is, therefore, to identify an existing thought with an evolving thought, that is, the relative to the absolute. In this context, the recovery of Banham's thought on the value of the technological image is fundamental in order to overcome the problem–increasingly felt in architectural culture of the division between technological innovation and the development of the architectural and city organisms.

Substantial cultural changes are never easy [9]. If in the last century the theme of fundamental research concerning the city was condensed in the statement the need of finding the correct measure, today, defining the correct distance from technology seems to represent the most remarkable perspective of investigation. The value of the city project that meets technology, especially the information and communication technology (ICT), lies in the purpose that technology itself allows the subject to set. Technology can be conditioning, in the sense that Technology appropriates the subject or instead it can be acted by the subject, when it strengthens the awareness as a citizen, in the case of its utilization in the city context. Only in this case does

technology become fundamental to the implementation of the development trajectory of the subject, and in this lies its value.

The chapter investigates the relationship between the bigness of the Metropolis and Megalopolis dimension and the concept of smartness. Several elements are always present when showing it: increase in quality of life increase for citizens, investments in human capital, social development and physical assets, usually in a blend of public and private initiatives, key role of Information and Communications Technology, and more effective and efficient use of available resources. But how can we be sure to develop a Metropolis or a Megalopolis based on actual citizens' lifestyles and not only a city underpinned by advanced technology-based infrastructure?

We are interested in the setting of those operations which let us define the public and common realm as a more porous space, through the making of a layer, that we used to call Meta-city [8], at the scale of Metropolis and Megalopolis.

Our attempt is to explore the integration of ICT into urban and architectural discipline. The dimension of the Meta-city is necessary to recognize urban space in the bigness dimension as a desirable object from far away and as appropriation field from nearby. Then, the urban space will be no more used according to the relationship housing/factory, as radical theme of the city, but concerning its substitution with a relationship with the public/communication space theme in real time. The consequences will influence:

– economic and social aspects; institutional aspects;
– research of the consensus;
– local and global values and their influence on the citizenship concept itself.

XIII. Megalopolis Governance 4.0. Systemic Approaches and Solutions

XIII.I. The Mega-project Transnational Role as condition for the Megalopolis Governance need

The project of a new open-data and big-data cartography is a basic instrument to achieve a systematic approach for the development of related mega-projects of a Megalopolis. It is a cognitive structure, which gives real reading and appropriation capability to the people interacting with spaces, even those dealing at the scale of the metropolitan region creating new codes of visibility.

The issue is to create a new imaginary model for the matrix of the territory's elements at the Metropolitan and Megalopolitan scale. Different maps are created where every final draft is brief and integrated, as it tries to show at the same time the different information pointed out from the analysis, focusing on possible links and connections; and it is dynamic, as these maps are the representation of a metropolitan mega process showing landscape mutations over time due to the Mega-project's impact.

Metropolitan Cartography Protocol Maps are the tools to conceive the conditions for the Metropolitan and Megalopolitan Governance. At the extra-Large scale, a Protocol map bounding box must be established considering the trans-national metropolitan boundaries relations necessary to enlighten the Metropolis' role within

the international arena. Nevertheless, Transnational relations are crucial, framing the geo-political scenario for Megaproject planning.

Nevertheless, the aim is also to support the top-down, but also bottom-up governance forms. Influencing a decision-making process is more suitable for environmental protection and transparency allows a participatory planning approach to engaging the local communities in the comprehension of the benefit of a Megaproject even at the local scale. To avoid the alienation that a so-called incommensurable project could determine on the local inhabitant population [10].

Changing our way of looking at cities becomes the medium by which we reconsider our relationship with the territory and our habits. It becomes a tool to evaluate the city, speculating its extension beyond the administrative boundaries and shaping the invisible dynamics that steer it, in order to draw draft considerations regarding its commitment to protect biodiversity and human rights. Moreover, in opposition to the usual indicator-based analysis, the research answers to the need of spatialization that is systematic in contemporary city's issues, raising a deeper level of awareness through an efficient medium: the map, which becomes the catalyst of analytical and communicative purposes.

XIII.II. Approaches and Solutions to Megalopolis Smart City Model

Starting from the typo-morphological and the landscape reading of the context, the issue of representation can be introduced as a community visualization instrument, and bottom-up governance participatory activity which involves media and aims at the symbolic construction of another space inside the city.

Our aim is to create learning, interpretative, interactive, and experimental instruments through the identification of an apparatus, which collects spatial data from the urban context and simultaneously returns information in crossing scales. Our attempt is to demonstrate that the most important mapping 4.0 value and its smartness is to allow citizens to localize a place to be able to relate it with their own life. Therefore, ubiquity is no longer the most important value associated with new technologies. The proposed maps are evocative instruments mediating between physical forms and dimensions and immaterial qualities, through which users will be able to explore, interpret, conceive and transmit the components of the Metropolis and Megalopolis context throughout the passage of time and corresponding to the urban context [11].

We are framing the Smart City concept and process within the Anthropocene era looking at urbanism, energy sources, policies and ICT approaches that are able to perform detailed geographic analysis, mapping much more broad impacts but also looking at the global energy scenario and urban distribution. This approach also brings out the landscape and public space issue as a participatory governance process, establishes performative spaces approach with agents/actors, that open also the critique of neo-liberalism and choice discussion, overlapping perhaps planetary urbanism arguments.

In this context, a direct relation between local community and private sector could be innovative in terms of the Governance approach, but it is clear that the large companies have an interest not only in political interventions in the rural and/or

peri-urban areas through their typical corporate social resposibility programs, but also in shaping the cities in accordance with their needs and greeds. They succeed in intervening in the material interconnection of transnational infrastructure networks with their intangible and symbolic dimensions, and in the political areas through their planning, installations and governance. The political role of transnational companies on the territory is growing; while the capital accumulated in the extraction of raw materials (copper mining, forest industry, for example) is rooted in the territory through peri-urban mega-projects. The territorial resources could be under attack.

The institutional issue of governance of megapolises requires some attention. Tokyo's smart cities are not government-funded, unlike India's, but cooperation between industry and the local community to solve certain technological and local problems takes place without a governance structure as such. The invisibility of government in the governance of the Megalopolis is what is needed. The question we ask ourselves is whether a sort of shadow dictatorial and paternalistic power of the big ICT companies is taking shape.

Often, the smart city projects refer to a small urban scale development where the information system and technological advancement provides full support to the inhabitants' lives.

The concept of Fujisawa SST [12], a smart city project conceived in collaboration between Vodafone and Panasonic provides a robust strategy that meets the principles upon which sustainable cities are designed. Its vision, targets, and provision of services are functioning with the primary focus of creating a city based on actual lifestyles.

However, the city size is strategic to the creation of the vision and achievement of the desired targets. This project allows the postulation of the creation of a smart city vision and strategy is applicable to cities of only one thousand households, that have the particular characteristics of a small size functioning community. A big city can be defined as a Smart Vertical; since its complex dimension, it is only possible to sum different smart solutions. Instead, it is possible to apply a Systemic Smart approach in a small town with a greenfield initiative. According to the project, the implementation priorities expecting high potential impact are education, living and health, followed by the secondary priorities of utilities, public services and working environment. Mobility has the lowest priority with the low expected impact. According to the project report, "*To make a town truly sustainable, we need to involve its residents in building a community. With the participation of partner companies that implement advanced initiatives, innovation through co-creation among industry, government and education along with residents will be generated*" [13]. Besides some considerations related to the architectonic and urban design results and the possibility to reply that model of participation in another context not so close to Far East culture, the project conveyed us to reinforce in the Megalopolis governance approach the local variations and intelligence. These we must transform into the invariant elements of a Megalopolis city not to generate another generic city only.

However, when the scope is expanded to the Megalopolitan scale, the application of smart city model becomes complex, not only due to scale but also due to the diverse territorial context and due to the provision and availability of data. The

Territorial Intelligence, a concept developed under the Sixth Framework Program of the European Community between 2002 and 2006, addresses the development of technology and information innovation for sustainable development of territories and community.

Flexibility in governance is also closely related to the metropolitan management of resources. An example commonly observed is water governance that is often a challenging and sensitive issue, especially where the fresh water is scarce, and the infrastructure system is not adequate to serve the increasing population. Many Metropolises have water authorities that control the quality and quantity of water, but in practice, it became an issue because the water authority does not define the land use around the watershed. Flexibility and cooperation in dealing with such issues are mandatory, advancing from the current situation of working in silos.

The governance strategies of Lombardy region in Italy is an example where the new policies, often through the application of information technology, advanced the integration between the urban and rural areas and successfully promoted the territory in the global network. According to the Milan Charter prior to the 2015 Expo, the great challenge for contemporary societies is to reconcile growth and sustainability by doing more with less, thus breaking the link between economic development and environmental degradation, in order to enhance or preserve the present level of wealth with fewer resources [14]. The agricultural park model is a noteworthy strategy where the interface of the urban-rural area has a balance between the values that need to be preserved and the functions that should be developed [15].

The chapter investigates whether the processes triggered by Smart City constitute to be the basis for a paradigm shift in city models, through the creation of new metropolitan values capable of supporting convivial engagement and territorial development. The research examines if the Smart City and Territorial Intelligence are models of a city oriented towards the values expressed by contemporary society, if it is a feasible plan, and how the concepts place the project according to the definition of policies that meet the criteria of verification of impact on the territory and society.

Staring from an analysis of the Lombardy within the Po River Valley Region water system governance, chapter puts a proposal for the Megalopolis Eco-Centrality of the East Metropolitan Milanese Area. The second aim of the chapter investigates whether the processes triggered by Smart City constitute to be the basis for a paradigm shift in city policies and governance at the *bigness* scale, especially through the creation of new metropolitan values capable of supporting convivial engagement and urban-rural development. Through the new Eco-Centrality case study based on theoretical hypothesis, the research assesses a model oriented towards the values expressed by the contemporary society; if it is a feasible plan; and how our Smart City concept allows the definition of policies that meet the criteria of verification of impact on the territory and society.

Focusing on the social aspect of technology allows us to explore the following questions: What is democracy model, that the public and common spaces of Smart City communicate? Can we talk about the ethics of Technology that do not impose constraints but push towards collective responsibility? What is the real power of the

technology deployed by Smart City? How can a global interconnected data infrastructure change the life of the city? And finally, what does globalization impact the Smart city approach bring out?

ICT is not only intended as a tool for the exchange of knowledge or competition between cities. Instead, it is a tool that implies the acceptance of open collaboration and project sharing. Technology enables us to recognize the contribution already made by others in the social field and by doing so multiplies its effects.

XIV. The Metropolitan Glossary and the Semantic Question

Language is a fundamental tool for the metropolitan practice. The word accompanies the evolution of society (the Subject), the city and its architecture (the Object), the transformation of the environment and its landscapes, and introduces into culture the words of technology. The glossary helps us to define a theory of inclusion because it maintains words as symbolic values that arise from the stratification of culture. It educates to the integration between the single individual dimension and the *macro* dimension of the city (the social discourse) and introduces the *meso* dimension of the relations between disciplines and cultures. The metropolitan identity is therefore no longer linked to a general sense of belonging, but the ability to understand information: the new relations established between the different spaces and the inhabitants within the metropolitan dimension [16] defines it. The word, therefore, defines common spaces between different cultures and helps us to decode the different meanings.

Smart and intelligent are two adjectives often attributed to the city and the territory, cancelling essential differences in the meanings that they convey. Smart city is a model where technology is implemented as part of the urban development. Even though there is not one clear definition that everyone agrees upon, we can define the Smart-City model through some projects:

1. City or foundation settlements: new construction of Masdar city; it is a Vertical Smart City;
2. Cities with existing structures within sectorial development in smart areas, mainly supported by ICT technologies: Cat Med UE Project http://www.catmed.eu/index.php?idioma=en;
3. Smart Cities at a human scale: http://www.openlivinglabs.eu; https://eu-smartcities.eu/place/lisbon; New Amsterdam Climate pdf.

In the post-industrial societies, Territorial Intelligence is the science with an objective of sustainable development of territories and having for subject territorial community. More specifically, the concept puts the multidisciplinary knowledge of territories in relation with their dynamics; strengthens abilities of territorial communities to take part in their development in a transparent and sustainable way; improves territorial information sharing and spreads its analysis methods and tools using ICT; promotes governance, decision making processes and practices which value participation, partnership and research-actions that contribute to transparent and sustainable development of the territorial community.

The concept underlines the contribution of the immaterial resources to general development, allowing the differences not becoming an obstacle to the affirmation of these needs but underlining a territorial heritage. Territorial intelligence conciliates the post-material values with those of the industrial society culture, by supporting the territories resources development and recognizes the latter implicit qualities, uniqueness and makes their use attractive for the heterogeneous *glocal* societies.

In the context of Mega-City and regions where the scale of the urbanization goes beyond the traditional definition of Metropolis, the two approaches do not exclude each other. It is important to recognize both the material and immaterial values of a territory and develop tools that allow the territorial actors to elaborate, to manage and to evaluate partnership and participative projects of the sustainable development of territories in all scales. How do we juxtapose Smart City project with Smart Territory project? For this, two cartography tools are necessary: open-source and big data maps, for the definition of the size of megapolis as well as to make the territory more porous through the identification of its values.

XV. Comparative Key Studies: The space-economy transformation in the desakota region. General principles, issues, and related questions

The territory we are currently dealing with is a hybrid territory. Together with the hyper-dense urban cores that structures the basis of the Mega-city region, the body space of the in-between" landscape once was defined as periphery has an important role in the contemporary Metropolis. The desakota model [17] determines the new regions of extended urban activity surrounding the core cities of many countries, in Asia and particularly in India by studying the space-economy transformation in the desakota region.

Distinctive areas of agricultural and non-agricultural activities are emerging adjacent to and between urban cores defining large mega-urban regions. It deals with set of conditions in one place, which interact with broader succession of metropolitan change: the local dimension implementing the global vision.

The informative layer that is becoming more and more significant in today's urban scenes, has a significant importance in the Desakota region. The virtual connection that it provides, allows us to be somewhat free from the physical distance and disconnection that the urban-rural continuum may preserve the local cultural landscape and yet be connected through the Green-Grey infrastructure.

The chapter will explore, through comparison of Indian mega cities projects, the possibilities of the meta city level network on the desakota region and how the new morpho-type composed of Green-Grey infrastructure act as a backbone and how the local pattern may provide a vision for the future of the metropolitan territory that is constantly exposed to complexity in multiple scales. We also demonstrate a methodology and tool of digital mapping that concerns issue of data availability at the local scale and the validity of open-source data.

Thus, not only public spaces must be considered, where metropolitan inhabitant can meet physically, but also those common spheres provided by communication technologies, that have strongly changed our conception of space, time and relations.

Starting from the physical dimension we could define the rules of governance issues for the desakota space, giving an answer to the question: *How to regulate the public, collective and private space of the rural-urban linkage that constitutes the desakota space and that is by its nature a hybrid space? How to create networks of small and medium municipalities? Moreover, how to relate them to the mother city? How to determine the possibility of e-democracy in the meta-city*? [8].

The Governance, so within the Metropolitan framework, even assuming all that concerned with the traditional polycentric city knowledge, must deal with metropolitan city and its desakota region as in-between spaces: looking beyond the traditional definition of borders, aiming at investigating metropolitan region as spaces of interaction of local and global forces and powers, challenging fixed administrative borders at different scales (state, region, city). The goal must be the balance between the various interests of actors who are, although different, must aim to reach an agreement on what are the public goods and services at the metropolitan scale.

Metropolis and Megalopolis as multiple space is a complex and fragmented action arena. Looking beyond traditional urban regime theories, the chapter aims at investigating new emerging spatial actors in desakota contexts.

Metropolis and Megalopolis, as fields of innovation in institutional design and planning, need innovative forms of institutional organization and planning to be able to cope with problems of public action in the in-between contexts of Megalopolitan and metropolitan cities, regional institution, inter-municipal cooperation, functional agencies. Moreover, we have to study the Indian Cities and their desakota spaces as spaces of mobile citizenship and acceleration in change, looking beyond traditional models of citizenship, and democratic issues investigating how the traditional right to the city takes different forms and meanings (right to the landscape and right to the lifestyle) under the pressure of accelerated process of social change and producing pressures-resources for change within public policy design and implementation (multiple citizenships; new social demands; third sector and social innovation). We must then investigate the real significance of services at the *mega* scale: can we think that it is possible to scale municipal services to the upper scale?

1 The Italian Po Valley Case Study and the Indian Desakota Region Comparison

In the desakota region, the urbanized area consists of agricultural and non-agricultural activities beyond the major cities and its peri-urban areas, much flexible governance is recommended, ranging from most urban to least urban areas [17]. Even though the desakota model has emerged from studies in the Asian context, the recognition of this in-between space as a potential driver of the economy allowed scholars to explore the rural-urban partnerships embracing different geographies beyond administrative boundaries in other contexts, especially in Europe [18]. While recognizing

this in-between settlement pattern, the study of this chapter goes beyond and investigates how the Meta-city of information [8] layer can shape the governance of the Megalopolis that encompasses the urban-rural continuum.

2 The Metropolitan City of Milan: Constitution Process, Objectives and Instruments of Government

The Metropolitan City of Milan (Città Metropolitana di Milano) is located in the north-western region of Lombardy in Italy. The metropolitan city has 133 municipalities (comuni) covering an area of 1,575 km2. The metropolitan city has a population of 3.279.944 inhabitants (2019). Since 2015, as an effect of Law 56/2014, the Metropolitan City of Milan replaced the province of Milan, inheriting some of its functions and assets. The Metropolitan City of Milan has a metropolitan council, a metropolitan mayor which coincides with the mayor of the provincial capital city -Milan-, while the metropolitan conference is the assembly of the city. The Metropolitan City Council has divided the metropolitan area into 7 homogeneous Zones, characterized by geographical, demographic, historical and economic specificities and institutional. Each area is functional to better articulate the activities in the area and to promote an ever-greater integration of the services provided with those of the municipalities.

The Statute of the Metropolitan City of Milan was approved by the metropolitan council on 22 December 2014. The Statute contains stipulations regarding the territory, the objectives, participation, among other in the metropolitan areas defining provisions and functions for the organs of government in the metropolitan city. Furthermore, the Statute defines the general dispositions of the city, including its competences and also stipulates the Metropolitan Strategic Plan as the fundamental instrument to carry out the necessary actions in the metropolitan city in the long-term span. This plan formulates the development vision of the city for every three years and determines the general objectives of development of the city. The 2030 Agenda for Sustainable Development is the reference for the Strategic Plan that aims build a territorial Pact within all the agents of the territory. The Metropolitan City in that vision is an interlocutor for the other municipalities. According to the plan that aims to define a vertical structure within integration of horizontal territorial agents for the creation of multi-stakeholder platforms for the promotion of initiatives and projects and sharing a common horizontal strategy.

The plan proposes 10 strategic projects, 8 territorial agendas (homogeneous zones) and 24 operational projects for the three-year period 2019-2021 within 6 policy areas. Namely:

Simplification and Digitalization; Intercommunity relations, support to the municipalities and European policy; Economic development, training and employment; Territorial planning, urban regeneration and metropolitan welfare; Environmental Sustainability and Parks; Infrastructure and Mobility.

The Strategic Plan is the reference framework for financing the actions of the municipalities by the Metropolitan City. The Territorial Metropolitan Plan is the instrument that the Metropolitan City shall use for detailing the spatial planning of its territory. The plan is composed by four principles: Principles on the protection of non renewable resources (soil, water, air, energy from fossil sources); Territorial equity principles; Principles inherent to the landscape and environmental heritage and; Principles for the implementation of the simplification of procedures, the digitization of documents, support to municipalities and inter-municipal initiatives. In addition, the plan has 10 objectives and refers to the SDG.

The technical proposal of the PTM is accompanied by the Environmental Report. Both are filed for the purposes of the Strategic Environmental Assessment and the request for the Impact Assessment. The proposal of the PTM is also forwarded to the Lombardy Region and to the entities managing Natura 2000 network.

Through the Economic and Social development and Private transport and Tourism sector of the public administration as well as through the Labour Policies Sector, the Metropolitan City of Milano seeks to support the sustainable growth, improve the productivity of businesses and the attractiveness of the metropolitan city for investments.

2.1 Overall Protocol of the Methodological Approach of the Analysis

We are defining a set of analyses structured within three actions: Explore, Extract and Enrich. The case study is the complex territory of the Area Metropolitana Milanese. The ambit of analysis in this chapter is the physical context and the focus is on the stratification of the consisting layers of the physical morphology. The main objective of this part is to study the physical context in a different yet innovative way. In other words, the analysis aims to re-read the physical context based on the multi-dimensional complexity of its constitutive components. The relations among the elements of physical contexts and the new technologies infrastructure then, will reveal the complex mechanism of relations between the physical context and the communication dynamics.

Explore:

This action is related to the analytical exploration of both the physical and communication contexts. Regarding the first one, this action aims to explore multi-characteristics of the physical context through a set of morphological analysis. We demonstrate that the Area Metropolitana di Milano was framed by infrastructure technologies able to interpret, evaluate and implements the local resources and territory intelligences.

Same analysis is evolved on today's communication ambit (the meta-city) as the new infrastructure technologies, order to explore the communication infrastructure

the way the hardware part put its roots down to the physical context creating a material layer of its immateriality. In other words, the context-based morphology of the communication ambit is the issue of exploration aiming to produce a new model which is meant to give alternative solutions for the problem of discontinuity between the spatial and communicational experiences of the metropolitan physical context.

The exploration of the physical context regarding to the contextual and technological evolution of the city of Milan, starts from the fourteenth century and proceeds until the present day. The hypothesis is that the communication technology and new devices are potentially able to act as those evolutional elements of the past.

Regarding the architectural and urban disciplines, such processes, besides innovative and experimental aspects, also study the territory according to suitable and sophisticated perspective for the urban mobility, infrastructure and spatial operations. The references and examples have been taken up from There have been taken references and examples of the Territorial Plan published by Milan municipality, the studies of PIM Research Centre, Green Corridors of eco-sustainability, the project of the nodal function of the Segrate Municipality (such as a metropolitan eco-centrality) for the new railway station for high speed trains, the re-qualification of the transportation system in local, regional and inter-regional scale as well as national and international scale according to the integration of the city with the Linate airport. In order to distinguish the potential relations between the elements and generate the relational network, we refer to a study [19] that defined three types of contrivances as harvesting data operators in a shifting scale process and according to three different levels of knowledge and experience. Starting from the territorial scale and gradually descending to the local and architectural and finally to the single elements, the Study show how it is possible to activate further stimulate interaction between the user and territory by leaving visitor a chance to experience physically the place, or virtually through technological supports from distance or both simultaneously. That is the meaning of Smart-City related to the Area Metropolitana Milanese.

Extract:

In these actions, the interface elements of the physical context are extracted as potential symbolic mediators [20]; convergence points between subjective and objective interactions and space-use. In other words, what differentiates this analysis from the traditional similar ones, is based on the inter and intra-relations between the components of the physical layers-infrastructure, urban spaces, water and green ambit, etc. not in a compact simplified map but through analytically deconstructive ones to reveal the multi-dimensional hidden complexities. Such inter and intra relations are looked through an apparatus as the contextualization of a network of relations [21], which despite being rooted in the physical-material-context, associate it to an immaterial layer of subjective spatial-temporal relations (Protocol Maps).

After the extraction of the interface elements-developed in the previous phase of the protocol adaptation, in order to activate them into a system which embodies their both physical and mental relations, they were categorized, itemized and differentiated based on their geographical, historical and social characteristic and finally arranged in a matrix. Such matrix has basically two major functions: incubation of data related to

the so-called elements and the generation of narrations between them. Such narrations make the relation between the elements by generating physical paths on the territory, tangible.

Enrich:

Through the superimposition of the two previous phases, a set of experiments regarding quantitative and qualitative indicators are evolved. The experimentation is related first to the re-examination of analytical indicator of urban analysis from a more complex point of view and secondly, as quantitative and qualitative indicators regarding the effective dimensions of the physical context. Consecutively, on one hand, the emerging areas where, the dynamic flux of communication converge with the physical context are identified and on the other hand they are neglected, yet effective ones are recognized, each based on their effective scale and dimensions both qualitatively and quantitatively.

The main objective of these analyses which evolves regarding the physical context and then relating to the communication dynamics is to analyse the physical context with superior level complex porosity, not only regarding to the new technological achievements but also according to the emergent and resilient areas. The so called 'complex porosity' is driven from combinational permeability in both physical-spatial context and communication ambits. This means that besides the studies related to the communication technologies, we need to deepen also the question of urban transformation in its spatial senses. In words, if the area is going to be highly permeable, first it needs to have flux of people coming into the area and this is possible only through a careful study related to mobility, transportation system and accessibility to the area through a well thought framework.

3 Megalopolis' Governance of Green-Grey Infrastructure: A Glocal Ecosystem Project Through Metropolitan Cartography

Nowadays, Megalopolis is protagonist and responsible for the changes that are also taking place globally because they are the main focus of consumption of large quantities of natural resources such as water and soil. The contemporary Megalopolis, according to the principles of consumption and Metabolic process, produced large amount of waste causing high gradients of alteration and ecological vulnerability with effects not only in the urban limit but especially in rural areas where small and medium-sized cities survive.

For this reason, while the dramatic effects on the structure and function of ecosystems is of particular interest for the development of Megalopolis, on the other hand are the medium-sized cities (with a population between 1 and 5 million inhabitants) that will see the highest levels of urban growth in near future. In fact, it is estimated

that the majority of the global population will live in cities of about 1 million inhabitants by 2050. However, the inhabitants of urban and rural areas of Megalopolis are exposed to risks to human health arising from the degradation of environmental quality. For this reason, air pollution is one of the most significant effects on the quality of life in urban areas [22].

Recently the EU Court of Justice has upheld the application for failure by the EC to fulfil its obligations against Italy for systematic and continuous overcoming in various areas of the national territory, the limit values laid down in the European Air Quality Directive for concentrations of particulate matter PM10 [23].

Following the Health Crisis caused by the effects of the Covid-19 pandemic, it is very clear that air pollution also has a considerable economic impact. Impact which can be quantified, and which represents the cost to society of environmental and health damage. In addition, due to the presence of industrial sites and the high intensity of vehicular traffic, the urban areas of Megalopolis contribute to global warming to a higher degree through greenhouse gas emissions such as CO2, CH4 and O3. For this reason, encourage projects to arm spaces according to the principles of the Green-Grey Infrastructure (based on tree coverage areas, urban and peri-urban forests, road trees that coexist with armed structures) constitutes a priority action for environmental improvement in order to facilitate the activation of the Ecosystem Services. Green-Grey Infrastructure development is strongly promoted by the EU, starting from the EU strategy for biodiversity 2020, up to the program Enhancing Resilience of Urban Ecosystems through Green Infrastructure [22].

In addition, according to the Italian State, the main regulatory instrument is the law 10/2013 *Norme per lo sviluppo degli spazi verdi urbani*, which constitutes the ministerial implementing tool for the development of public natural green capital. However, from a technical point of view, the most important executive document is the Guidelines for the management of urban greenery and the first indications for sustainable planning" of the Ministry of the Environment supported by statistical and monitoring data provided by ISRPA: national research body essential for the provision of open-source data and open-access documentation, as well as driver of investigation for local municipal authorities of the Megalopolis. However, scientific experimentation and cartographic practice in the academic field detect a clear gap between what is disseminated in universities and in technical literature and what is happening in the territorial management of ecosystem resources, especially water and vegetative heritage, thus favoring a considerable pressure on the natural capital of Megalopolis.

The management and design of new spaces for sustainable development of the Green-Grey Infrastructure is strongly linked to the Water Management Policy as it is necessary for the management and mitigation of the risks of exposure to climate change of contemporary Megalopolis. Focusing on the growth of the Green-Grey Infrastructure means to be efficient in the use of resources, especially the local water resource, in order to achieve a sustainable recovery that will allow us to exit from the current economic and environmental crisis, adapting to climate change and increasing resistance to natural disasters [24].

According to Communication from the Commission to the European Parliament, the Economic and Social Committee and the Committee of the Regions, the EU could focus more on the growth of the Green-Grey Infrastructure strengthening the sustainable use of water resources in order to achieve a sustainable recovery that will allow us to emerge from the current economic and environmental crisis and thus to adapt to climate change and increase the inventive resilience of cities to disasters natural. Addressing the current and future hyper-vulnerability of the internal territories of the Megalopolis means boosting the competitiveness and growth of the European water sector, which includes 9,000 Small and Medium-sized Enterprises, offering more than 600,000 direct jobs in water supply companies. There is also potential for green growth in other water-related sectors (water-using industries, development of hydraulic technology), where smart innovation can increase operational efficiency. Moreover, increasing efficiency means, at the same time, ensuring the accessibility of the water also to urban settlements disconnected from the water infrastructure of Megalopolis, thus being able to ensure the right to the Water for all [25].

In conclusion, it can be inferred that, according to the EU's Legislation Directive of Water (Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy), water management is an extremely relevant issue to the geography and tectonic structure of the Megalopolitan Green-Grey Infrastructure. It is a Glocal dimension issue, since it is believed that water management goes far beyond the activity of treatment and distribution of the resource on the hyper-local dimension. Water management, in inventive Green-Grey Infrastructure project, is a problem that determines the quantity, the quality and accessibility of Water as a public good. Therefore, water management requires coordination with water management planning by Megalopolis member regions/districts, not only government measures are needed, but above all urban and architectural planning choices with immediate socio-environmental spatial effects integrated into Ecosystem Service Accountability.

3.1 Metropolitan Cartography as a Support-Analytic Theoretical Practice Tool for Data Mining of the Trans-Scalar Spatial Relationships

Interpreting the complexity of the modification processes of the contemporary city requires the transversal reading of multiple inter-disciplinary analyses so as to understand how the territory is constituted. This has to be done by reading the morphological and anthropic structure existing in the territory, analysing the spatial components and their relations through the representation of maps that highlight the discontinuity of the Green-Grey Infrastructure. The study has to be done to understand how the territory is exploited through the geo-localized reading of the factors of land use and its temporal change according to the dynamics of Urban Metabolism, how to live and transform the territory considering the potential social and environmental

accountability evaluating the relationship between individual and environment with respect to the benefits of the ecosystem that the inhabitant could still enjoy through the assessment of Ecosystem Services active in the Metropolitan Land-scape Unit where the project field of action operates.

The need to read the territory through a context-based analysis approach was developed through the investigation of the research unit MSLab with European International Universities (Italy, Spain and Slovenia) and Latin American (Argentina and Mexico) within the framework of the project co-financed by the European Union (EU) TELLme 2017–2020 (Training for Education, Learning and Leadership to a new Metropolitan Discipline); in the three-year research period the objective was to develop a theoretical framework to study the problems of metropolitan territorial complexity starting from the observation of the city and its transformation processes through the application of space operators of Metropolitan Discipline: structured rules to support the economic, social and environmental dimension of urban and rural areas.

The purpose of Metropolitan Cartography (MC) is to generate a set of open-source maps for different cities, which can be comparable with one another, in order to connect the generative principles of Metro-dology [5] with a more operational and technical section related to territorial reading and spatialization of quantitative and qualitative data; therefore, MC map project is as new analytic-theoretical practice device.

Using alphanumeric data, the Metropolitan Cartography selects, orders and relates the values of unexpressed quality of the territory. It is therefore a matter of evaluating and representing qualitative-relational data through a new logical sequence of choices.

Through the practical approach of the Metropolitan Cartography, the metropolitan expert, the planner, and the designer might be able to grasp the symptoms, the exposures, sensitivity and adaptability of the environmental and social variables that make up the territory.

The potential of maps produced through the methodology of Metropolitan Cartography is expressed in the investigation and analysis of open access data that can not only explain the meaning of use of alphanumeric data but also of those that contain relational value, distributive and device of the implicit properties of the territory. This study allows to generate synthetic maps that try to mark the communication of information through analytical maps that represent the implicit connections between the levels of information. For this reason, Data Mining is the preliminary research phase that is the criterion capable of extracting the implicit knowledge from data and informative patterns that have not been explicitly associated with specific spatial conditions; this step is determined by the preliminary knowledge of the territory.

It is therefore necessary to define spatial rules through which it is possible to understand the usefulness of a global or local data for the cartographic representation of the metropolitan dimensions. Spatial data analysis is a fundamental condition for investigating the property of information, researching the spatial attributes of informative level, but also quantitative attributes linked to the eco-nomic and governance dimension to clarify their usefulness in urban planning.

Currently, the production of local data is carried out by institutions or public administrations that produce open data in digital format for specific purposes of managing their territory. Many national and regional European public bodies, with the support of EU funding, can provide a high potential and reliable service for the research of data related to the protection of national environmental ecosystems, with high spatial detail. They are entities that, through the participatory collaboration of various institutions, allow the totally open and accessible exchange of geo-referenced data in space.

The national, local (regional) and communal apparatus allows to guide the searching the data through transmission, in a not always explicit way, of the internal structure of the dynamics of administration of the territory.

However, the local and global Data Mining and Data Collecting phases determine a great potential of the methodology. They allow to understand the inter-dimensional and scalar dynamics of the metropolitan area, facilitate the choice of information related to the field of action project and guarantee the understanding of peculiar aspects to the metropolitan city through the classification by category of the level of information. It is an introductory research phase of spatialization and relationship between data in synthetic maps, but at the same time it is a necessary step for the association of the individual informative layer to the spatial dimension of evidence. For this reason, the Metropolitan Cartography map project is fundamental to define the relationship between spatial data dimensions (XL–extra Large, L–Large, M–Medium) in the process of choosing global and local information in the field of study. Methodological experimentation, through digital technologies such as the software GIS (Geo-graphic Information System) and the processing of data generated in Remote Sensing, allows to exploit information on a global scale that follows a temporal catalogue through the identification of a chronological evidence threshold of the geographic, historical or environmental phenomenon linked to the Urban Biography of the project area. So, there is a need to direct research towards the achievement of local and open data that can ensure an adequate quality of expression of the level of information by position (relative to its altitude, latitude, longitude coordinates), shape (shape defining a polygon, line and point), size (relative to the state, supra-regional or regional size) and orientation of the data related to the field of action reference system.

TELLme maps have allowed the generation of an experimental process that makes it possible to structure the representation of the territory, redefining the information system through the determination of criteria such as:

– The categorisation of the concept and data, from the Semantic Package to the map, using ISO 37120: 2014 standards, indicators for citizens services and quality of life for sustainable development, defined by the Member States of the United Nations (Sustainable Development Goals) as set out in the 2030 Sustainable Development Agenda;
– The quality of the data (Data Quality) identified in relation to the potential use of the data through a selection that takes into account their integrity, accuracy,

timeliness (time of acquisition and production of information), consistency with the purpose of the map;
- A sequence of historical data (Data Time Series) that allows to identify a series of interrelations between the changing physical variables, ordering them in relation to the dynamics expressed in each phenomenon.
- From this research it is deduced that the setup of a project of Metropolitan Cartography allows the expert to know the territory understanding its structure, identifying events and causes, in progress or in evolution, triggering factors of development and critical regression of the urban context.

3.2 From Narrative of Urban Statement to the Extraction of Spatializable Keywords

The Metropolitan Cartography experiment was also presented as an innovative support tool for local territorial intelligences in participatory planning processes [5]. That is way, according to the development phases of the Metro-dology, the comparison between the narratives of the local agents, their interpretation and diagnosis constitute to be a fundamental step for the extraction of keywords that can be associated with the concepts contained in the Semantic Packages of the MGIP TELLme Software Glossary.

Semantic Packages are containers of a finite number of keywords (categories) to which correspond the specific concepts of the descriptive variables of the metropolitan complexity, through which it is possible to select and pull out spatializable concepts in the map.

The individual Semantic Packages may contain concepts related to each metropolitan dimension: physical, social, economic and governance, according to the classification structured by categories or Keywords.

Semantic Packages are the theoretical tool for researching and arranging data in the GIS space and are essential for building two types of maps: Protocol Maps and Maps of Dynamics. Protocol Maps are maps that show the fundamental relationship between the elements that make up the metropolitan system and reveal its structure through the stratification of the physical aspects of geographic, historical, and geometric data. The Maps of Dynamics are maps that represent the factors of change of the metropolitan landscape in the time through the differentiated perspective of the local agents that interact with the instruments of the Metropolitan Discipline through specific software: MGIP Software Glossary and TELLme Hub (Fig. 2).

Therefore, Metropolitan Cartography (MC) presents itself as a methodological tool consisting of a strong innovative and technological apparatus through the support of theoretical and executive software tools. Thanks to the technical knowledge of the MC, the construction of the map allows to evaluate the city as an experimental laboratory of innovation and research. For this reason, the designer of the urban and architectural discipline and the metropolitan expert need to work with new types of maps that can give a persuasive image of the territory.

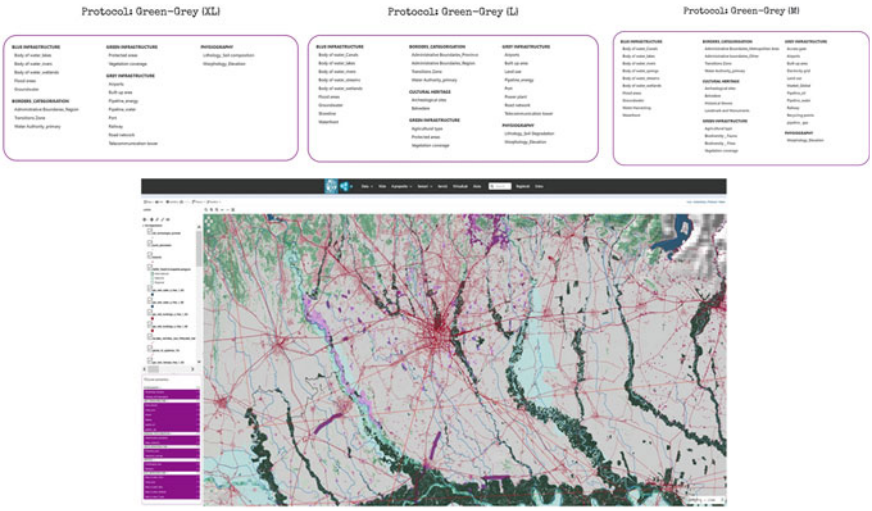

Fig. 2 Correspondence between the Semantic Package in TELLme MGIP Software Glossary and the Protocol Maps in TELLme Hub as a dynamic in-formation system. Image from TELLme Hub.getit

The link between the keywords and the associated levels of information allow the metropolitan expert and the designer to acquire a practical-theoretical inventive ability working through interaction between geography and history [26], geography and function [27] in order to build a new logical geography of the city [28].

3.3 Metropolitan Cartography Protocol Maps to Structure the Knowledge of the Territory

3.3.1 Green-Grey Infrastructure Protocol Map

The attractive value of the territorial image linked to digital information and technological interaction, in the last decade, reveals its importance in Smart Mega-City research according to professional and academic field. The Smart City is commonly intended as a model of urban development built following a structuring of systems and processes highly performing and efficient for monitoring the operations of land change in accordance with recent urban dynamics: it is space paradigm based on new technologies, sensors and Big Data.

Therefore, the research purpose is to demonstrate how the spatial trans-formation process of the city, and its urban and rural context, should not be understood as a result of a sequence of automated processes in the technological field, but as an investigation linked to the possibility of developing new skills deeply rooted in the territorial knowledge. It is therefore a matter of updating the techniques and knowledge of the

past, which have characterized the development of territorial intelligences and the strengthening of theoretical-practical awareness for the construction of new urban quality spaces. To achieve this goal, it is essential to start from the morphological analysis of contemporary geographical and urban contexts in order to orient new sustainable planning strategies through a new techno-morphological objective [29].

For this purpose, the maps of Metropolitan Cartography are preparatory to the understanding of the basic principles of spatial evolution over time.

It is therefore necessary to begin by understanding the morphological structure of the city and its territory, considering its structural and formal aspects, by reading the existing topographical, morphological and anthropic property, analysing the spatial components that highlight the discontinuity of the Green-Grey Infrastructure.

In current urban planning and policies scenarios, the Green-Grey Infra-structure is the strategically planned network of natural and semi-natural areas with environmental characteristics designed to provide the activation of ecosystem services such as: water purification, air quality, space for recreation and mitigation and adaptation to climate. This network of infrastructure armatures, green and blue areas can improve the environmental conditions and, therefore, the health and quality of life of the inhabitants [30]. According to the Conservation International Practical Guide to Implementing Green-Grey Infrastructure [31] there are different synonyms for understanding the complexity of Green-Grey Infrastructure as Ecosystem-Based adaptation. It is a concept based on the use of biodiversity and ecosystem services in the context of a local design strategy with global repercussions. It is therefore a complex system adaptive to the obvious effects of Natural Hazards, due to climate change on human-engineered armature.

According to this theoretical awareness Metropolitan Discipline considers Green-Grey Infrastructure as an operative project strategy with territorial-scale effects, aiming to overcome the fragmentary nature of urban extensions in the metropolitan area through a structural reading of the landscape system, characterized by forms of continuity with which architecture collaborates to define unitary interventions aimed at generating a new form of urban places.

In design field of action, the continuity project of the Green-Grey Infrastructure considers architecture and landscape as co-participants in the definition of a unified intervention characterized by a structured and organized form of soil. The interaction between architecture and the environmental dimension is born in a gradual process of transformation of the existing natural heritage from which landscape emerges defined by the relational forms that architecture establishes with the landscape system. For this reason, the purpose of the protocol map Grey-Grey Infrastructure induces map-reader and local agent to detect spatial interruptions of interface elements of the physical context, in order to ensure the continuity of the ecological infrastructure not integrated with the territorial urban system yet.

The object of the Green-Grey Protocol Map XL is to represent the intermittent spaces between the most densely built-up areas and high natural capital ones of Lombardy. The map outlines a strategic framework in which the city of Milan is a large dynamic urban exchange centrality between the region of Lombardy, Piemonte and Liguria. The maps show an historical linkage of urban and regional centralities

of flows trades based on the primary and secondary sector of the Italian national economy.

The purpose of the map is to tell the narrative of the metropolitan city of Milan, strongly linked to the complex water system of canals, underground waterways, linked to the hierarchical scheme of primary and secondary roads that sets up territory as Net-City [8] (Fig. 3). Nevertheless, the map highlights the lack of connection between the infrastructure and the ecological system of the plains. It is a condition that allows to consider Milan and its territory as an ecotone [32] reality. This spatial condition could be identified in the ecological corridors currently existing at the main rivers of the city. The River Lambro and the River Ticino are ecological wedges to encourage biodiversity links between the Po and the pre-alpine valley and the Alpine relief.

The map Grey-Green Infrastructure L (Fig. 4) shows how the link between densely urbanized areas is inseparable from their geographical roots and how informal urban settlements grow constantly by contaminating areas recognized as protected. The representation of the corridors of high and low anthropization in the maps of the dimension Large (L) and Medium (M) dimension, points out the emphasis on the following note: the urban footprint of Milan is constantly growing and expanding at the expense of the existing ecological heritage. In the last decade the Lombardy Region, through the regulations and the territorial plan of the region has focused on the ecosystem and landscape value of the territory, recognizes the potential ecotonal value of urban settlement and the territorial value of regional canalization

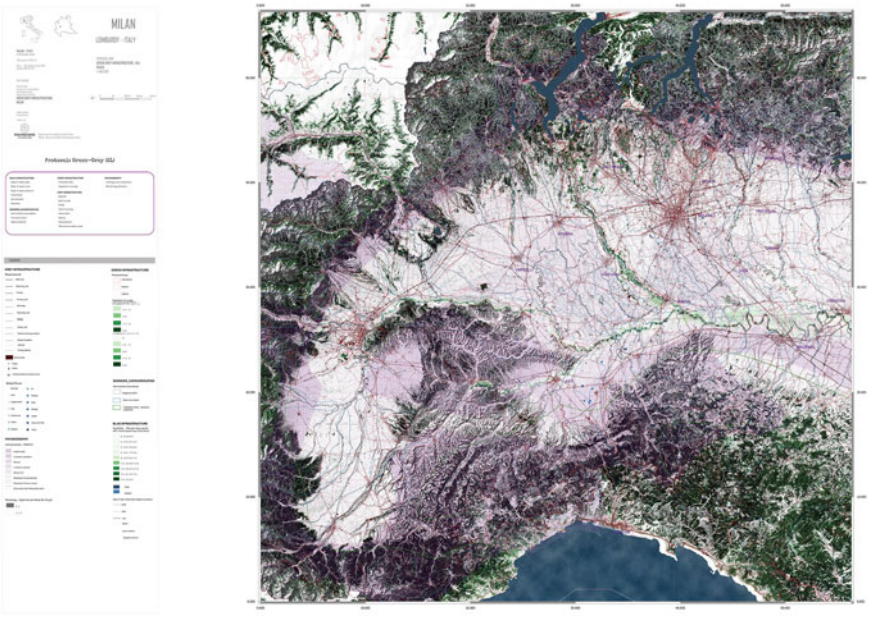

Fig. 3 Green-Grey protocol map XL–1:500000. *Credit* 2019, by V. Galiulo, MSLab–TELLme

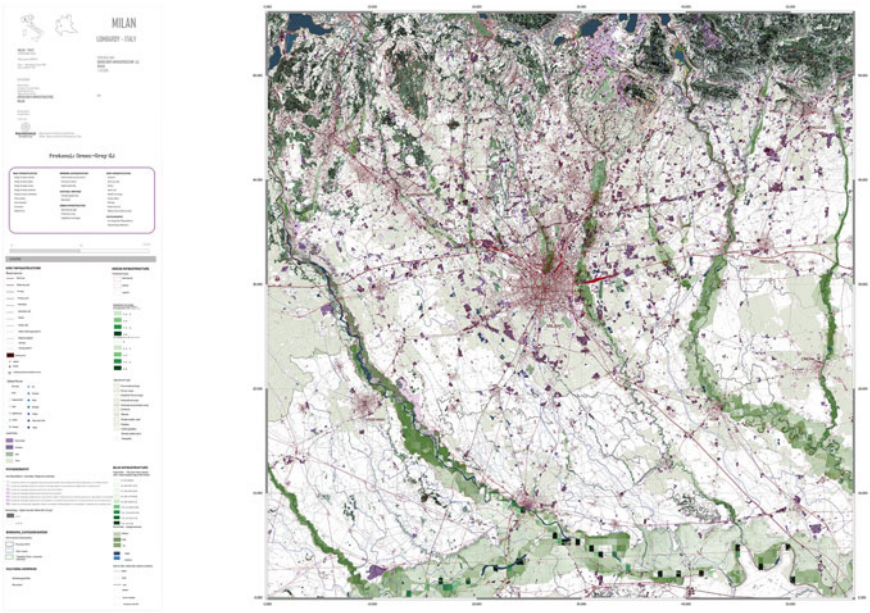

Fig. 4 Green-Grey protocol map L–1:150000. *Credit* 2019, by V. Galiulo, MSLab–TELLme

systems (Fig. 4). The relational constant of each map is the river Po and its tributaries, understood as an invariable geographical reference through which it is possible to explain the spatial relationship between informative elements that generate lines of force on the territory [33]. The lines of force allow to root the use and the meaning of the quantitative information of the data to the cultural identity of the space context in which it acts. In the Maps of the Protocol, the change of bounding box and scale is determined by the will to represent the constant and permanent relationship with the geographical and structuring lines of force of the three dimensions XL–L–M, which correspond to three different scales: 1: 500,000, 1: 150,000, 1: 50,000 (Fig. 5).

In summary, the maps produced with the TELLme methodology are not simulations of reality, but are instruments through which, in the projective geo-referenced space of the GIS (Geographical Information System) Spatial relationships, not yet expressed through a new vivid and memorable image, become visible [34]. It is therefore interesting to understand how to read and interpret the fragility of a territory through spatial images related to the time variable of the data processing. Metropolitan Cartography map become a technological tool for the transmission of a new methodology and new knowledge that allow to move from urban analysis to the theory of metropolitan design, which requires the presence of geographical references strongly bound to the topography, considering it the main support for the analysis of the city.

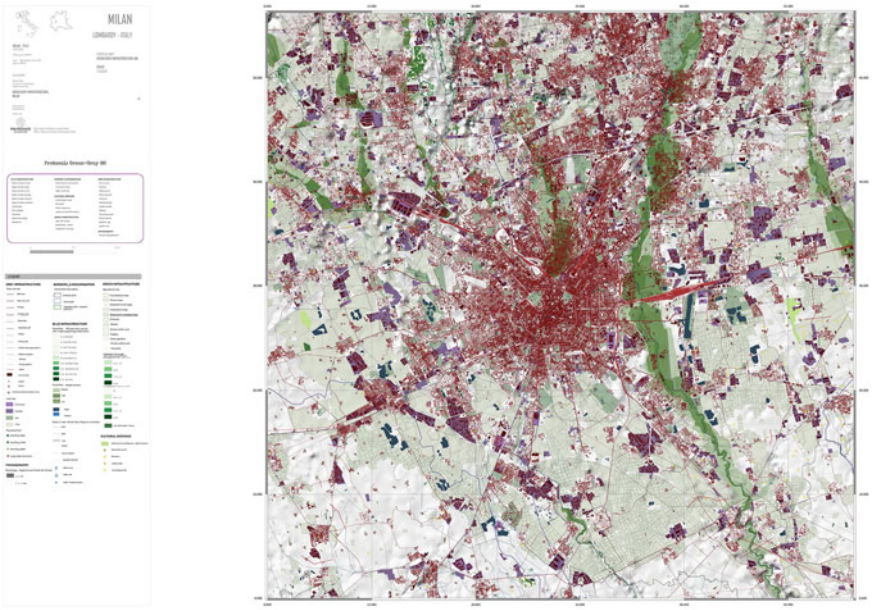

Fig. 5 Green-Grey protocol map M–1:50000. *Credit* 2019, by V. Galiulo, MSLab–TELLme

3.3.2 Urban Metabolism Protocol Map

According to Urban Political Ecology vision (UPE), it is possible to deal with Urban Metabolism when the city is considered as a living organism that functions in a similar way to the natural system, in terms of production or consumption of energy. Reading metropolitan territory must be carried out considering the natural and artificial processes of consumption of the resources of the ecosystem, and this implies the tracing of the flows, not always explicit, linked to the production and processing of building materials, traffic in goods, food, transport, energy and marking the possibility of depletion of energy resources and the over-production of municipal waste.

The intersection of social and economic variables and the consequent spatial changes of shapes and uses are the constituent attributes for the composition of contemporary urban social landscapes that are subjected to the acceleration of the metabolic transformation today are more visible, in both physical and social dimensions.

According to Metropolitan Discipline, Urban Metabolism has a dual meaning of the term: it is not only a concept empirically measurable through the ecological footprint of the urban inhabitants, but it is a complex system of actions that tend to enhance a sustainable urban planning approach. It is a criterion for the design of a coordinated, interdisciplinary, and changing territorial strategy to optimize spatial,

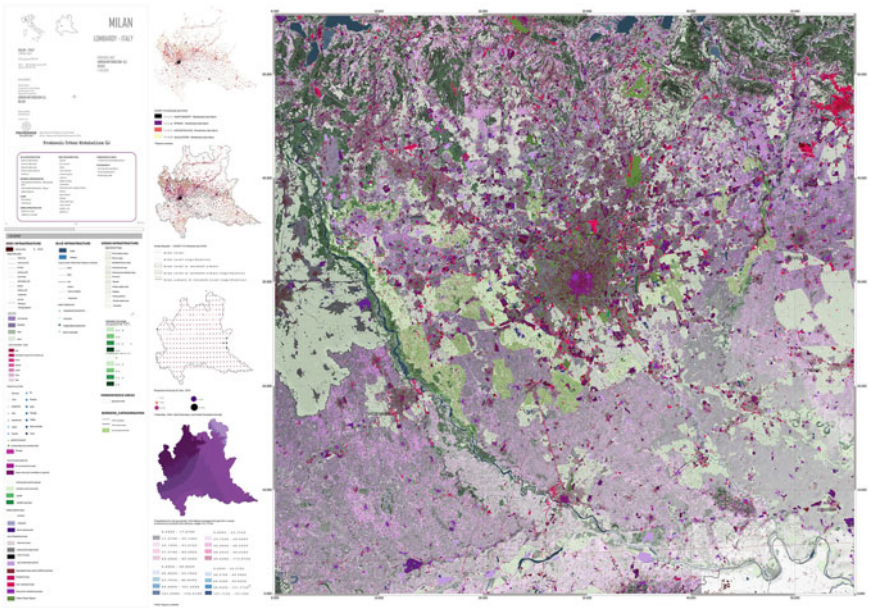

Fig. 6 Urban metabolism protocol map L–1:150000, How the territory is exploited. *Credit* 2019, by V. Galiulo, A. Contin, MSLab–TELLme

social and economic dynamics that can guarantee a quality of life accessible to all citizens.

The incremental objective that the maps of the Metropolitan Cartography propose is to think to a plan that, although consuming, compensates, shapes and increases also the quality of the life of the citizens and the natural ecosystem in which they live (Fig. 6). If on the one hand this approach integrates the temporal space of the Urban Biography and the time of the urban agenda, on the other, it is possible to make the individual interest coincide with the social interest through targeted strategic metabolic actions of maintenance, replacement and transformation [11], which are inspired by the ethical axis of governance and the principles of equitable and sustainable well-being [35]. A further important aspect of the metabolic approach in the design of the metropolitan city spaces is the possibility for institutional bodies to manage environmental, social and economic changes by implementing the ethical axis of territorial transformation in shared urban planning policies starting from the municipal dimension.

3.3.3 Unit of Metropolitan Landscape Protocol Map

The definition of Metropolitan Landscape Unit, in the Metropolitan Discipline, arises from the synthesis between different concepts such as Landscape Unit in the context

of regional planning; Figurative Landscape Unit [36], Cultural Landscape Unit [37] and Implementation Unit [38]. These definitions are the key concepts to outline specific criteria for the description and measurement of Metropolitan Landscape unit. They are definitions deeply related to the geography and morphological structure of the Green-Grey Infrastructure at the scale of Metropolitan Region. This means extracting the components that make up the minimum Metro-unit by placing it in reaction with the formal anthropogenic-geographical types [39] de-signed as indicators of formal transformation following urban and architectural planning project aims. For this reason, each unit of Landscape must contain at-tributes related to the cultural biography of the territory and the citizens who inhabit it.

The goal of the Landscape Unit Map is to be able to understand how to live and transform the territory. The Metropolitan Landscape Unit map allows an in-depth analysis of the human, natural and technological systems that insist on the territory (Fig. 7). The map spatializes the overlap of activities, land uses and local habitus, and then organizes reciprocal relations in territorial sections that show the overlap of activity processes in the context of the reconstruction of the ecological balance of the site [8]. In addition, the map of the Landscape Unit aims to represent not a new model on which to rethink the city, but rather identifies a structured dispositive organization according to a flexible physical configuration, repeatable and practicable not only on the scale of the single urban unit but above all on Metropolitan Region scale.

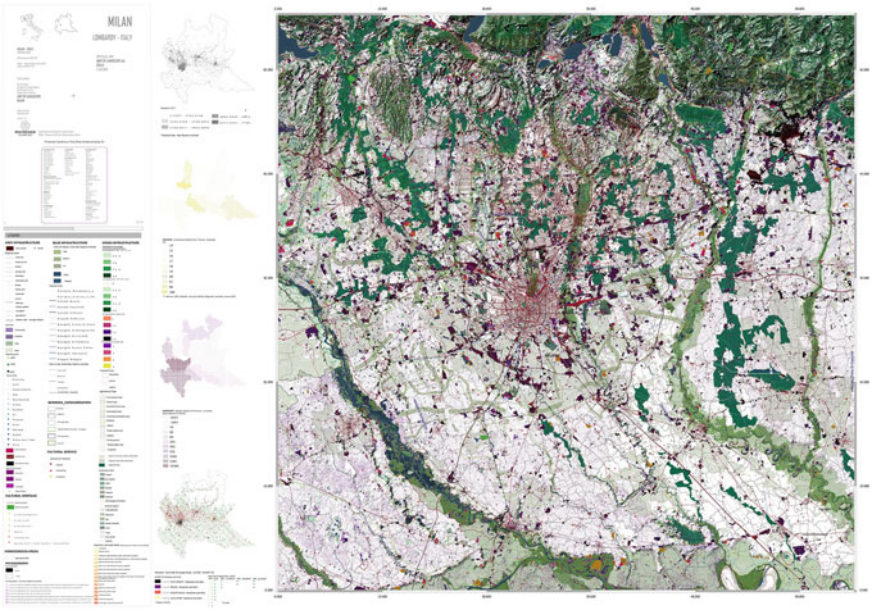

Fig. 7 Unit of landscape protocol map L–1:150000, How the territory of the Smart Mega-City is lived and transformed. *Credit* 2020, by V. Galiulo, A. Contin, MSLab–TELLme

The Protocol maps presented are some of the possible reproducible ones to investigate the MESA (Metropolitan Existing Situation Analysis) and the phenomena and transformation impacts of the contemporary city. The Metropolitan Cartography maps are methodological projects supported by technology that make it possible to read spatial dynamic correspondences between quantitative and qualitative data. Knowing how to decipher and interpret certain correlations means being able to understand the principles of selection, order, hierarchy, and composition of the cartographic project. Moreover, the Metropolitan Cartography (MC) allows to draw up maps through a synthetic process that helps metropolitan experts to interpolate the different perspectives of interdisciplinary specialists with the narration of local actors.

Furthermore, MC maps allow to define the structural schemes of the intrinsic reasons of the territory, enabling the activation of pilot projects through communication between local actors. For this reason, maps are projects that produce spaces that are not limited to the two-dimensional delimitation or to their symbolic communication.

For Metropolitan agents, the inter-scalar coefficient of Metropolitan Cartography is necessary to define which physical and immaterial spatial variables can ease the mapping of the territory. It is a tool of dialogue and the representation of reality, interpretation of what is possible considering the needs of the residents, temporary inhabitants with the aim of activating practices for the implementation of a pilot strategic project.

The main research goal is to identify, through cartography, investment projects with a high social impact in order to advance integrated and sustainable urban development for all and to promote environmental and social cohesion between local citizens, migrants, commuters, temporary users and local authorities. The high purpose of the methodological tool is to activate and stimulate continuous experimentation to strengthen dialogue between different agencies, governmental authorities of different levels and sectors, UN Agencies and development partners, representatives of small communities and private sector actors. Therefore, the investigation leaves the questions in suspense temporarily and critical observations raised by the context-based analytical approach. However, the methodological research and Metropolitan Cartography have made it possible to highlight the variables that leave open discussion in the academic theoretical and practical through dialogue with local administrations and agencies.

4 Morphological Layers and Constitutive Elements in the Milan Metropolitan Area Scene

It is important to consider the particular situation of the Milan Metropolitan area in depth, which is not only rich of history, agricultural and landscape fabrics and images, but also is characterized by overlapping infrastructural systems–railways,

urban motorways and airport that make of it a paradigmatic example of a multi scalar territory.

The starting point of this research line [19], is to analyse the deep infrastructural change that the city is dealing with due to the construction of the new bypass road–Tangenziale Est Esterna-, a freeway, parallel to the existing Tangenziale, linking the two main existing motor ways in Italy and converging to Milan; the Milan–Naples and the Turin–Venice. Such emerging infrastructural change and the realization of a new high-speed train connection between Milan and Venice stimulate the idea of a possible new station/infrastructural Hub to be directly connected to the Linate Airport.

These new elements increase the possibility to look at this landscape through a new dimension in the metropolitan area–that would go beyond the traditional binomial city countryside. This part tries to imagine a new synergic system made of landscape, urban fabrics, and infrastructural nets through the recognition of the physical constitutive layers.

The infrastructural presence indeed, has been felt as an alien element that is totally detached from the local dynamics. This point of view aims to go deep in the relationship between local and global levels, between green and grey infrastructure that must work together and look for the necessary continuity which can generate new possible figures of public space at the scale of a net city giving it a new system of references.

Lombardy is a metropolitan region between the three main airports that could be considered within a scale of the net city defined by the infrastructural net, different urban fabrics, and the landscape system within a square of 100 × 100 km. In this scenario, the focus on Milan and its Eastern metropolitan area is mostly regarding to the new infrastructural scenario Tangenziale Est Esterna, the new high-speed railroad, a possible new Station and connection to Linate airport.

5 Milan Metropolitan Area, Infrastructural System

For several years, the existing motorway ring had worked first as the border between city and countryside and then as the edge of the compact-dense city towards what we might call sprawl. Among the fundamental natural and artificial elements that have been forming the agricultural and urban context of the area, it is important to consider the old bypass road and the Lambro River on the eastern side, the new bypass road and the borders of the Parco Sud and its preserved areas on the west, the street towards the cities of Monza and Lecco on the north and finally the railway tracks, Idroscalo and the Linate Airport on the southern part that on the one hand perform as physical barriers surrounding the area and on the other hand, form infra-spatial conditions for the embedded-ness of the agricultural system. Such expansion model of parallel streaks will in fact, replace the obsolete concentric model of the urban growth fitting in a more equilibrated way-into the territorial system and pursuing more effective roles within the global sustainability perspective (Fig. 8).

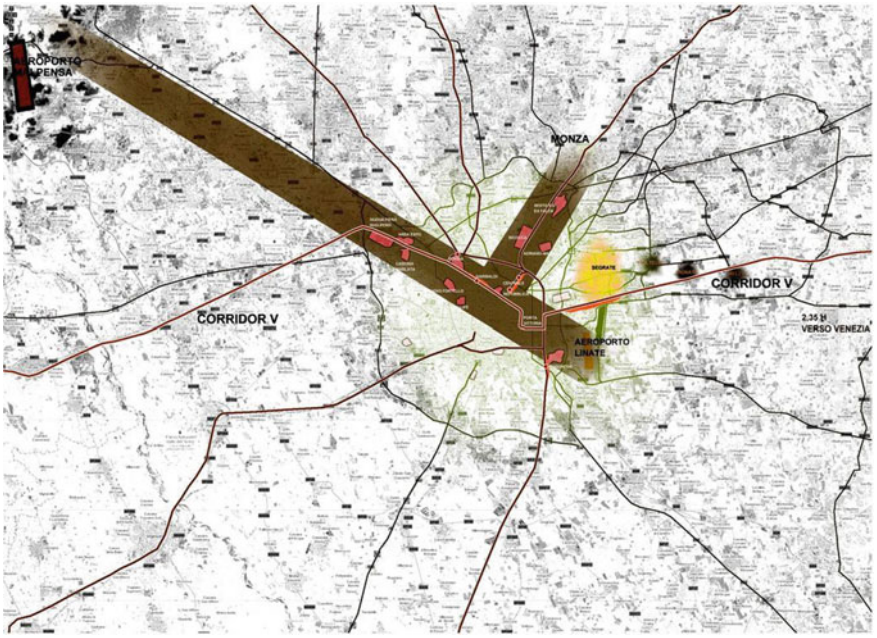

Fig. 8 Milan metropolitan area, infrastructural system

The existing rail yard had been for decades, a wall that disconnected the southern and the northern part of Segrate. The re-connection of the two parts asks for a comprehensive way of dealing with continuity of green and grey infrastructure converging in a dense point of interchange.

The new tangenziale might define, 15 km far from the existing one, a new threshold: and by this, a new centrality. This perspective gives an important chance to experiment new possibilities of interaction able to deal with the contemporary idea of identity and sense of belonging to a place.

Natural vacant areas mostly structured by the water system of the territory–as a fundamental feature of the local economy based on the agricultural character of the place must be revalorized as multifunctional green areas within the urban scale that are able to meet both, the necessities of inhabitants and sustainability requirements of the place.

Accordingly, we can consider this territory as a Strategic switching location structured by strong infrastructural systems that bring the area into the light of accessibility in different scales. In the national and international scale, its proximity to the international airport of Linate is the link between the city of Segrate and other European countries especially during the Expo 2015 events, while within the regional and inter-regional scale, there is the rail yard, that on the one hand acts as a strong physical barrier cutting the area into two parts and on the other hand, makes it accessible from other cities. The train station located in Segrate and the realization of the metro

line number 4 makes the city become an eastern entrance gate to the city of Milan and through that to the western Italy and the departure city within the leaner system towards the eastern parts. Coming down the scale into the local one, the transversal parallel longitudinal streets that exiting from Milan and entering to it, perpendicularly to the city, provide the access to four major points: the Cascina Gobba stop of the metro line number 2 on the northern extreme, the Rogoredo stop on the extension of the metro line number 3 on the southern extreme, the railway station itself and the Linate stop on the future metro line number 4 in the middle.

In this scenario of large infrastructural transformations, attention has been brought to some specific issues, which clarify how the local context-mainly characterized by infrastructural networks and natural and artificial fabrics can be re-activated as a multi scalar continuity. To achieve that, it is necessary to consider the macro-configuration of the territory especially according to the intertwined green and grey infrastructures. In this regard, four parallel 'streaks' are taken into consideration, all in the north-south direction. From east, respectively:

– The one consisting of the Lambro River occupied mostly by the old bypass road. In this first strip, there are already naturalistic paths aimed to the re-qualification of some ex-industrial areas such as the park of ex-Innocenti Maserati;
– The second streak is that of the lakes of Segrate that in the southern part includes the Idroscalo;
– The third and the fourth pass through the Cascine Park and Invernizzi Park that are actually considered as the access points to the agricultural southern park.

All of these four parallel streaks are traversable, on the East-west direction, by the railway tracks where there was reanalysed the high-speed train that connects the western parts of the city of Milan, and also western Italy, with the eastern parts. According to the west-east continuity, the railway has the role of linking several cities, starting from Segrate as the terminal, Pioltello, Settala, Vignate and Melzo, and so will form a sort of complex linear city that perpendicularly connects and overlaps with the parallel strips (Fig. 9).

According to the model, it is important to consider, that the transformation of the built and non-built areas in these parallel streaks, does not take place in a solid and boundary making manner, but it is expected to interconnect the bands with each other and converge gradually from one condition to another. Moreover, the re-qualification of the marginal areas, buffering between natural and artificial context, has to emphasise the unique values of the territory such as its green footprint of agriculture and re-activate the historical and genesis identity of the place.

In order to go deep into the context of spatial configuration, it is classified into four layers, which are: the water system, the green areas, the local companies, and the cultural spaces. Such stratification is based on two main scopes: first to study and analyse the context through its physical constitutive layers, and then, to prepare the ground for evolving a new reading of the context through the revelation of the multi-scalar relations between its layers. In other words, these layers will be broken down into urban space-scale components and re-structured within an analytical apparatus in the next part.

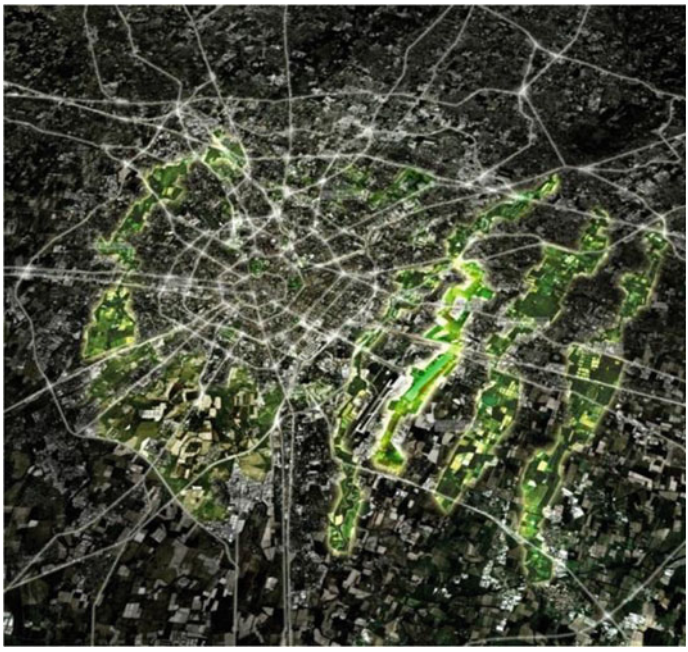

Fig. 9 Parallel green streps [40]

The first layer is the water system. Based on the previous explanations, the area of Segrate and Linate, like the whole Lombardy system are structured based on the penetration direction of the water resources from north to south. Such configuration is based on the agricultural characteristics of the territory which is rooted in the ancient roman land constructions. The productivity of the land and its rich subterranean aquatic means have always had the main role of giving economic support. Such system is composed of the natural lakes, rivers, artificial canals, irrigation ditches, resurgences, etc. The examined area is defined on the north by the Martesana Canal and on the west by the Lambro River as the two main water tracks and barriers. Proceeding southward, there are three main islands-like water concentrations penetrating the land through small-scale lakes. The three main ones are the Centro Parco lake which is mainly used for the sand extraction; the Idroscalo artificial lake on the eastern side of the Linate airport, which was built as a seaplane during the 30's and converted into a leisure area during the 60's and the Pioltello lake on the south-eastern part. However, there are other scattered water concentrations in the territory such as Forlanini, Redecesio and Lavanderie lakes. Another group of components of this layer is the irrigation ditches and the resurgences, which configure the distributary permeation of the water system.

The next layer is the green ambits as another natural infrastructure of the territory that relates to the water system. Although the main characteristic components of the area are the agricultural lands, the green layer relates to those areas with are

not considered mainly productive. In other words, the public green areas and the protected green resources are the components of this layer. Such components, as previously explained, closely follow the water infrastructure. For example, the two main green traces are found on the two sides of the Martesana canal and the Lambro River on both and west as sell as Pioltello and Forlanini parks. Other important elements of this layer-form the historical point of view as well as their dimension and scale-are Cascina Park, protected lands on the eastern side and the Parco Sud on the southern side.

Accordingly, the interconnection and co-performance of these two layers result in the agricultural and productive character of the territory, which is consisting of local products, and artisan manufactures. On the other hand, such productivity accompanied by the strategic location has caused the area to host several industrial companies as well as institutional and logistic sites. Such a functional transformation from one side makes this area, the eastern hub for the Milanese metropolitan industry especially Media-related products and on the other side emphasizes on the spatial fragmentation of the context especially regarding the space-use and connectivity. The third layer thus consists of the both agricultural sites–also the cultural and historical heritages–and the institutional and industrial ones. Mainly, the components of the first layer are old Cascinas–complex residential bourgeois villas with productive lands rooted in the feudalism history-such as Baraggiante on the north-east and agrotourism lands on the east-south. Regarding the industrial one, companies and institutional components are the most important ones as effective in the scale of performance are Mediaset, Mondadori, IBM, 3 M, etc., which are mostly related to the Media and communication industry.

The last layer in this studied consists of the cultural places which are related to both public cultural activities and hybrid ones of social exchanges. The latter one is mainly related to the connection hubs such as railway station and Linate airport while the first one includes the libraries, public expositional spaces, and educational complexes (Fig. 10).

So far, the analysis proceeds with the stratification of the physical context based on their individual characteristics. These layers then are merged together based on a hypothesized apparatus which is meant to magnify the context through different yet more complex relations. In other words, the purely material context can be observed over immaterial shaping orders. It is important to note here that the analyses are gradually tending towards the non-physical layers especially the communication dynamics and space-use-movement aspects. But first it is necessary to extract the immateriality hidden in the material context.

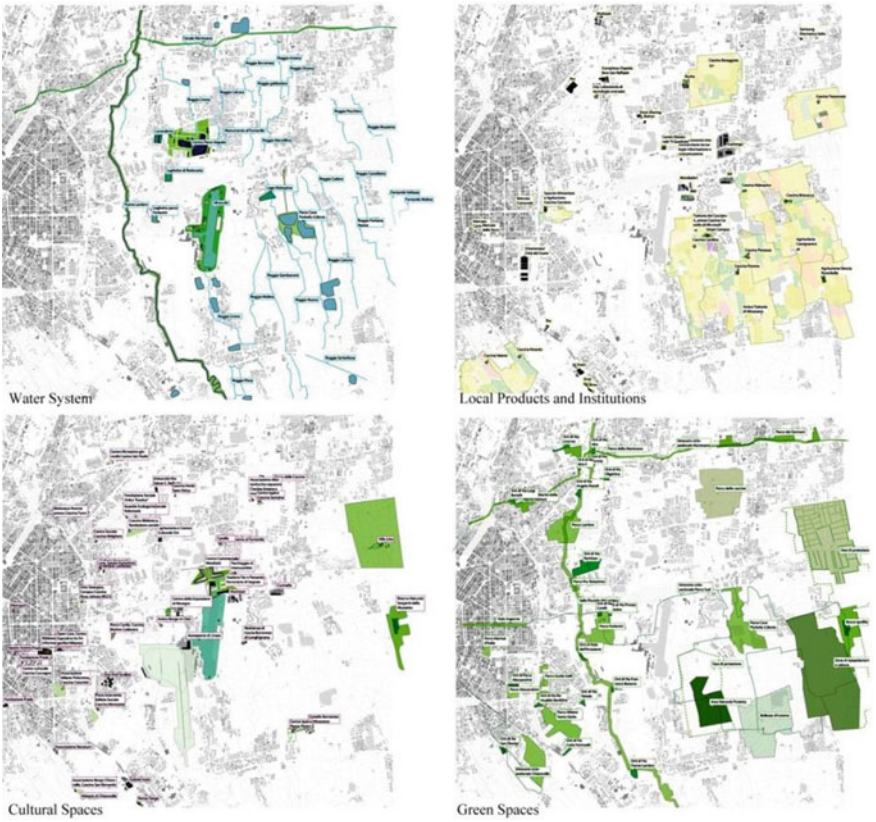

Fig. 10 Physical layers: water system, local products, cultural spaces, green areas

6 Water Management and Milan as Core of the Po Valley Smart Megalopolis

The tradition in the exploitation of water in the Po valley comes from a much older culture, related to the use for energy purposes of the rich natural and artificial water systems, starting from Roman times (but probably, even before) and leading to Middle Ages [41]. Milan was already a Smart City in Roman times and the Po valley had a Smart technological component that developed in the following periods, using water at several different levels, being a primary resource for drinking and watering fields, thermal purpose (for the famous Roman Spas), transportation of people and materials/goods through waterways, and energy production source (for mills). Actually, the abundance of water has certainly been a very important resource for the development of the Po Valley and has necessitated, more than once, interventions of regulation and drainage that have contributed strongly to imprint a particular conformation on the land. In the Roman times already, there were numerous projects of

canalization and intense yet diligent commitment to the maintenance of the canals, used for navigation, irrigation and for the working of the mills [42]. This also comes from the peculiar situation of the Po valley and its special geological, pedological, and hydrological condition, being delimited by "two mountain ridges, the Alps and the Apennines" [43], that create a natural amphitheatre leading to the Adriatic Sea, the enclosed marine basin that represents the last extension to North of the Mediterranean sink [44].

The natural and artificial water system of the Po valley [45] is divided between surface (lakes, reservoirs, rivers, channels, streams, swamplands, transitional waters, humid areas, and so on) and underground water bodies, identified through specific hydrographic basins and sub-basins. This is the first Italian area by river extension (including rivers, like Po, Sesia, Ticino, Adda, Oglio, Mincio, Brenta, Adige and Piave, for a total of more than 46.000 skm): water bodies and streams are divided into types and classified by water quality, ecological status and hydrographic levels [46]. The main collector of water flows is the Po river, the longest Italian waterway: it receives all the waters coming from Prealpine lakes (the main ones are Garda, Maggiore, Como, Iseo, and Endine), both through surface and underground bodies. Another unique feature of the local water system, which has been smartly used from the Roman times, is represented by Thermo-mineral Waters [47], generated by the prolonged contact with rocks, which makes them acquire a particular chemical composition, exploitable for therapeutic purpose, independently from their spring temperature. The quality of and quantity of water is constantly monitored by a network of Public Agencies and Administrations with different duties and tasks.

As a matter of fact, the Po valley has a long course of historical events connected to water management and the development of artificial water bodies [44], starting, in the modern era, from the renowned 'Navigli', the navigation and irrigation canals [48], linking the Maggiore and Como lakes and converging in Milan, connecting Switzerland and the Ticino area both to the Northern navigation systems and the Adriatic Sea through the Po river [49]. The drainage works started in the 10th century, with the facilities planned by local monks (who also invented a primigenial Cash-Flow Analysis method to check the economic efficiency of their investments) and lasted up to the 19th century [42]. The city of Milan, the core of the Po valley, was considered to be a 'water town', having a circular canal enclosing the centre (termed as Cerchia dei Navigli' or 'Fossa/Cerchia interna'), that was covered only in the 30 s of the 20th Century [44]. After the II World War there has been many different proposals of reopening it, but the lack of space for the internal roads and mobility spaces always restricted the municipality from accomplishing it [45].

This network of artificial and semi-artificial water bodies was a primigenial Smart Infrastructure of the Po valley, as it has been conceived as a multifunctional system [42] from its origin, being a hydrographic, agricultural, economic and resource management, transportation, communication, risk management and energetic facility grid [46], centuries before the idea of Smart Cities was introduced. Artificial and semi-artificial channels in the Po valley have always been used for fulfilling many

different regional and local management objectives [50]. The technological development of water facilities also encouraged the development of economic and environmental assessment methods [51], from the beginning of the 14th century, that will lead to the development of the modern Project Appraisal sciences in the Italian tradition (called 'Estimo') since the first half of the 16th century [50] and through the development of ancient and modern cadastral systems [52].

Another peculiar set of semi-artificial water bodies, meant to have a multifunctional use with a high technological content, is represented by the so-called 'fontane' or 'fontanili' (namely, spring, trough, [48], or better "*lowland man-made springs […], which originate from natural resurgences occurring along the alluvial fans of the main watercourses, namely in the transition zone from the higher to lower plain which is characterized by changes in slope profile and sediment granulometry. These habitats usually show low variation in hydrological, hydro chemical and thermal conditions throughout the year*" [43, 53]. The quality and quantity of water in the Po valley have always been a good starting point for the development of human settlements and economic activities [41, 54], not only in the agricultural field, but also in the industrial sector [44], considering that the 'lack' of water in the higher part of the valley (known as 'piana asciutta', where springs and troughs are not found commonly) has led to an early industrial development of the Como-Varese-North Milan area, after the 14th and 15th agricultural revolution (*ibidem*) (Fig. 11).

6.1 The Governance Structure of Water Management in Italy and in the Po Valley

The governance structure that is in charge of water management, supply, protection and treatment in Italy is highly complex and it is divided in many different functions and duties, related to the multidimensional nature of water and its administration, which includes the consideration of the resource itself and the related services, in terms of supply for different uses e.g. domestic, agricultural, industrial, of wastewater treatment, of infrastructure provision and management, of risk detection and controlling, pollution assessment and monitoring/reduction/mitigation, energy production and management [55]. The complexity of the structure, basically referring to the development of Smart Cities in Italy, is represented by a fragmented scenario, in which duties, related to policy making, coordination, advisory, policy implementation, management and surveillance, lead to a situation, where many issues can be identified: "*the fragmentation of responsibilities between State and Regions, the difficulty of coordination among the several bodies at national and subnational levels, the inadequate basin planning in the river basin districts, the preference for emergency actions instead of prevention measures to face floods and drought risks, the slowdown of the municipal water services reforms can be identified as the main weaknesses*" [55, 56].

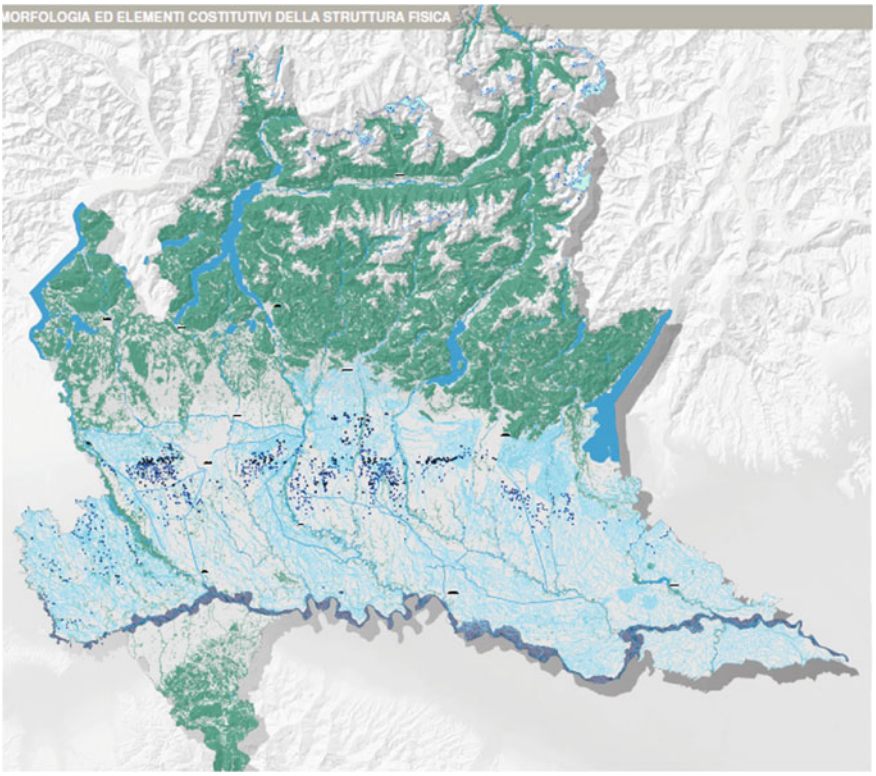

Fig. 11 Morphology and physical structure of Lombardy, Regional Plan (Piano territoriale regionale), 2019

The recent change of approach in the legislative definition of the role of water in the Italian Regulation [57] is fundamental, also for the role of Smart Cities in Italy, as the previous attitude, related to ensuring a sufficient provision of fresh waters (as per the Royal Decree n. 523 of 1904 for hydraulic infrastructures), the Sanitation Laws ('Leggi sanitarie'), promulgated in 1934 and connected to the RD n. 1775 of 1933 on hydroelectric power plants, turned to a new consciousness towards the quality of waters (see Law 319/1976 for the protection of waters from pollution) and hydraulic risks (see Law 183/1989 for the hydraulic protection and Law 36/1994 for the water sector reorganization through Territorial Divisions called 'Ambito territoriale ottimale', or ATOs), significantly influenced by the modern European legislation (see Legislative Decree 152/1999 for the water protection, then abrogated by the Leg.Dec. 152/2006, the new reference framework for the Environment protection rules). Though the water protection is basically overseen by the State and its bodies (mainly, the Environment and the Transportation Ministries, *ibidem*), being a matter included in Environmental protection, which is a duty assigned to the State by the Italian Constitution (1948), also Regional and Provincial Authorities have an

active role in it, with a number of other Public Administrations [55], focused on other tasks, such as the Integrated Water Supply Service and its economic management, that will be described, for the Po valley (as other Regional Authorities have different structures and tasks distributions), in the following paragraphs.

6.1.1 The Main Public Administrations Managing Water in the Lombardy Area

The local Regional Authorities in the Po valley (Piedmont, Lombardy, Emilia-Romagna, and Veneto) include the management and protection of water resources in the list of their main political and environmental objectives, regulated through legislative, planning (including infrastructure), and decisional tools [46]. The regional authorities are responsible for the identification of areas, characterized by high hydrogeological risks, and the hydraulic police, meaning it is the subject that controls activities and works that can be performed inside water state properties and/or in the related buffer areas of waterways (10 m or more, as established by Minor Hydric Network documents compiled by Municipalities), and that determines the related fees. Regional authorities are also responsible for overseeing the irrigation and drainage authorities (Consorzi di bonifica), defining fees and the standards for their respective planning norms, tools, and the integrated water supply service, which includes all the public services related to water supply, sewage and treatment facilities, directly managed by the provincial territorial divisions for the integrated water supply service authorities, as described in a specific annual report edited by the regional authority [57] (Fig. 12).

Priority infrastructures are identified by the regional authorities through the Priority Objectives (POs) of their development plans (*Piano territoriale regionale*, PTR), and updated annually: i.e., lamination basins are included in the list of POs with the municipalities involved, being the highest strategic level that influences 'River Agreements' and sectoral planning tools. The Regional Authorities are also the reference bodies for several planning interventions (Water protection Plan or *Piano di Tutela delle Acque*–PTA; Water Use and Protection Program or Programma di Tutela e *Uso delle Acque*–PTUA), for the identification of the Main Hydric Network (*Reticolo idrico principale*, RIP) and for the data production and update [46], through its Geoportal Services (e.g. for the Regional Water Assessment or Bilancio idrico regionale and the cartography for the first layer underground hydrostructure), plus the implementation of a long list of programs and projects related to water. Another interesting planning intervention at the regional level is called the 'Contratto di Fiume' (namely, River Agreement) promoted by Lombardy, that is, in the regional authority definition, a voluntary tool of strategic and negotiated planning, contributing to local development, that pursues the protection and accurate management of water resources, the enhancement of river basins, together with the safeguard from hydraulic risks, which are enforced using local development agreements, or *Accordi Quadro di Sviluppo Territoriale*–AQST (e.g. the Agreement for the remediation of the Varese lake–AQST per la salvaguardia e il risanamento del

Public Authority	Duties	Tasks	Planning tools that can include policies/ actions influencing water	Geoportal
Regione Lombardia Lombardy Region	Resource management, strategy, policy making and implementation, priority setting, quality standards, economic and environmental regulation, control at sub-national level of national regulations enforcement	Planning (including infrastructure) and large derivations decisions, water supply management for all uses, wastewater treatment, compliance of service delivery for agriculture and industry	Piano territoriale regionale (PTR), Piano gestione acque, Piano di tutela delle acque (PTA), Programma di tutela e uso delle acque (PTUA), Piano di gestione per la tutela del rischio idrogeologico, Piano di gestione del rischio di alluvioni (PGRA), Piano regionale per l'adeguamento delle infrastrutture, Contratti di Fiume, Accordi Quadro di Sviluppo Territoriale (AQST), Programma d'Azione regionale per la protezione delle acque dall'inquinamento provocato dai nitrati provenienti da fonti agricole nelle zone vulnerabili ai sensi della Direttiva nitrati 91/676/CEE – 2020-2023, Programmi d'azione, Piano territoriale regionale d'area dei Navigli Lombardi	yes
Direzione Generale Ambiente e Clima di Regione Lombardia Department for Environment and Climate of Lombardy Region	Technical-administrative and planning activities	Plans enforcement, technical advice		yes
Province e Città metropolitana di Milano Provincial Authorities and the Metropolitan City Agency	Resource management, allocation of uses at local level	Small derivations, water supply management (domestic, agriculture, industry) and wastewater treatment	Piano territoriale di coordinamento provinciale (PTCP), Piano cave, Piano provinciale di gestione rifiuti (PPGR), Programma provinciale di previsione e prevenzione, Piano energetico provinciale, Piano di settore del demanio lacuale	most
Comuni Municipalities	Allocation of uses at sublocal level, compliance of service delivery commitment	Domestic water supply management, wastewater treatment, control at sub-national level of national regulations enforcement for domestic waters	Piano di governo del territorio (PGT), Piano urbano di gestione dei servizi del sottosuolo (PUGSS), Piano energetico comunale, Piano di emergenza comunale, Elaborato semplificato invarianza idraulica, Reticolo idrico minore, Piano regolatore generale degli acquedotti	only few
Città di Milano City of Milan	Allocation of uses at sublocal level, compliance of service delivery commitment	Domestic water supply management, wastewater treatment, control at sub-national level of national regulations enforcement for domestic waters	Piano di governo del territorio (PGT), Accordo Quadro di Sviluppo Territoriale (AQST) Milano Metropoli Rurale, Piano urbano di gestione dei servizi del sottosuolo (PUGSS), Piano energetico comunale, Piano di emergenza comunale, Elaborato semplificato invarianza idraulica, Reticolo idrico minore	yes

Fig. 12 Main public administrations involved in the water management activities at regional level

lago di Varese, and the AQSTs for specific river basins, such as Olona-Bozzente-Lura, Seveso, Northern Lambro), that are executed by specific action programs (Programma d'azione) and strategic sub-basin programs (*Programmi strategici di sottobacino*), that define the framework of measures and actions (general and local), coordinating planning intervention at different levels. AQSTs also implement the environmental objectives of the European Union, particularly related to water, as per the 6th Environmental Action Program and Directive 2000/60/EC.

Regarding the thermal and mineral waters, regional authorities are responsible for determining incentives, marketing activities on the hydromineral heritage, planning and supervising the touristic and economic development of the sector, plus monitoring and controlling the entire industry [55]. Another important duty of Regional Authorities is linked to their participation into Environmental Impact Assessment (*Valutazione d'impatto ambientale*, VIA) and Strategic Environmental Assessment (*Valutazione ambientale strategica*, VAS) procedures concerning projects, on one side, and programs/plans, on the other, that can involve water at different levels and

for several purposes, plus the Landscape Autorization (Autorizzazione paesaggistica) and various other environmental authorizations procedures (e.g. *Autorizzazione unica ambientale–AUA, Autorizzazione integrata ambientale–AIA, or Autorizzazione unica*–AU) for major public works and infrastructures, main agriculture, industrial developments and waste management projects [57].

Regional authorities and their departments administer the resource management, including planning interventions and large derivations, while small derivations have been transferred to provincial authorities and the Metropolitan City Agency [57], as a reference body for Milan and the Po valley as Smart Megalopolis. This means that water derivation and drawing can be authorized by the Regional Authority (e.g., over 1,000 l/sec for irrigation purposes, over 100 l/sec for springs and wells, over 3000 kW for energy production), or the provincial ones, that deal with minor instances related to water use and energy production requests related to stable or temporary uses of superficial and underground (through springs, wells and pits) water bodies [46]. Every province has a specific service with different procedures [55], which is also responsible, usually, for authorizing new urban wastewater connections to new and existing facility networks, and industrial or domestic wastewater drainage activities into surface waterbodies or into the ground (as per Legislative Decree n. 152/2006).

Provincial authorities, besides being the administrations entitled of ensuring water quality protection, safeguarding soil, defining water regulation and use [57], and approving the Minor Hydric Network (Reticolo idrico minore, RIM) layout identified by Municipalities, can also be involved into different environmental authorization procedures (VIA, AUA, AIA, or AU) in the waste management field and in the research and cultivation permit for mineral waters. Another important duty of Provincial Authorities is related to collecting, digitizing, and controlling volume notifications about water derivation and drawing activities (sent before the 31st March of every year), as per art. 22 of the Leg.Dec. n. 152/2006 [46]. Provincial authorities are also involved (through a specific written recommendation) in the assessment of the delimitation of protection areas for surface and ground water collection for human consumption, through services offered by third parties using pipe installations of public interest.

The city of Milan, as core of the Po valley Megalopolis, has an active role in this topic as well, being a part of the Regional Agreement made in the support of integrated rural systems and multifunctional agriculture as drivers for the soil consumption control and the ecosystem services strategies implementation [46]. In general, Municipal authorities have an active role both in the planning sector and in service providing and management [57]. Concerning the planning tools, townships are involved in water management through the geological studies for the general planning tools, which include a simplified document for hydraulic invariance, the identification of the minor hydric network (*Reticolo idrico minore*, RIM) and the related regulations [46]. Another important role that municipalities can have is regarding the definition of the General water management plan (*Piano regolatore generale acquedotti*), that is not mandatory though, differently from the Underground Facilities Networks Management Plan (*Piano urbano generale dei servizi nel sottosuolo*, PUGSS). Townships also have an active role in the development of minor hydraulic

works for the mitigation of risks, plus in the management of the compliance of service delivery commitment at local and sublocal levels [57].

6.1.2 Sectoral Public Bodies Representing the Governance Structure in the Lombardy Area

Park Management Authorities of national and regional level (in Italian, Enti parco nazionali e regionali) have a primary role in the environmental protection and the landscape management, but they are also involved in many sectoral activities concerning water quality and its biodiversity [57], as the Minimum Vital Flow (MVF, deflusso minimo vitale, DMV) calculation and management. The MVF is the runoff that, in a natural waterway, must be guaranteed, considering all possible intakes, in order to keep the functionality conditions and the ecosystem, quality of water-bodies, compatible with a sustainable use of water resources [58]. Park authorities also oversee the definition of compatible activities with the environmental protection, such as the opening of new dockyards and the environmental and landscape authorization of new developments (being also involved in assessment activities regarding implications on Natura 2000 sites, in Italian, Valutazione d'incidenza, VINCA). Plus, Regional Park Authorities also have specific duties in hygienic and drinking water infrastructures, water, air and soil pollution reduction, aquaculture regulation and sectoral planning interventions, aimed at protecting water as a source of biodiversity [46] (Fig. 13).

The Territorial Divisions (*Ambito territoriale ottimale*, ATO) for the Integrated Water Supply Management, one for every Provincial Authority and for the Metropolitan City of Milan, manage water services in the Po valley [59]. ATOs oversee the entire water cycle management, which includes collecting (reception), inducting (production), and distributing water for civil uses, sewerage, and wastewater purification. From the planning point of view, Territorial Divisions can approbate their own Catchment Area Plans (*Piano d'ambito* ATO).

From the infrastructure and resource management point of view, several sectorial authorities and agencies are in charge of different functions and duties [55]. The most important Authority in the Northern Italy area (covering 8 on 9 Regional Authorities and including also some French and Swiss regions) is the River Basin Agency for the Po river (in Italian, *Autorità di bacino del fiume Po*), which is responsible for the hydrogeological risk management (based on the 2000/60 EU Directive and the basin definition given by the Italian laws, through the D.P.R. 06/01/1998), that is realized through several legislative, planning and regulatory tools, starting from the Hydrogeological Structure Plan and its excerpts (*Piano di assetto idrogeologico*, PAI, established by the Law n. 183/1989), the Flooding Risk Management Plan (*Piano di gestione del rischio di alluvioni*, PGRA, introduced by the EU Directive 2007/60/CE), the Hydrographic District Management Plan (*Piano di Gestione del distretto idrografico del fiume Po*, PdG Po, approved by the Institutional Committee Resolution n. 1/2010) with its Water Balance Plan (*Piano di bilancio idrico*), and the Strategic Sub-basin Plans (*Piani strategici di sottobacino*).

Public Authority	Duties	Tasks	Geoportal
Enti parco nazionali e regionali Park Management Authorities of national and regional level	Resource management and protection, allocation of uses at local level, environment and landscape management and protection	Water supply assessment (domestic, agriculture, industry) and wastewater treatment evaluation	most
Ambito territoriale ottimale (ATO) Territorial division for the Integrated Water Supply Service	Compliance of service delivery commitment, economic regulation	Domestic water supply management, wastewater treatment, compliance of service delivery for domestic waters and wastewaters, economic regulation for domestic waters and wastewaters, control at sub-national level of national regulations enforcement for domestic waters	no
Autorità di bacino del fiume Po (AdBPo) River Basin Agency for the Po river	Resource management, allocation of uses at local level	Agriculture and industry water supply management and wastewater treatment	yes
Agenzia Interregionale per il fiume Po (AIPo) Interregional Agency for the Po river	Allocation of uses at local level	Water supply management	yes
Agenzia Regionale per la protezione ambientale (ARPA) Regional Authority for the Environment Protection	Information, monitoring and evaluation, quality standards	Water quality standards definition for all uses and for wastewater treatment	yes
Consorzi di bonifica Irrigation and Drainage Authorities	Resource management, allocation of uses at local level, compliance of service delivery commitment, economic regulation	Agriculture and industry water supply management and compliance of service delivery, wastewater treatment	several
Agenzie per la promozione turistica Agencies for the promotion of artificial waterways	Resource management, coastal areas protection, navigation management	Touristic development and promotion of artificial waterways	no
Agenzie di Tutela della Salute (ATS) Health Agencies	Resource management, health risks prevention	Wells and springs management and protection, local regulations assessment, burial ground areas protection buffer definition	no
Gestori servizi idrici Integrated Supply Companies	Resource management, allocation of uses at local level, compliance of service delivery commitment	Water Mains/Sewage/Water Treatment services	some
Gestori dighe e centrali idroelettriche Hydroelectric Energy Production Plants and Dams Management Companies	Resource management, energy production, water levels definition	Dams, Energy Production Plants, Water level management	no
Autorità di regolazione per energia, reti e ambiente (ARERA) Authority for Regulation Energy Networks and Environment	Resource management, energy production regulations	Competitive markets development	no
Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA) Institute for Environment Protection and Research	Environmental Research and analysis	Datasets collection, research activities and programs	some
Protezione civile Civil protection	Risk management, Emergency management	Alert Systems management, Emergency activities	no

Fig. 13 Sectoral public administrations involved in the water management activities at regional level

The second most important body is the Interregional Agency for the Po river (*Agenzia Interregionale per il fiume Po*, AIPo), which was introduced by 4 Regional Authorities (Piemonte, Lombardy, Emilia Romagna, Veneto, corresponding to its 3 different offices and the headquarters in Parma) in 2003 for the management of the main water system (that formerly was a duty attributed to the Magistrato per il Po, instituted in 1956), dealing with safety, public resources and property management, navigation issues and water levels monitoring, thanks to actual and historical datasets, that are made available through its geoportal [59]. The River Basin Agency has some Territorial Divisions, entitled of managing specific rivers and lake basins.

From the point of view of the resource management, the Regional Authority for the Environment Protection (*Agenzia Regionale per la Protezione dell'ambiente*, ARPA)

is in charge of managing the water quality and the reduction of pollutants, focusing on ground and underground waters, but also considering sustainable uses and wastewaters, through data and indicators, synthesized in annual environmental status reports [46]. Most of the available data collected, processed, and synthesized in indicators is also made available through a geoportal, that is focused on the hydrological information.

In the regional context, the management of water consumption and distribution for different purposes, including agricultural uses, is a task of Irrigation and Drainage Authorities [59]. They promote the development of projects, initiatives, and interventions for the multiple and sustainable use of water, hydraulic soil protection, safeguard and enhancement of the environment and the landscape. From the planning point of view, Irrigation and Drainage Authorities, being entitled of the management of artificial water bodies and their infrastructure, have an active role in developing their own District Plans (*Piani comprensoriali di bonifica, irrigazione e tutela del territorio rurale*), coordinated with specific Three Years District Programs for hydraulic works (*Programmi comprensoriali triennali delle opere*), Hydraulic Police Regulations (*Regolamenti di Polizia Idraulica*), Properties Classification Plans (*Piani di classificazione degli immobili*), and Hydrogeologic Risks Mitigation Works Maps (Mappe degli interventi di mitigazione del rischio idrogeologico), plus, being the manager of physical infrastructures, their own Facilities Details Abacus (*Abaco delle opere idrauliche*).

The local Health Agencies (*Agenzie di Tutela della Salute*, ATS) have several important duties in the field of water protection and management as well, according to the Regional Law n. 23/2015, mainly focused on prevention and reduction of pollution, including the definition of buffer zones for wells, springs, and burial ground areas, potable water and water mains analyses, vulnerability classification assessments for water-bodies, swimming pools opening permits, monitoring and controlling (chemical and microbiological assessment) of waters for the human use, and so on [57]. Health Agencies can also monitor and control the 45 Integrated Supply Companies and the 238 Townships managing their own Water Mains/Sewage/Water Treatment facilities.

Dams and Hydroelectric Energy Production Plants are managed by different local companies, though they are mostly owned by the Company for Electric Infrastructures (formerly, a National Agency managing the Electric Networks and Facilities, in Italian, Ente nazionale per l'energia elettrica, E.N.E.L.). There are different companies managing both the infrastructures (some dams are only regulating infrastructures, some include energy production facilities as well) and the energy production plants, involving Electric Supply Commercial Companies directly, or Public/Semi-Public Agencies, but also specific Consortia and Groups.

The Authority for Regulation Energy Networks and Environment (*Autorità di regolazione per energia, reti e ambiente*, ARERA) promotes the development of competitive markets in electricity, natural gas and drinking water supply chains, mainly through different policies involving fees regulation, access to networks, service quality standards, and the protection of customers and end-users.

The Institute for Environment Protection and Research (*Istituto Superiore per la Protezione e la Ricerca Ambientale*, ISPRA) is involved in several research programs concerning water in all of its dimensions (quality, quantity, pollutants, ecological role, risks, and so on), and produces many important databases (actual and historical, spanning from inner waterways to Hydrosphere indicators), plus it provides many important services, as the Operational Hydrology, Hydro-morphology, Floods, Water Resources and Drought Service [55]. Plus, the Pesticides Portal of ISPRA presents datasets synthesizing national monitoring programs on inner ground and underground waters, including a specific geoportal.

The last two important roles at regional level in water management policies and actions are played by Touristic promotion agencies and the National and Local Civil protection (Protezione Civile, PC), which are responsible for the prediction and prevention of natural and anthropogenic risks and the management of the National and Local alert systems, including hydrogeological events. Agencies entitled of water management and promotion are Public Bodies created by Regional and Local Authorities, with the aim of promoting the cultural and touristic development of local channels. They can be entitled of managing the touristic navigation of channels and developing policies, governance tools and development programs for the promotion and the sustainable growth of waterside areas.

6.2 A Possible Governance Mission for Water Systems in the Smart City of Milan

Efficient resource management is essential to reduce energy and water consumption and prevent waste generation, even in a modern Smart City. Milan is already included in a Smart Megalopolis from a few points of view (and it has been so for centuries, as we stated in the first paragraph of this chapter), being the first city in Italy in this sense, but it can become even smarter [60], by ensuring a more efficient water supply, wastewater management and drinking water treatment on a large scale, as key services that every Smart Megalopolis and its Municipalities should offer. The smartness concept for cities involves around 6 key factors, which are, economy, people, governance, mobility, environment, and living (*ibidem*).

From the perspective of water management, Milan is a Smart Megalopolis as it has reached some objectives in terms of environmental sustainability, mobility, participation, and economic innovation, but there is still a lot that can be done from the point of view of including the value of resources [61] in its strategies, spatializing this concept with innovative methodologies [11]. The starting point can only be a new digital consciousness, using the existing infrastructures and networks to develop a new mission for the Smart Megalopolis of the future, also in the light of the latest achievements in terms of sustainability [61], proposed by the Sustainable Development Goals.

Integrated management platforms for drinking water treatment, water distribution networks, sewer systems, and sewage treatment facilities can help monitoring the efficiency of systems in real time, ensuring a reliable supply service and efficient maintenance programs using adequate prediction models, solving issues in a fast and well-organized way. This can help saving resources, reducing consumption, and minimizing pollution and emissions [60]. For the use and reuse of waterways as transportation and communication systems, or as risk mitigation structures and energy sources, for reusing the vast network of minor mills still existing in the agricultural areas of Lombardy, the same principle is applicable. In this part of the Po valley, watering is one of the main goals to ensure, recovering modern and ancient smartness of districts and regions [11], through maps, information and data, defining correct spatial distribution rules [61] aimed at maximizing the economic sustainability of Smart Megalopolis and their resource consumption.

7 Potential Component of a Symbolic Mediators System for the Cultural Smart City of Milan Metropolitan Area

The metropolitan area analysis starts in both physical and communication ambits. Regarding the first ambit, after the exploration of constitutive physical layers, the crossing point' elements of them will be extracted as interface spaces. Such elements are in fact the contextualization of the theoretical deepening especially regarding the concepts of symbolic mediators [20], mental map [62] and Drift [63]. To precede so, the physical context is read through the hypothetic possible narrations between its constitutive layers and components. Moreover, the extracted components arranged within a comprehensive 'shape of order', based on the four layers: water system, green spaces, local industry, and cultural activities.

The apparatus is a matrix, which is meant to embrace the physical elements of the territory objectively selected on the one hand, and on the other hand, to create subjective narrations among them by a hypothetic user. In other words, the matrix, can be converted into a socio spatial temporal database capable of producing multi-directional recitations between the elements. Such narrations will make perceptible the relations between the elements by generating connective paths on the territory.

It is conceptually meant to function as a micro cosmic apparatus that reveals unlimited passages from one layer to another. In other words, the main scope of such deconstructive apparatus is to arrive as close as possible to the communication ambits in terms of cross-referential flux of information (Fig. 14).

Such deconstructive apparatus could actually help us investigate through immaterial dimensions of the territory in terms of the way we use the spaces, interact with them, and move through them. Such apparatus is a conceptual passage machine of which the logical order is based on the chaotic channels between subjective and objective presence. In an absolute condition, where geographical constraints are not of importance, would operate like what we know today as digital networks and data

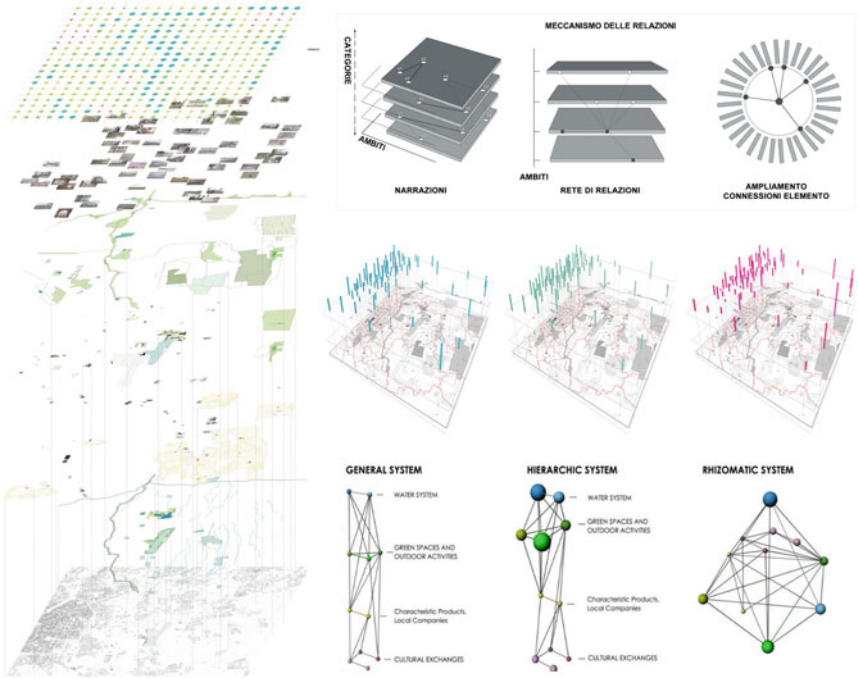

Fig. 14 Apparatus [40]

management programs: first comes the spatial organization of territory's components data in an equally-valued distribution and arboraceous structure where there is no privilege of one theme over another and so it comes with a liberty of choice like the world wide web (www) where the user is free to navigate without any linear pre-established path. Therefore, whilst the contents are categorized and differentiated, what activates them is, potentially, in chaotic and unpredictable use, movement/scroll. The second similarity is the act of movement itself through the parts positions of each component in the matrix which take the user from one stage to another, like the act of click in the cyberspace. According to the explorations of such hidden relations, we might imagine three systems of relational structure shaping the order of the apparatus:

- General System: Reflects direct and immediate relations with no privilege for one element over the other in terms of attractiveness of space;
- Hierarchic System: where places acquire greater or lesser importance depending on their public frequency potentials, location and connections they can generate with the other ones;
- Rhizomatic System: it creates preferential navigation based on the user's choice taking the territory to a polycentric condition. This later system is in fact closest one to the network-like nature of today's society, especially in the virtual world.

Up to this point, the main focus was on revealing spatial-temporal relations between physical elements of the area giving those relations a communication like shape of order. In other words, the important issue so far was to re-read the territory and moving through it by using the communication devices. The main question that rises here is: does this new 'reading' of the territory lead towards the definition of new spatial characteristic for the urban spaces, which could consequently address the projects in their physical aspects and lead to the definition of a space/scale morphology? Since in the physical context this ultimate liberty and instantly chaotic navigation is limited by geographical constrains and temporal fatigue, this kind of deconstruction of the territory in both objective and subjective ways, helps to sketch out discontinuities stand out, especially when the analysis tends towards the communication layer.

The superimposition of the physical context and tele-density layer as a component of the communication layer would result in the identification of an in-between context; a meta context where from one hand the trilateral interaction between physical context, smart device and user would be defined in a dynamic scale morphology and from the other hand the so called crossing-point elements can be re-verified as temporal symbolic mediators [11] opening theoretical interpretations regarding the psychological dimension [34] of mobile society. It is also crucial to note that the ultimate scope of these experimental analyses is not directly related to the psychological features of the communication and space but to study the mechanism of relations between those two strictly related to the space-use, urban context and urban regeneration. These parts are in fact the useful stages, which this research finds inevitable in order to comprehend the changing dimensions of the contemporary urban context.

8 The Meta-City of the Metropolitan Area of Milan for a Smart Metropolitan Communication System

Our research focuses on how Milan Metropolitan area balances both macro/micro economic factors and its spatial structure according to cultural factors: the underlying form of residential, public areas and landscapes. It discusses the relation between new settlement, activity and space and it rises from the way its culture and its activities require diverse demands on movement, new settlement of formality, gradients, and co-presence. Finally, we have to determine both the way how patterns of infrastructure and space integration influence the location of different settlements, classes and social groups in the city and how it is possible to solve the pathology of housing and public realm estates. The spatial form needs to be understood as a contributing factor in forming the patterns of sustainable urban metabolism, integration, or segregation in the city.

The starting point of this work comes out from the necessity of defining the contemporary Milan Metropolitan city within its territory, through a clarification of a new scale of intervention. The framework of the metropolitan city coincides with

the formal and structural dimensioning of the metropolitan territory. The need for a cultural jump is necessary in order to identify a range of elements and relations in the urban context, rather than simply considering that a city is Smart due to an upgrade of the technologization of its ground, and the instruments of intervention and investigation. This means a better definition of the structural pattern and spine of this reality, is needed first [32].

Still, today, it is fundamental to consider the Metropolitan Area of Milan's role as a smart city starting from some questions:

- The role of urbanity at the contemporary metropolitan scale;
- The role of technology as a tool and medium but not as goal;
- The need of keeping quality of space and man at the centre of architectural and urban design.

Considering that, according to Cedric Price (1966), the main question on the background is: Technology is the answer, but what was the question?

The Milanese area faces a quantitative dynamic, quickly accommodating the greatest number of inhabitants. This phenomenon also raises expectations of efficiency, of rapidity in the result, on the part of the owners of urban mega-projects in developing countries. The approaches of powerful developers providing design and implementation, or even part of the financing, get the decision-makers under the pressure of rapid implementation. We know that urban development is traditionally a slow process of maturation, a slowness which is rather accentuated in Western countries by the improvement of sustainable development approaches with the sophisticated and iterative interplay of good governance, consultation, segmentation of the interplay of players. The most interesting of these new city projects utopias such as Masdar's project, serve as a field of application for innovative solutions imported from Western countries: renewable energies, electric mobility, virtuous water cycles.

This somewhat disillusioned point of view must give way to an objective observation of innovation in urban design. What do new products, new technologies, innovative methods, and approaches make possible?

The urban growth of the second half of the 20th century, still plagiarized in many emerging countries, produced the shortcomings of the all carriage system, functional and social segregation, the artificialization concretization of the urban landscape, the destruction of food-producing practices. In reaction, new expectations are asserting themselves, conceptual proposals are being developed and theorised in the fields of the walking city, soft infrastructure (describing the values of the use of public spaces in the city and articulating these in an organised network), urban and peri-urban agriculture, etc. Circular economy, urban metabolism are emerging concepts which are still rather theoretical, but which should gradually become established in the design of urban projects. The Milan Metropolitan, in particular for the Expo event in 2015, started the digitalisation of the urban environment. Still, the last few years have been characterised by the digitalisation of the users, driven by the internet and mobility growth. In the last 3 years the penetration and usage of smartphones has increased substantially.

Digital technologies exploit the data and service infrastructure space, offering a way to design new experiences and contribute to fulfilling the demand. The digital experience layer is the place where city services and digital user are meeting. Citizens are interacting in the day to day living with the urban space through a variety of innovative touch points, mostly personal (smartphone, tablet, e-glasses) but also public, in the attempt of public institutions to re-qualify traditional interactions [64]. Working on innovative sensible metropolitan patterns, the focus of a Smart Metropolitan City is the use of technologies trying to enhance the accessibility of the territory at various scales and to gather proactive feedbacks as a profitable resource and legacy of the event. Setting new mental maps at the metropolitan scale of the Milan Metropolitan City Area, the meta-networking operation triggers spatial transformations and awareness. Milan so promotes the engagement of local stakeholders through different involvement policies, from formal to informal, working on public administration, associations, companies as well as on bottom-up participation and sharing-economy processes.

In an informational ecology perspective, the Milan Metropolitan Area project aims at proposing a sensitive network of reactive nodes through the definition of mapping interactive tools, thanks to the embedded technologies, fast tracking systems, augmented reality, field and immersive maps available through 2.0 smart devices. The purpose is to open possibilities for further plug-in implementations to relate the mapping experience with local economy's support and enhancement. The chapter so underlines the main theoretical premises regarding the relationships among urban space, mental maps and ICT tools and then presents a case-study focused on the west area of Milan: a critical neglected area requiring the combined effort of digital and physical design for regeneration. A Metropolitan Smart City tries to implement solutions providing services access in the framework of an integrated vision of the territory and its future, addressing therefore the following interlinked questions: Transition towards what? What do we need access for?

Alì Madanipur in his book "Whose Public Space" [65] draws four types of access regarding the socio-spatial interfaces:

Physical access: as material access to the environment;

Social (or symbolic) access: in relation to the positive or negative reception that specific social groups experience in the space;

Access to activities and discussions: particularly regarding development and use processes of the space itself;

Access to information: again, regarding development and use processes of the space itself [65].

Although from a critical point of view, such integration between social and symbolic, risks to fall into a state of generalization and simplification, since as we previously discussed, symbolic values are connected to the signs and subjective spatial connotations which do not have to be necessarily attached with social interaction in terms of interface of the masses. To avoid such theoretical error, we focus on the symbolic access since the social access is also found in the third category which is considered as real in the symbolic access is the received message as the trigger that influences and governs our actions. The third one is the access to

activities and discussion and as explained before we put the social access here-the reality is in the momentary decoding of meanings in the socio-linguistic context. For example, the traditions, the cultural behaviours of people in a specific cultural context and the fourth one is the access to information to which Madanipour assigns the ways of using the space. So, the real here lays on the spatial signals that come from the ways we interact with the space which as explained before can mute from person to person and from time to time. Overlapping the four categories, we find out that what is in common in all of them is the access to information. In fact, the fourth category is what defines qualitatively and quantitatively the access to the reality in all of the fourth categories. In other words, we see, we smell, we hear things by the information we receive with our five senses, we interpret the space, we decode the meanings of signs by the mental processing of information and our memory, we interact with the multi-dimensional information. This is what defines for us our way and quality of access to the reality and almost in every case the information comes prior to what then is considered as real. In short, we access the information as mediated reality of all kinds. Moreover, this can be the focal point: information that links them and makes them co-exist in a level above the purely objective space; a Meta level.

A state where all the substances of a society (of a city) are configured together and streamed down to the physical environment through the human-device-based conductors, can be called a Meta-city. Proceeding so, we find ourselves in front of the question: how this level converges to the physical, spatial space we inhabit? In other words, how the ways of accessing the information as Meta reality relapse on the space? To find out possible responses to these questions, requires chrono-technological stemming in the occurrence of Meta-city through different historically distinguished transitional thresholds [19].

9 Spatial Patterns of Communication Morphology

9.1 Contextualization

The phase is related to the data mapping in both digital and physical contexts and the analytical, comparative reading of both in relation to their morphology. The first step is mapping the wireless (floating) environment as an upper level of complexity above the physical urban spaces the city of Segrate where the existing private Wi-Fi environment is explored through the two steps of data capturing, and intensity contextualization processes.[2] The presence of Wi-Fi fields detected has been mapped

[2]To the research date, nearly similar experiments of mapping Wi-Fi areas were produced. Above all, the Salt Lake City Wi-Fi Map developed at Senseable City Lab, MIT. See Sevtsuk, A., Huang, S., Calabrese, F., & Ratti, C. (2008, in press). Mapping the MIT Campus in Real-time Using WiFi. In M. Foth (Ed.), Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City. IGI Global, Pennsylvania, 2008.

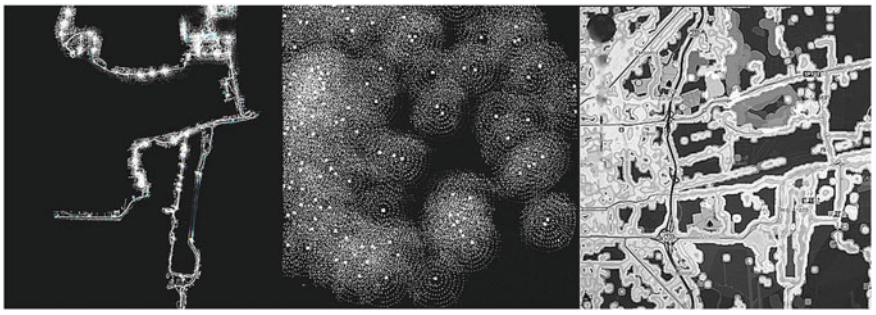

Fig. 15 Left: wi-fi pattern on the main axis [40]. Middle: cellular masts spatial distribution in the areas of Segrate and Linate. Right: coverage effective pattern in the areas of Segrate and Linate [19]

according to their locations and varying intensity. Google MyTrack is chosen as tracking program and installed on a smartphone; the measurement unit is the Wi-Fi antenna of an iPod and the covered area includes the North-West entrance to Segrate from Cascina Gobba station, towards the central and eastern parts of the city, down through the Idroscalo and finally South-Western via Forlanini [66] (Fig. 15).

9.1.1 The Hybrid Morphology

The next step of mapping is the spatial pattern of cellular masts distribution in the area of Segrate and Linate resulting from cross-referencing analyses through interactive open sources [67]. The aggregation of the cellular masts and their coverage pattern is mapped based on the coverage area of single mast while in reality coverage area results from the complex and synthetic performance of the mast. The complex pattern will be analysed in the next steps. As seen in the following image, the cell towers are mostly concentrated on the eastern edge of the examined territory. The densest areas therefore are at the borders with the city of Milan and towards the south-west near the Linate Airport. What is noticeable here is the central gap where the logistic area of the rail yard is located.

This pattern is the static condition which means that it is resulted from a manual calculation of the coverage areas. the dynamic-temporal- condition occurs through the accumulative operation of the mast in a given territory called Handover. In this regard, the following image shows the complex effective coverage pattern which alike the previous one is driven from cross-referenced data [68]. As it is noticeable in the image, the contextualization of the effective coverage areas follows mostly the physical infrastructure system in the areas with strong signal intensity (Fig. 16).

Based on this comparison, three main differences stand out: the first one is related to the spatial aggregation: in the case of physical layers, the constitutive components have a scattered distribution while those of communication infrastructure are aggregated within continuous patterns. For example, the green areas and the built fabric are both configured in separate units without spatial continuity while the cellular

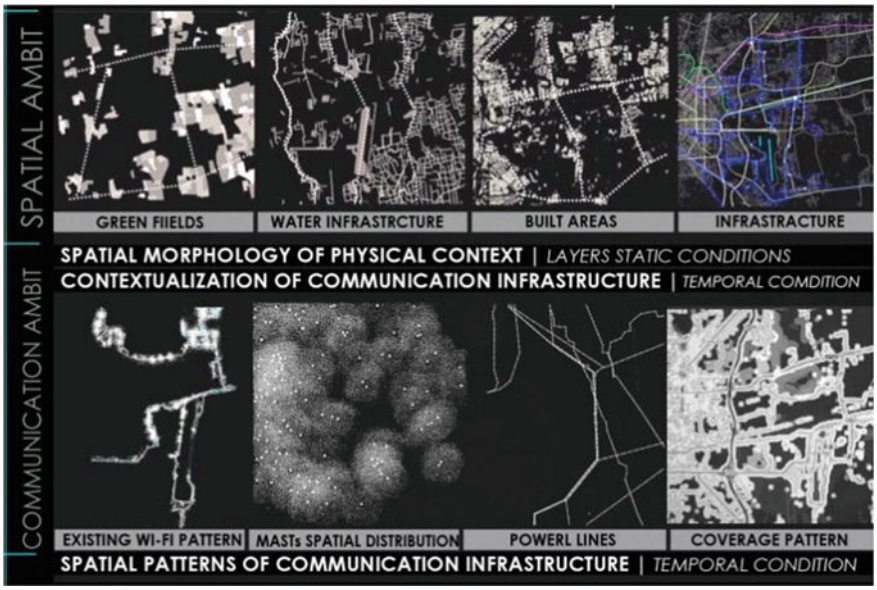

Fig. 16 Comparative contextualization of physical and communication morphology [19]

coverage results in a more or less homogeneous shape. The second difference is the connectivity between the elements: in the physical layers the elements are connected to each other by the infrastructural system that penetrates among them. The connectivity in the communication ambits is due to the spatial overlap between the component's accumulative performance. The third dissimilarity is related to the spatial direction: the built fabric, that follows a north-south direction which is mostly due to the agricultural characteristics of the area and the fact that the land is basically structured by the water system and the irrigation pattern. In the non physical ambits (the communication layers) there is no distinct direction. By overlapping the two ambits, it is more obvious that the spatial distribution and the performance pattern of the telecommunication, despite of appearing irregular, are majorly compatible with the physical infrastructure. In other words, the two infrastructural ambits have a complementary presence within the urban context. The following image illustrates the overlapping situation, and the three rectangular yellow frames are areas where the continuity of the non-physical patterns is interrupted by the physical elements, especially the infrastructural tracks (Fig. 17).

It is important to note that this examination of telecommunication pattern is however within the temporal sphere which means that while the physical attachment of the components–for example the cellular masts-is fix and stable, their performance is dynamic and alters from time to time especially due to the external variables such as weather condition or the data-traffic. Nevertheless, the total performance of such components follows quite the same pattern. What is resulted out of this set of mappings, is that the telecommunication layer has a physical and material

Fig. 17 Superimposition of cellular masts on the physical context [19]

relapse, which is affected and driven somehow, form the physical configuration of the context. It means that in spite of differences between the two ambits, both are configured together based on the physical connectivity. Such co-configuration of the two ambits is also dependent to the activities running in the urban areas. In the next part, through a set of calculations, the telecommunication pattern on the city of Segrate will be extracted.

9.2 De-Contextualization

At this point, research proceeds with the mapping of telecommunication dynamics-regardless the physical context geometry, using the big data provided by Telecom Company, which has almost 40 percent of the mobile users and telecommunication services in the Italian market [69]. Telecom's data user monitoring process is based

on the division of the territory in pixels of 223 × 223 m. To each pixel, the number of active users in every 30 min is assigned. Therefore, the resulted information is hourly dynamic maps based on different temporal threshold, which is in contrast with the static configuration of the physical territory. Such dynamic maps, besides their statistic information can in fact illustrate the changing spatio-temporal modalities of space-use and the relation of such modalities with the spatial capacities of urban spaces regarding the aggregation of people-data flux. Moreover, through the superimposition of Telecom's hourly maps with the physical territory we can identify passive and active areas in a temporal sphere of daily use which consecutively can lead towards numerous qualitative and quantitative interpretations regarding the multi-dimensional complexity of contemporary urban context. Due to the diversity of these data, three temporal thresholds are chosen based on three types of spatio-temporal user activities during the 24 h of day: January 8th at 3:30 am, January 20th at 4:30 Pm, and February 25th at 7:30 am.[3] Such selection enables us to have a comparative sight of the users-information flux and a total possible pattern of such flux 'within' the physical urban context. The geo-referenced-data mapping process in this phase is developed by using the 'Geographical Information System: GIS'.[4]

Another set of data is the statistic information of the resident population from the latest Italian official census, provided by The National Institute of Statistics (ISTAT)–2011.[5] These data are mapped first, based on the cadastral sections and then, according to the pixeled tele-data territory, in order to be able to assign to each pixel the resident population, physical density and Tele-density.

In order to examine the interpretative capacity of tele-maps, we first examine and compare them in an abstract context-without seeing the physical one and then we compare them with the spatial configuration of the physical context overlapping all together. The city of Segrate and Linate, both were once, mostly working places (industrial and agricultural) with a few fragmented residential areas and there are still a lot of industrial sites, companies, factories, workshops and cargo sites closer to the railway stations. There are places with night shift workers that are active at that time of the day. On the other side, the local residents of the city mostly work in the metropolitan areas such as the city of Milan that made the city be called 'dorm town'. So, we can assume three types of people flux here: the first two are city commuters: industrial and institutional workers in the city and people who work out of the city–like in Milan-and the third flux belongs to the airport passengers (Fig. 18).

It is now more evident that the overall pattern of the tele-data flux follows a north-south direction. The significance of this map is that the resulting pattern is an inclusive one; a synecdoche that can contain all the previous temporal thresholds independent from the different hours of the day; one of the dynamic patterns of the Meta-city; a Meta-Context. By the superimposition of the maps with the physical context, the abstract data are contextualized and enable us to look at the physical

[3]To respect the sources, the corresponding year of the data is not mentioned.

[4]The mapping process of this part is developed in the Department of Architecture and Planning (DrPAU), Politecnico di Milano in collaboration with Fabio Manfredini, 2013.

[5]Up to the date of this research, the latest census was for 2011.

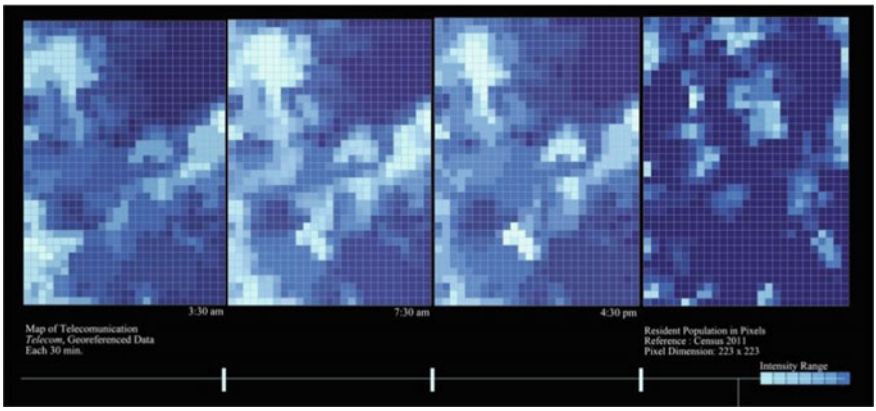

Fig. 18 Telecommunication cellular mapping in three given times [19]

infrastructure, access points, movement modality, space use and activities running in the city. In addition to the tele-maps and the physical context, in this superimposition, the physical aggregation of cellular is also overlapped with the other two which as an infrastructural layer for the communication 'hardware' can provide information regarding the permutation of the two types of infrastructure. Beside one exception which is the central city, we can observe that the major accumulation of the cellular masts is distributed within the tele-data pattern. This can be a curios ground for further interpretations as well as anticipations. In other words, can we predict sketch out the pattern of telecommunication of a physical territory without having the big data and just by extracting the physical aggregation of the cellular masts? Seemingly this theorem is not completely true due to a mismatch: the central city. As it is clear in the map, the central city in surrounded by cellular masts but is not present in any of the tele-data contextualization. There could be one possibility to eliminate the exception: analysing as many samples as possible-the different kinds of tele-data sets in different temporal thresholds to extract 'when' the central city appears as active in the pattern. Moreover, it is crucial to remind here that although the central city is not well seen in the pattern does not mean that it doesn't exist at all in the tele-maps. In other words, since visualization modality is based on colour gradient, as we can see in the first 3-pixel maps, the central city has a light colour. This means that there is a telecommunication flow in this part, but the density is such minor that in a comparative view, it may be considered as 'quasi-inactive' (Fig. 19).

9.3 Re-Contextualization

In this phase, through the superimposition of the two contexts, the research goes in deep to the urban scale and examines the changing dimensions of the physical context regarding the communication dynamics. The first set of outcomes are the extraction

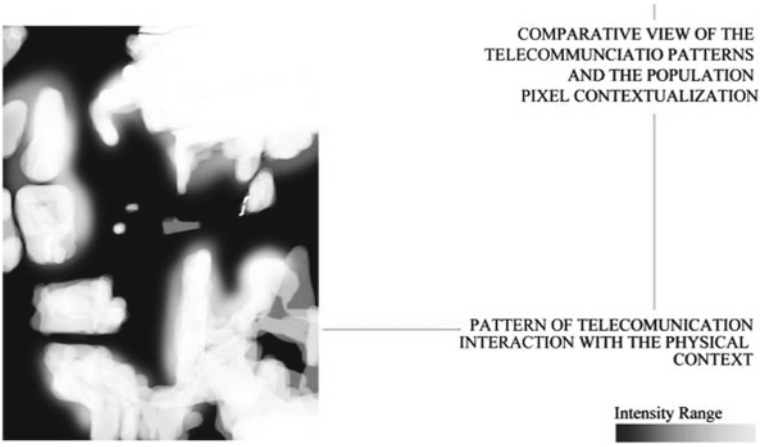

Fig. 19 Accumulative tele-pattern [19]

of areas with high telecommunication flow and low physical density: The Emerging Areas. Next, they will be quantitatively studied in a complex apparatus to calculate the Effective Areas: the surfaces that are effectively frequented; the footprint of the telecommunication in square kilometres. In other words, the recontextualization phase aims to study the two physical and telecommunication components based on their quantitative relations (Fig. 20).

9.3.1 Effective Density and Emerging Areas: Quantitative Dimensions

In this part, the recontextualization process enters to verify the effective telematic presence in the urban space scale. The objective of this part is to extract areas where the tele-density is higher than the resident population. In other words, the areas where the spatial qualities are low and so there are not noticeable characteristics for living or at least respect the densely populated areas but they fit into the daily dynamism of the city. We can assume these parts of the city as passage areas, which because of this very characteristic, have potentials to be integrated to the built fabric through urban governance and planning operations. The modality of this examination part is to cross-reference between the census and telecommunication data to areas where the number of mobile users is higher than the resident population. It is important to note that since some of these areas are completely empty not populated the mathematical assumption will be that the resident population for that area is 1. It means that we assume that there is at least one person that lives there based on the fact that most of those areas are in vicinity of ex-agricultural or ex-industrial zones and even if they are not inhabited, for the control purposes there is mostly a permanent custodian who is not counted in the census as the resident of that area. We take this assumption because for this part, the experimentation is interested in quantitative consequences

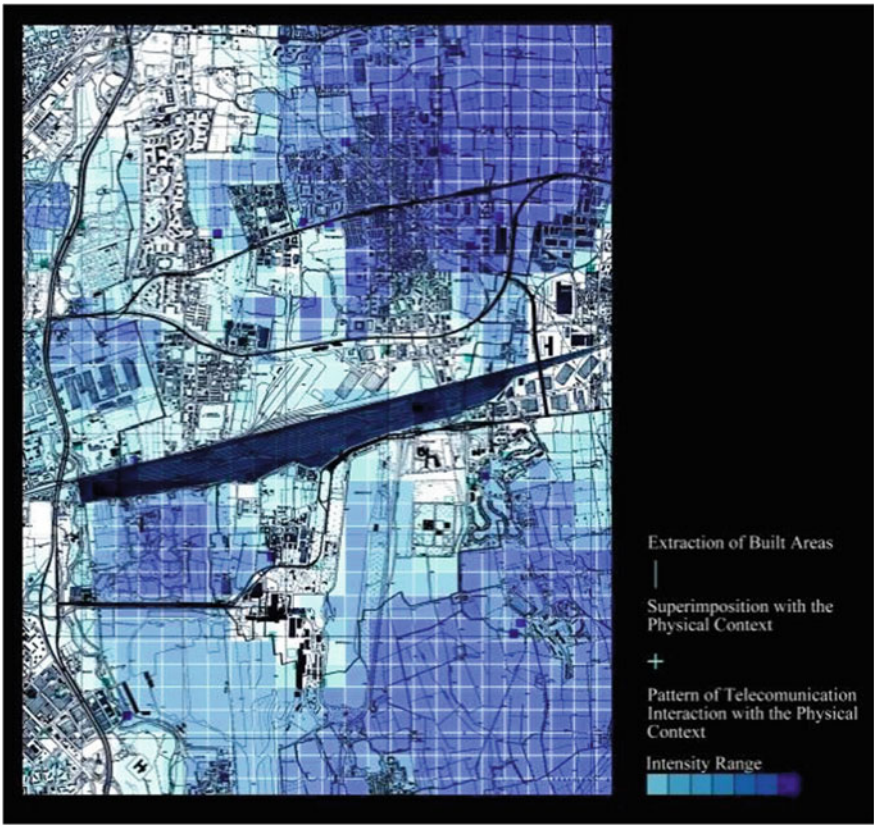

Fig. 20 Superimposition of the telecommunication pattern with the physical context [19]

of the contrast between the fix population and the changing one, therefore the cadastral statistics for the resident population integrated with the mathematical assumption mentioned above can provide us with information regarding the fix stable number of 'presences' which is in contrast with the mobile dynamic number of tele-presences. The result of this cross-referenced comparison is tele-density [70], which is interpreted as a quantitative coefficient for the effective telematic presence and will be used in the calculation of the affective areas in square kilometres. In other words, through the mathematical division of mobile users–as telematic presence and fix population as static presence we can see the capacity of the areas for further densification. Another important note is that in this process, where there is more than one area close to each other that can fit into the examination criteria tele-presence higher than fix presence they are taken altogether as one complex area which is composed of a set of data pertaining to its consisting sub-areas. The technical challenge here drives from the mismatch between the scale of applied numbers for the population and the mobile users. In other words, as we have seen in the previous parts, the

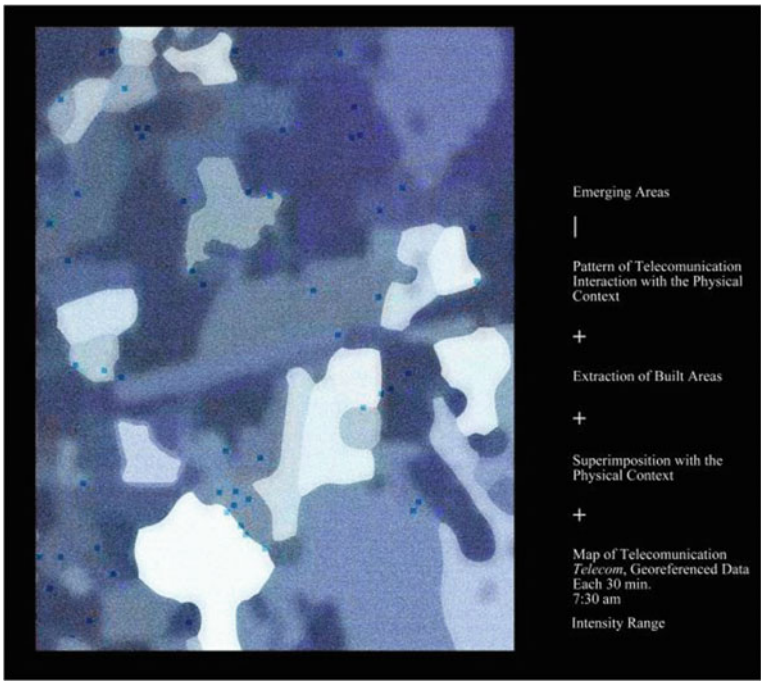

Fig. 21 Emerging areas [19]

population statistics are driven from cadastral sections while Telecom data pertains to pixels as big as 223 × 223 m. Obviously, before any mathematical operations, we have to first unify the two scale units to find the total number of mobile users for each cadastral section. This means that for each cadastral section we have to sum up the number of users belonging to its corresponding pixels and calculating the total number of users for each cadastral section (Fig. 21).

9.3.2 Effective Areas| Quantitative Indicator

In this part another quantitative indicator will be examined, which is the 'effective area' in square kilometre for each of those areas. In other words, through the mathematical relation between the effective density and the physical density in terms of the population aggregation in the area a hypothetical area is obtained which is mathematically a surface calculated in square kilometres. 'Effective area' is in fact an indicator regarding the space that is dynamically used; the area of the telematic flows. Such new data is meant to provide interpretative grounds of decision making regarding the urban densification and governance. In other words, through the comparison between effective areas of a given urban context, we can have a comprehensive sight on the potential scales and measures of the areas where future urban regeneration processes

must focus on. Although this indicator is related to the densification capacity of each area, it does not mean necessarily that all of them have potentials to be densified, since there will be cases in which the densification process must take a reverse direction to the deconstruction operation.

At this point if we substitute the physical density with the effective density, we will generate a complex formula. The remaining variable to be calculated is an area defined in square kilometres which is called the 'effective area'. Proceeding with the mentioned effective area, we can arrive to this quantitative interpretation that the areas where the number of the user-data is higher than the resident population have effective areas less than the physical ones. This reverse relation applies also on the opposite situation: where the telematics presence is lower than the fix one resident population the effective areas become bigger than the physical one. How can we explain such paradoxical situation? Is it possible that the practiced spaces become-simply speaking bigger than the existing one? As explained before, the 'effective area' is a quantitative indicator with qualitative interpretational value. It means that such indicator is a revelatory means to estimate the quantity of space that is potentially in use. Accordingly, when this indicator demonstrates an amount which is higher than the physical existing one, it means that the space under the use is overloaded-overflowed-and thus the spatial operations must take the deconstruction and/or the expansion direction.

The digital telecommunication, takes the contemporary dynamisms to a major, yet changing scales of performance, which according to Choay, is not completely compatible with the scale of practiced space [71]. Such shifting scale brings up the theoretical and practical dilemmas regarding the spatial qualities of urban spaces, especially regarding the spatial expressiveness. The dilemmas are driven from the mediating role of communication system in the environmental interactions. As mentioned in the beginning, the external manifestation of the 'convergence moment' happens in randomly resulted, anonymous temporary spaces of both physical and communication contexts with the characteristics of the two of them but without a formative and informative persistency. Such incompatibility, points to the importance of what Lynch calls "adaptive spaces" [72]. The adaptiveness of spaces, itself is dependent to the adaptiveness of different scales of spatio-communicational interactions. The performativity of the adaptation process depends to the variables which, are mainly the changing velocity, time and modalities of space-use. As it is explained at the beginning of this part, the calculation of the effective areas can be a comparative yet interpretational method to have a comprehensive sight on the quantitative spatial frequency of the temporal dynamics. This research aims to provide a method to extract the qualitatively neglected but quantitatively frequented areas and reveal their potentials for further developments.

10 Po River Valley Megapolis and Milan Metropolitan Area Eco-Centrality. A Metropolitan Architecture Project Proposal

The Milan Metropolitan area is no longer just an urban agglomeration, but a polycentric Metropolis that works within the Po River Valley Megalopolis with high environmental quality: sets of interactive Metropolises [73].

They constitute a third city capable of breaking the social and economic hierarchies between centre and suburbs, between urban and rural, as well as encouraging the coexistence of different cultures. An important aspect concerns the intention to find the right form to organize what already exists by adopting recovery strategies, to transform and invest in new meanings that are available. It is essential to develop the tools to implement the metropolitan vision that can consolidate its Megalopolitan identity through the new definition of regional boundaries and the planning of spaces among municipalities. The megalopolitan vision needs a multiscale interaction: the grey/green series. The construction of a set of landscapes is the primary element to determine a gradient of formality, which preserves the agricultural origin of the landscape despite the presence of intermodal nodes. It is a Green-Grey infrastructure understood as a sustainable in fill: porous infrastructural texture, remarkable points and reinforcements bifurcating towards the two directions and the respective landscapes. The objective is the metabolic reactivation of the territory: thematization and re-invention of degraded areas through ad hoc regeneration projects, for the areas of overlapping indicators on relevant ridges. It is a porous, permeable city, based on an ecological structure of wetlands and three types of spaces defined by high speed (cars), medium speed (public transport), low speed (pedestrian and cycle paths) that radically change the mobility of the metropolitan area. Reduced distances, sustainable travel times and accessibility to services for all are essential parameters of intervention. In this way, a strong perceptual and programmatic link is established between specific sites, the entire city, and the vast territory of the urban region, in its different values: identity/social, productive/economic, recreational/tourism, connective/infrastructural, regenerating and consolidating the entire network of actors involved, from the public to private, from local to the global scale. In this context, a structural role is played by the connection with the agricultural park, the South Park and the Adda Park.

MSLab the unit of research of the DASTU at Politecnico di Milano, within the Segrate Municipality made a proposal for the concept of a new pattern for a Megalopolis Eco-Centrality. Segrate Municipality is located in the Milan Metropolitan East Area in the center between two ring roads. Very lively municipalities compose its regional context whose growth dynamics have reached the threshold of territorial densification, which require a first degree of integration and supra-municipal and metropolitan articulation in order to support complex degrees of development. A "leap in scale" was envisaged starting from the supra-municipal dimension and the need for the relative infrastructural and functional urban support articulation.

In this context, it is necessary to encourage municipalities to become aware that they are part of a linear supra-metropolitan city, which is an element of recalibration of the city of Milan towards the East. The Linear City East of the Metropolitan Milan Area (Lem_City) has a robust infrastructural structure. However, the leap in scale needs, in order to be conceptualized, a centrality defined at the regional city scale. It could be a Centrality that connects the green and grey infrastructure, through the green corridor project, which reunifies the urban farming fragments left over from the infrastructure, renaming them by linking to new functions. It is necessary, then, not to bind these areas to private use, but to subject them to a central public use, which is fed by service functions and partly by residences on the edges, respecting a gradient of formality capable of modulating the grain (or density) from the edges to the center-left unbuilt. Being the seat of large industrial realities from a supra-metropolitan point of view, Lem-City could be the driving force behind this articulating and aggregating structural reform in metabolic terms, also through advanced forms of technological research and production, renewed in its potential to future generations. The quality of the differences of its agricultural territory compared to the North-West area must become a relevant factor of identity and enhancement of the context, a potential matrix that contributes to generating significant and widespread collective benefits. The East Linear City is the gateways to the South Agricultural Park, one of the strategic places in the Megalopolis area. Here it is possible to enjoy the advanced systems of the city and a unique Lombard landscape.

The role of the new centrality is the development in its territory of knowledge, competence and training related to the green deal. Nevertheless, for this, it is necessary to be aware of the fields that stimulate the improvement of competitiveness in terms of sustainability of the Po River Valley Megalopolis system. It is necessary, so, to move through a civil awakening of a city that not only had to refund territorial planning culturally but that, above all, had to rethink the reasons for its landscape degradation deeply. That is, to face the annulment of its symbolic power. Thus, even before talking about decisions and strategies for planning and governing interventions, the Po River Valley Megalopolis within Milan metropolitan Area outline a vision of the common good, which is the basis for a discussion on the evaluation of attractiveness. The East Linear City has its strengths in the Linate airport, in the new shopping center (its construction is stopped now due to the Covid19 crisis), in the Idroscalo, and the TAV gate station. However, we must reiterate that growth must find the points of articulation with the landscape and the entire territory of the East Linear City understood as events that create synergy.

Po River Valley Megalopolis is moving towards a model of an extended city. A balanced and sustainable region, connected and interconnected, a city of consumption and services, with a rationalized and efficient construction, densified and expanding blocked, attractive towards tourism and interesting historically and culturally). The East Linear City must become a new Eco-Centrality and the urban agricultural armature along the Lambro river a place of balance of full and empty green spaces and historical memories of the Lombardy area. Urban Design and New Technologies together could make it possible to define a network of paths to be followed in a final or spontaneous way (User Generated Content) to experience the territory as a unique

place: the water system (fountains line), the historical heritage, the leisure (Villa Invernizzi and Idroscalo).

10.1 Sustainability of the Agricultural Area to the New Metropolitan Centres

The new model of the Megalopolis incorporates agriculture in its relationship (wet/dry) including new functions and a new idea of public space. The East of Milan Metropolitan area must be increased in order to safeguard the South Park and the Lodigiano area by creating a mega-form where the Linate airport is located. Growth needs a discontinuity in its structuring, which regulates the logic of decommissioning structures that are no longer sustainable. However, against heritage dissipation, the sustainability concept must be perfected so that the transformation of this area can be sustainable.

The identity dimension of habitability must be re-conceptualized through a synergic relationship with the urban structures. The field conditions in the Megalopolitan area affected by the dynamics of infrastructural transformation of its agricultural and former industrial parts must determine a porous plot, searching for sensitive territories by reactivating parts in degradation as new care of the landscape. The architectural project must determine a place of exchange not only for consumption (part-time life), where it is possible to exchange beauty.

Today, the agriculture deals with a city's need for alternative energy linked to small waters and the local context. Based on the water as an energy-industrial resource, the industry built the Lombardy landscape and constituted a way of sustainability that was consumption, but also care. Today we are talking about agriculture for Park reasons, and therefore we have to disengage the farmstead from the field because, since the new vocations of the area, new formal properties require the definition of new functions.

The agricultural area is fundamental for the consolidation of the Megalopolis and its values. However, it is currently in a state of stagnation. The agricultural field must be re-conceptualized, as a consolidation of what is the citizens' leisure. Starting from the study carried out on intangible value indicators, expressly requested by the European Community, we read this part as an emerging and highly qualified area to become a cornerstone of the linear centrality at the upper scale of the Megalopolis. That is essential for the development of a polarity, naming the new entity, called the East Linear City. Vice versa, however, it is affected by degradation phenomena due to the abandonment of the agricultural function.

10.2 Strategy

MSLab has identified some actions needed to realize this vision for the metropolitan city:

(1) Consolidating identity: it is essential to think about the relationship between Compact city, infrastructural continuity, and the advanced systems of the Milan capital city;
(2) Multiscale interaction: from metropolitan to interstitial. New relations between the agricultural origin of the landscape and intermodal nodes;
(3) Creation of Eco-Centrality by strengthening a sustainable in-fill: porous connections/areas with low accessibility as a strategic tool;
(4) Metabolic reactivation: re-monetizing sensitive/neglected/vulnerable areas of the landscape through the method of urban sensitivity indicators.

11 The Indian Scenario

Urbanization is the megatrend of the century. The metropolitan areas in India are constantly growing as more and more people are migrating from rural to urban areas because of several factors such as growing economic activities, education and health-care, availability of higher order facilities etc. According to the 2011 census, there were 53 million plus cities in India & a total of 12 cities near the 3 million mark. These cities are bound to expand and grow over the coming years. Given the size and population of Mumbai, Chennai, Kolkata, one can understand that these are not cities, they are Metropolises. As Indian Metropolises are at a stage of massive trans-formation, the population growth in them indicates that unplanned spatial expansion in fringe areas and the development of satellite towns around the inner cities is inevitable in the future. The Metropolises are not a mere aggregation of the urban units. They are a comprehensive region that includes urban, peri-urban, rurban and the rural areas, surrounding a city core. In Indian context, the rural areas surrounding to the urban areas are on the verge of getting urbanized. The unplanned approach of managing this growth will not only affect the urban rural linkage but also hamper the sustainability of Metropolis comprehensively.

The conventional planning process in India males the rural-urban linkage and the Metropolises, present major planning challenges to planners especially about the territorial intelligence and regional balance. The general trend in India where the people migrate from rural areas to the cities, prefer to settle in its outskirts and the villages on the boundary of the city. There are several factors behind this that include affordability in housing, the cheaper land rates and the lower rental values. This results into massive infill in these villages, where the residing population and its demands are urban, but the supply and context is rural. The administration and governance of such areas and the demands of population becomes difficult as the powers of Grampanchayat are limited. Hence, it gives rise to violation of land use

rules, exploitation of water bodies and wetlands due to construction activities. This has a direct impact on the health of the city and its residents. Hence it becomes vital to introduce a new form of governance, the metropolitan discipline in India to increase their efficiency, to nourish the desakota regions, the rural linkages and the territorial intelligence.

To equip the Metropolises for fulfilling this gap, there is a need to think of governance at a metropolitan scale rather than the urban scale as the urban scale of planning is different than the metropolitan scale. Since metropolitan planning is a dynamic and evolving process in which population movements, economic variations, demographic and social dynamism play an important role, this paper tries to highlight how the obstacles in provision of affordable housing can be removed by introducing the Metropolitan Discipline [73] in the planning process in India to attain the desired precision and delivery.

Urbanization has caused rapid migration to cities and forced them to expand beyond their own administrative borders, resulting in creation of large metropolitan territories. Metropolises are engines of growth and development which have significant impact on national and global economies. However, this scale of urbanization has caused tremendous stress on housing and infrastructure. This transformational growth requires different scale and level of planning altogether as the Metropolises are fundamentally different, more complex and larger than the cities. Metropolitan Discipline in the process of planning is a new phenomenon that has appeared in the 20th century along with the thought that Metropolises require a different management mode than cities. The Metropolises are of an intermediate scale between the cities and the states in Indian context. The migration of people residing in the rural areas towards the urban, in quest of higher order facilities, better quality of life, employment opportunities, adequate physical as well as social infrastructure, is causing stress on availability of resources and basic infrastructure associated with the housing present in cities. According to census 2011, almost 20.5 million people migrated from rural areas to urban areas whereas 14.3 million people migrated from urban areas to the other urban areas. These numbers depict the extent of migration in India. As the growth in migration is directly proportional to the housing demand, the necessity to increase housing stock grows.

The recent trend of the promotion of smart city concept in India gave birth to the smart cities mission of India which aims to enhance the sustainable growth of cities by integrating the planning with ICT modules. However, given the character and historical evolution of Indian cities, the responsible usage of technology to enhance quality of life and the urban rural linkages is vital. The technology and ICT interventions shall be used in such a way that they comprehensively ensure the solution of governance and planning at a metropolitan level. The smart city concept in India has been perceived as an exaggerated usage of technology at an urban design level. Whereas there is a need to integrate these efforts at the metropolitan level.

The Blue Infrastructure present across the territories, that is the water bodies such as rivers and canals serve the rural areas as well as the urban areas. They flow through the rural-urban linkage as well. Hence, it is important to understand the governance of these water bodies has to be done from a territorial scale or the metropolitan scale.

This will enable the streamlined water management for agricultural activities that are there in rural areas and the industrial activities that are present in urban areas. Administration and governance of the water at the urban level leads to the exploitation of water bodies. The construction activities in peri-urban areas that block natural-rural water channels and take place in low lying areas cause massive water clogging and flooding. This flooding exposes the short-sighted planning and governance behind water management. To deal with such complex issues, usage of technology and ICT solutions has to be more of a territorial phenomenon than compacting it into a Smart City.

The study aims to understand the various patterns and linkages between two major Metropolises of India, the Chennai and Kolkata. We present the relationship between Open data and Smart city that recovers the concept of Desakota territory as an eminent of the territorial intelligence of the Metropolis and Megalopolis of the Far East through two projects developed in the Indian context (Kolkata and Chennai). One of the tools used in the study is MIDA–Metropolitan Impacts & Drivers Assessment which is a tool to gather, process and visualize data crucial for current metropolitan issues. MIDA seeks to enhance the understanding of the impacts and drivers of urban settlements from the territory to the alleys, through the use of multi-scalar mapping (Fig. 22).

Through the examples of two Indian Metropolises, we interpreted the interaction between Smart City (ICT/Technology) and Open data that covers the concept of Desakota territory as the fundamental part of the territorial intelligence of the

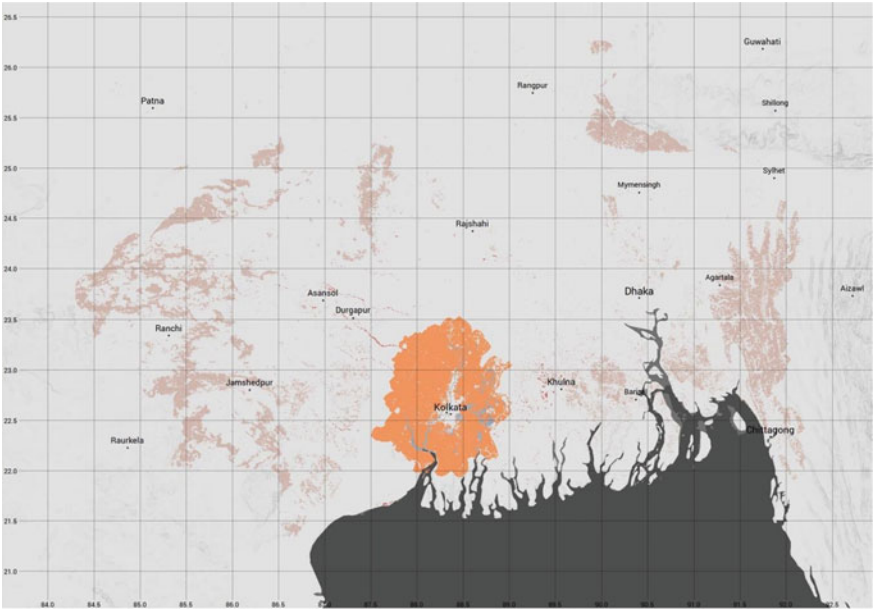

Fig. 22 The ecological footprint _ Kolkata. *Source* MSLab_. *Credit* I. Neri

Chennai and Kolkata Megalopolis. These two projects developed in the Indian context (Kolkata and Chennai), are presented as an asset-based approach to model, represent and manage the sustainability and resilience initiatives in the metropolitan architecture systems. The creation of a geospatial data ecosystem is done for fusing the secondary data, which is an open data of the government with the automated spatial-temporal analysis of remotely sensed imagery. For the comprehension of site-specific phenomena, undetectable through the simple use of statistics indicators the call for spatialization that is becoming more and more necessary because both these aspects are interlinked and attached to the territories and geoinformatics.

11.1 Chennai Metropolitan Region

The 400 year old coastal city of Chennai, formerly known as Madras, is the 31st largest metropolitan area in the world. Although this established global port city has gained Economical recognition being a part of international corridors like Mekong India economic corridor and also East India corridor, concurrently it has been ecologically vulnerable making headlines as a disaster capital with floods, droughts and cyclones, the reasons being severe alteration of coastline and unconscious urban sprawl that lead to the loss of green cover which has almost doubled during the recent years.

The Asian Urbanization has entered a new phase that differs significantly from the patterns of the city growth experienced in other developing and the developed nations. This existence and evolution of new and different kinds of settlements providing evidence of settlement transition is observed in Asia as Desakota Regions coined by T.G. McGee in 1991 (Figs. 23 and 24).

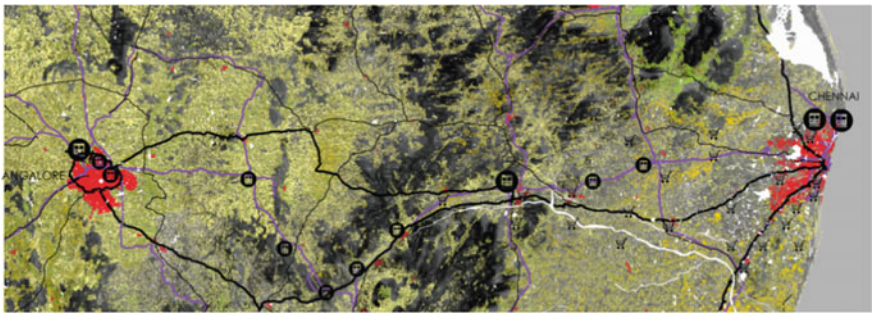

Fig. 23 Zones of intensive economic interaction between rural and urban activities are emerging. These zones are new form of socioeconomic organization that is neither urban nor rural but preserves essential ingredients of each. The landscapes in these metropolitan zones have changed little over decades. Most people live in villages, and almost all the land is under cultivation, however, most income now comes from non-agricultural sources [74]

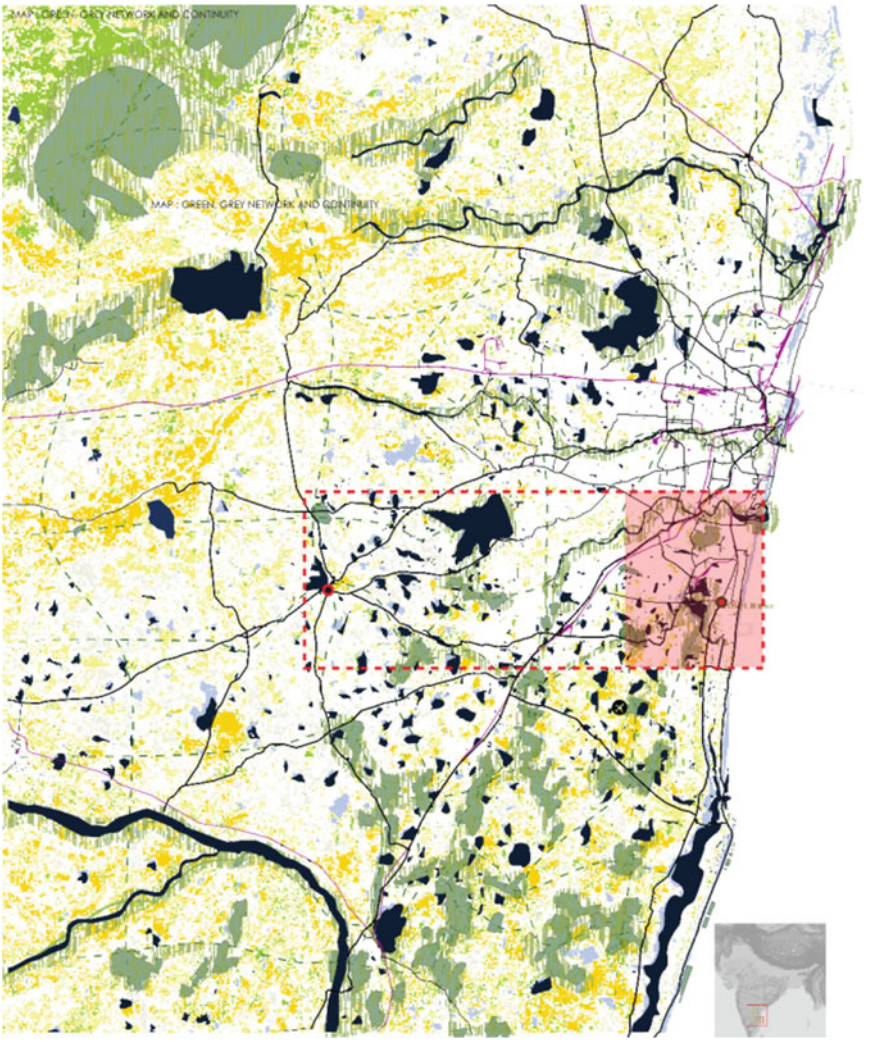

Fig. 24 A powerful civilization can begin to act on their total environment at a significant scale: how to form the total scene so that is easy for the human observer to identify its parts and to structure the whole,-total environment made visible-[…] A clear image enables us to move easily and quickly, and it is able to furnish the raw material for the symbols and collective memories of group communication. We need to pin images (the memorable ones) through landmarks to the ground to be able to see the hidden forms in the vast sprawl of our city. So that, we need a coherent order,–such as an antecedent form–ordering this complex environment [74]

These distinctive areas of agricultural and non-agricultural activity are emerging adjacent to and between urban cores, which are a direct response to pre-existing conditions, time-space collapse, economic change, technological developments, and labour force change occurring in a different manner and mix from the operation of these factors in western industrialized countries.

The project focused to acknowledge metropolitan landscape that deals with 4 main points: Territorial intelligence, Desakota system, Regeneration, Urban rural interface. Thus scaling down to the adverse effects of this human interference that saturated the urban cores, aiming to regenerate the last remaining marshland of Chennai city, the Pallikaranai marshland, a unique ecosystem of its kind, that has been reduced to one-third of its original extent due to encroachments.

11.2 Kolkata Metropolitan Region

Water has always been an important element in Indian city planning, and has been employed to created micro-climates; wells, tanks, areas for washing, recreation and ritual, which dotting the landscapes of the urban, peri-urban and the desakota as in the case study of Kolkata, where the intelligence of the site was once very comprehensively utilized. Located on the Hooghly River, one of the main distributaries of the Ganges delta, Kolkata is unremittingly exposed to water as some scholars say that its very name is delivered from 'khol'–canals and 'kata'–to cut meaning cut opening the shores.

The region frequented by floods during the times of the monsoon and faces tropical cyclones from the Bay of Bengal, at times bringing devastation and death to the area. With unfolding climate change, the city is ever more feeling the need to respond urbanistically to new dangers and challenges. Being located at an altitude just barely above sea-level, any increase in flooding or rise of the water level poses fundamental risks to the city. Due to this urgency, Kolkata finds itself in a strategic position with urbanistic responses to climate change necessarily having to be developed, tested out and implemented in the nearest future.

Today exposed to a steady influx of rural-urban migrants, combined with natural growth, adding almost 400,000 people to the urban population every year, in the future it might find itself in the center of massive movements of climate refugees. Understanding through the realm of metropolitan landscape is an attempt to answer how a city copes with these elementary conditions of climate change while simultaneously experiencing rapid growth. Does it expand steadily or grow in stages with phases of stagnation, reinventing itself over time, or holding on to an identity of the past.

The typical 'Bengal landscape' of the Kolkata metropolitan area is one of its strongest assets. The diversity of landscapes, the inter-linkage of land and water-the ponds or 'Pukur' & canals or 'khal', countryside and cities and cultural heritage with ecological values are of great importance. With an efficient water management system which can be classified as traditional knowledge system. It shows how water

is closely linked to the everyday lives of the people and thus has been an important tool in the settlement patterns. Over the years as the city is expanding and engulfing its periphery not only is there loss of traditional knowledge, agricultural land and deforestation resulting in climate change affects but also the city suffers due to change in social structure and living conditions. The mutual relationship existing between the city and suburb is at a stake and of the most is its water body-the ponds and wetlands, which play a crucial role in maintaining the temperature, sewage treatment, drainage etc. In the metropolitan landscape of Kolkata water again has an important role to play in the planning of the city.

The diagram is a hybrid model of the unit of our peri-urban area inspired by Grahame Shane's Desakota Megablock diagram may be the most appropriate solution to the issues related to our site. The study tried to identify this landscape of flux, since we cannot define the dimension of the desakota which is huge and spread very organically. So, from the desakota system we recognize the pattern and identify the elements and putting them together theoretically to form an endless network. By connecting the blue green-grey infrastructure between these settlements and creating new centralities we provide a better way of life to the existing communities living around it. Here, along with preserving and conserving the wetland practices we also define a strong mode which provides an alternative way of sustainable development. The attempt tried to gain another layer of existing pattern over its existing layers, strengthening its network of systems promoted on a global level (Fig. 25).

12 Metropolitan Urbanity Toward the Desakota Strategy and Pattern

In both the 2030 Agenda for Sustainable Development and the New Urban Agenda, Member States agreed to normative policies supporting integrated urban and territorial planning and development, calling for new, inclusive approaches and enhanced synergies between urban and rural communities and spaces [75]. Governments at all levels, who are the primary agents of transformation, must move from recognition of climate change, and food scarcity challenges to coordinated actions to strengthen urban-rural linkages and implement integrated territorial development. Urban-rural linkages are understood to include all flows between urban and rural spaces in the world, including people, goods, and services.

In the Western Megapolis, the green infrastructure is the regional network of environment parks that go from the higher level of national parks to the lower level of urban parks, until the city garden. They are all interlinked to provide for the fluency of the biodiversity. Moreover, each of them takes a different function depending on the role it has to play concerning rank and proximity. In Europe, the peri-urban parks well assume the role of urban agriculture. Conceptually, this fact is crucial. For that, concerning the far east cities, we start to discuss the desakota mixed-use patches model of management of the city. It is an open model that namely conceives

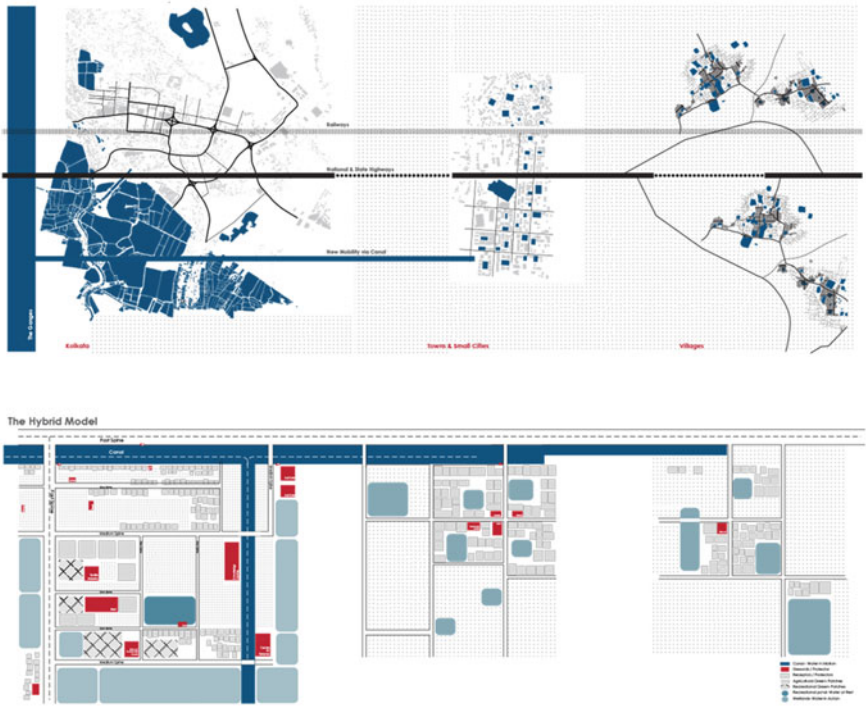

Fig. 25 Reinforcing the network between city-town-Desakota shown through the hybrid model [74]

the metropolis as something in between the town and the village with a continuum countryside territory among the urbanized points. Indeed, a green parks system able to be efficient in order to produce a balance with its bio-potential power (ecological footprint) is very strategic. Through this system, therefore, it is possible to determine a new condensation of agricultural land use in the between of the patches and the interchange node becomes the centre of almost two of them.

Because the park, the relations among the different functions and their positions are not so regular as in a dense city and the movements inside are free: lanes and channels which constitute a second range armature. It could be reinterpreted as a new pattern for the new dimension of the city, that have to determine new projects, policies, governance strategy, and tools. That is also the scope of the Practice of the Metropolitan Discipline [76].

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authored together paragraph 6. Sravya Lutukurthi, Ravali Sathiwada, Kushal Kumar, and Piyush Girgaonkar wrote paragraph 11.

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Tokyo

Tokyo Smart Global Megacity—Smart Sustainable Energy Solutions

Sharma Krishan Anjali, Suwa Aki, and Inagaki Kenji

Abstract Tokyo, is a uniquely placed to be the one of the only smart global mega cities in Asia, leads the path of technology for numerous aspects especially energy and the relevant infrastructural technology, nuclear power energy sector among others. Standing tall among veteran landmarks of London, Paris, New york and the later additions of Sydney, Shanghai etc. being the global mega city since 90's and continuing now for almost to over three decades with speaks loudly of its inherent strength to be consistent and sustainable merits as well. Pioneering with best of information technology the nation has paved the path for nuclear energy; a need arising, as the country lacks with natural resources. For a global mega city to operate large quantity of energy is of required; from sources to network distribution to consumption, energy efficiency and its related impact of carbon emissions to zero carbon as the need of the hour with climate change on the horizon. The city has been steady for number one ranking among the global mega cities now for over three decades just speaks volumes for the consistency of nature of growth and governance at large. The thrust of the paper is to demonstrate, with case example of Tokyo, how the mega city positions energy as the sector the crucial nexus to the one for climate change, by firmly arranging it into its policy framework and for the future as well; also it looks into how Tokyo has made energy efficiency solutions are smart and sustainable. The take away of the chapter also overreaching into how may be from the organizational structure governance arrangement can optimise use of technological and social smart grids and consumption solutions patterns at large.

Keywords Tokyo · Global mega city · Smart energy solutions · Sustainability and governance

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1 Introduction

Tokyo is largest mega city with highest population in the world, now for almost a decade and continuing. Tokyo while maintaining its status quo has shaped up truly a Smart Global City addressing the sustainable development goals pioneering with state of art technology that is regularly updated especially for the energy sector. The approach is largely holistic with a framework of development that is agile, robust and thrust on all key areas for economy, social and environment through efficient governance. Additionally, Tokyo has taken numerous initiatives at international arena among them the foremost for political ideology is QUAD that is significant for maintaining peace and harmony in the region and as best practice for other regions as well. The city is economically sound with par excellence research and global production strongly underpinned by international education of repute. As leading global city in the region that is technologically smart, duly recognised by many key nations like Germany, France and others. However like other global megacities Tokyo too faces challenging issues i.e. environmental sustainability, climate change, social equity, inter alia for growth and development with the aspects of large concentration of population in "mega cities" accentuated the issues even more. Cities have been customarily the aggregation of consumption within the modern economic market. The mega cities are dependent on international/domestic markets for their sustenance. There is, however, increasingly less bond to connect consumers and producers in the market system, to the extent where the consumers take the energy and materials as commodity, rather than service with differentiated value. Megacities, is essentially a community of more than ten million people, are naturally exposed to vulnerability since the sheer volume of their demand surpasses the capacity maxima. Mega-cities have themselves have a huge environmental and sustainability implication, with their problem being that they demand energy far greater than what they produce. Also, as the 2020 outbreak of COVID-19 incident demonstrates, high interaction within human settlements are, though being a logical conclusion to economically efficient logistics, exasperate natural calamities. As per the World Econmic Forum report 2030 states among the top meags cities of the world Tokyo along with Osaka listed for population growth since 2017 till 2030 are relatively on the downsize that is unique for the nation. While GDP growth is on a gradual rise relfcleting a stable and consistent approach to growth in a sustiable manner. The political outline by the current governance focues on energy sector and Tokyo aspiring to be a smart energy global megacity with zero emissions. to preserve the green areas of the city, revilatise SME's to ensure economy growth that shall be sustainable and others. The trust for such development is extended beyond the city to immediate pheripheral areas and regions as well, such an approach shall weave the sustaibale texture of the city as continuity rather than building isolated sustainable pockets.

On the other hand, cities can also be the simultaneous saviours of human coexistence with the planet [1]. While being the mass of consumption demand, cities, when designed as such, are able to exercise their position to deliver sustainability [2]. The megacities are gradually seen as prospective hubs of innovation, where the

expectation that high levels of resource efficiency may be conceivable. Critics argue that megacities can develop sustainability if they can pay sufficient attention to how they obtain, share, and manage their energy and material resources [3].

Numerous studies address quantitative assessment for capability of cities to provide sustainability outcomes [4, 5], but the thrust has being how to design the cities that are equipped for the desirable outcomes are relatively less claimed. In addition, the degree in which cities' sustainable activities largely depend upon a number of governance factors that determine the intensity of the cities' innovative policy emergence and implementation, while exercising its bargaining power to request its hinterland suppliers to provide sustainable resources [6, 7]. In fact, as we see it more closely in Sect. 5.4, its energy resources are delivered from the global and local suppliers. The enabling conditions require broad and sustained engagement of local stakeholders, including city government officials from different departments, communities, and civil society and business partners [Roppongi et al. 2012]. In this regard, Tokyo is an indicative example, being not only the biggest of the world megacities, but also an epicentre to shift its policy to establish its position as sustainable energy consumer.

Tokyo can also make a significant contribution in addressing an efficient governance structure, through legislation and a series of progressive sustainability policies and schemes, in consultation with the associated stakeholders. It is with the background that the question of "who runs the city, and more importantly, how, is becoming ever more important question for the cities around the world. This concern echoes an increasing trend towards urbanization where city government, in both developed and developing nations, are in the need to envision urban future under the circumvent of shrinking public funding and declining economic bases. Despite its size, Tokyo has a distinctive feature in metropolitan governance system where the TMG handles broader administrative works, local municipalities are responsible for local services such as education, health and welfare. The 23 special high-density wards are home to major business activities, with different needs from the other municipalities in the prefecture. 16% of the TMG budget goes to education, 14% to transport and civil engineering, 14% to social welfare, and 15% is allocated to more local special ward initiatives (Fig. 1). Therefore its governance model shall be highlighted to give a lesson for other megacity management.

2 Global Mega Cities

Globalization propelled the growth of the urban areas to alarming proportions. The global economy has clubbed the mega cities i.e. Tokyo along with London, New York, Paris, Shanghai. The city's population is essentially characterized by diversities for ethnicity, religion, cultures among others and this social connotation is reflected for participation in work force, behaviour pattern for resource consumption. These cities are hub for high-energy consumption while they are equipped with resources and research capacity. Of all the civic utilities of these cities, energy sector is expected

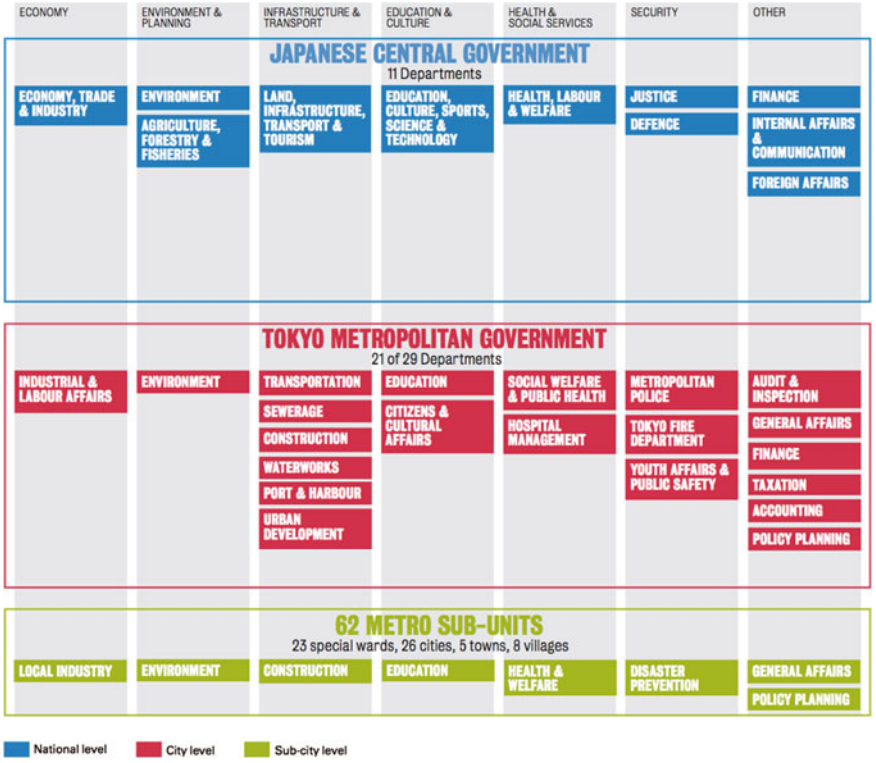


Fig. 1 How Tokyo is governed. *Source* the Gurdian [8]

to play a crucial role for the efficiency, from access to energy through renewable sources to smart grids for distribution to consumption at the user end. Tokyo paves the path especially for energy sector strongly facilitated by its governance structure and regular updated technology inputs as seen below.

3 Tokyo—Global Mega City

Tokyo is uniquely placed as one of the financially influential cities of the world along with London, Paris and New York. Not just economic sense, however, Tokyo has been consistent as the highest populated city in the world since 1975. Dating back in 1950, it was at the second populated city next to New York only with a marginal difference of one million. Tokyo accommodates with around 30% of the total Japanese population with ten million plus. The high density is expected to continue till 2025, though the increasing trend is suddenly halted in 2020, when the COVID-19 incident has accelerated remote work, that enabled a certain volume of white-collar workforce to become willing exodus that migrate out of Tokyo, emigrated population observed as

in Fig. 1, which is the first case where Tokyo witnesses population reduction in the recent 8 years (Fig. 2).

Nevertheless, it is also rated as one of the economically important cities in the world Tokyo to be the strongest for GDP at US$ 2 billion followed by New York with a substantial gap, ranking fourth for Asia as per Sustainable Cities index—Social, Environmental and Economic health [National Geographic, 2016]. These indicate Tokyo has been established as a city of significance in the world landscape (Figs. 3 and 4).

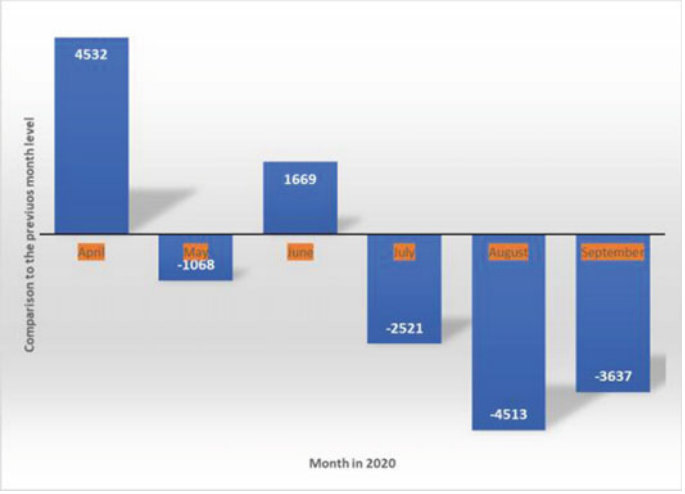
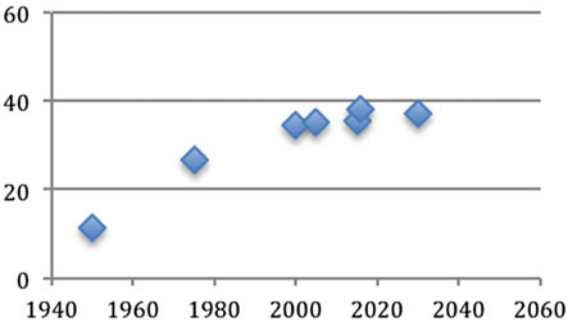


Fig. 2 Tokyo population change [2020 April-September]

Fig. 3 Population of Tokyo



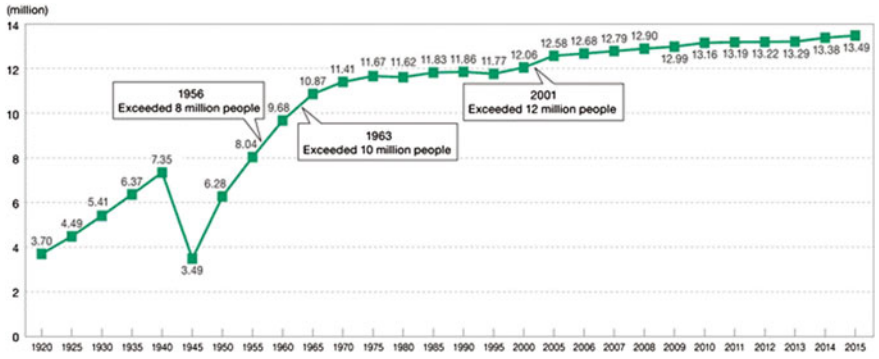


Fig. 4 Population growth of Tokyo mega city as per TMG *Sourc*e UN [9]

3.1 Fact File of Tokyo's Urban Planning

The high population density of Tokyo is, however, rather the result of planning failure, especially during the period after the World War II economic recovery: Historically the Tokyo Town Planning Ordinance in 1888 was the origin of city planning legislation in Japan, after the Great Ginza Fire [1872] with the need to build a fireproof city was felt. The city planning concept, however, once was a pillar for controlling urban sprawl, became "ignored" after the WWII, when Tokyo was heavily destroyed by the US attack and the city reconstruction became the first priority. Later during the post-war economic boom, the city planning regulations were further relaxed to the extent the influx of population into Tokyo area was allowed and the urban sprawl is formed as currently observed in Tokyo.

Dating back in the early 20 century, though, there was a series of efforts to make Tokyo as comparable with the Western cities. For example, in 1919 the City Planning Act replaced the Tokyo Town Planning Ordinance with the underground passenger transportation system was constructed for the first time in Japan [between Asakusa and Ueno in 1927, Ueno and Shimbashi in 1934, and Shimbashi and Shibuya in 1939].

During the post-war reconstruction, former Tokyo Prefectural Government and Tokyo City Government were merged into Tokyo Metropolitan Government [TMG] in 1943, and TMG executed the Tokyo Special City Plan with main thrust on land readjustment for reconstruction. With city gaining momentum for growth and development, enormous expansion of urban areas into the suburbs occurred, which resulted in the establishment of the National Capital Region Development Act [1956]. The move was followed by TMG that promoted revision of urban plans for expressways, open spaces, railways etc. The City Planning Act, carrying the same name with 1919 City Planning Act, but modernized and enacted in 1968, has undergone partial revision almost every year since its inception, responding to changes and needs of the city and circumstance then.

In a decade after 1975, the population flow into cities was mitigated while there was a stronger trend in their settlement in rural areas. Consequently, the "district planning system" was established [1980], in which municipalities—local governments closest to residents—were given decision-making power. TMG [1986] adopted the Urban Redevelopment Policy wherein the framework of development master plan facilitated effective implementation of projects related to urban redevelopment and land readjustment (Fig. 5).

A digital study by UN with twenty-nine partners have developed The Global Human Settlement [GHS] framework that produces global spatial information about the human presence on the planet over time for time slabs as 1975, 1990, 2000, 2015 & 2016. The form of built up maps, population density maps and settlement maps for various cities of which for Tokyo for degree of urbanization is as follows (Fig. 6).

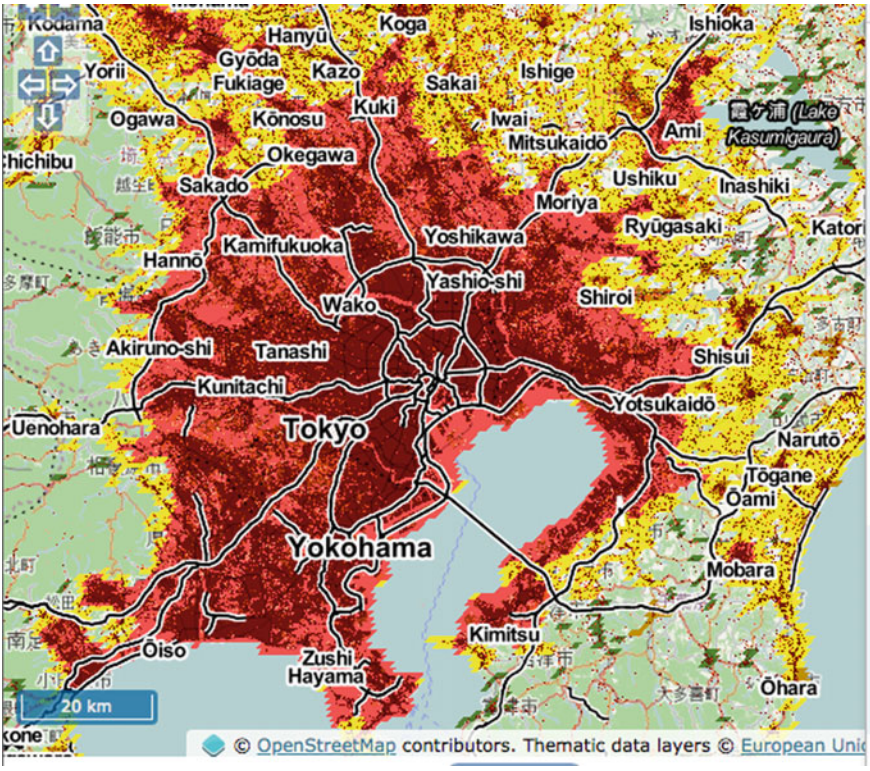


Fig. 5 Tokyo for built up, degree of urbanisation & residential population 2016 *Source* EU-GHSL—Global Human Settlement Layer

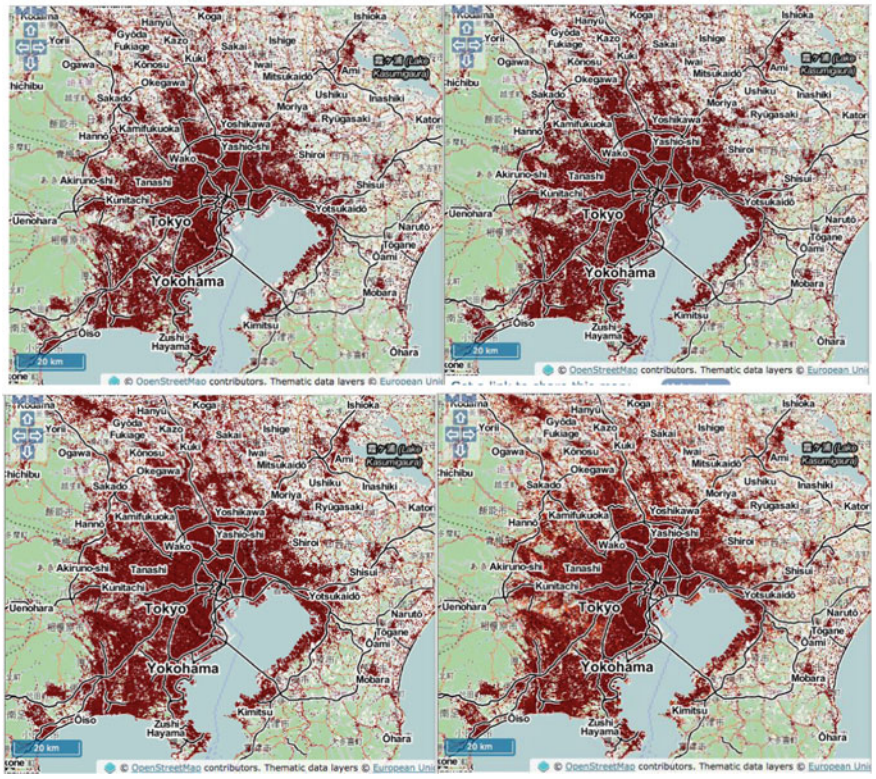


Fig. 6 Tokyo–**Built Environment**: Clockwise 1975, 1990, 2000, 2016. *Source* EU-GHSL Global Human Settlement Layer

4 Background of Energy Sector for Tokyo-Japan

Japan has marginal fossil fuel reserves, which makes the country heavily rely on imported energy sources. The nation uses fossil fuels, which accounts for over 70% of the total power generation, in 2018. The Great East Japan Earthquake on 11 March 2011 became also the background to the high dependency on fossil fuel: after the catastrophic accidents in the Fukushima First Nuclear Plant, over 50 nuclear power plants, irrespective of their locations were ordered to suspend their operation. Contribution of Nuclear share decreased substantially, while LNG and coal power generation were resorted to make up the electricity deficiency, forcing utilities to import fossil fuels [10] (Fig. 7).

This led Japan to spend $250 billion on total fuel imports in 2012, a third of its total import expenditure [12]. The formal institutional support system for renewable energy narrative has been the Feed-in Tariff [FIT], resulted in the efficiency and effectiveness over its predecessor of Renewables Obligation Portfolio [RPS], eventually introduced in 2012 [13].

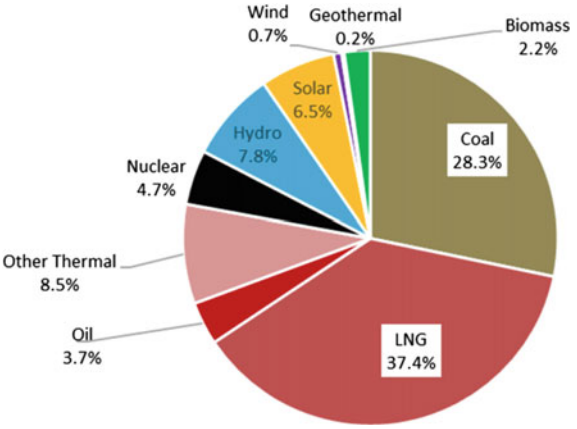


Fig. 7 Trend of the share of renewable energy to the total power generation in Japan. *Source* ISEP [11]

Over the past few decades, a number of countries initiated the policy for electricity market liberalization. Electricity markets were reformed in Japan, first in the 1990s–2000s, then further in 2016 wherein, market allowed options for households and small businesses to choose electricity suppliers. Such a background encouraged a number of local governments to establish power producer suppliers [PPS], often with the cooperation with local stakeholders, to develop and supply renewable energy sources for their community. The PPS renewable energy development is expected to play an important role both in economic and social integration as is widely known, Japan is facing rapid aging and population decline problems, where local revenue through household and business taxes are diminishing, and the locally produced electricity often functions to enhance community financial income through the sales of the electricity [14].

The liberalization of the energy retail market has certainly opened up possibilities for expanded parties to venture into power production. Currently [June 2020], there are around 665 entrants, with a variation of sizes, backgrounds and stakeholders. Many of the new electricity retail companies appeal to the customers with the electricity price discounts, e.g. packaged concessions with telephone and mobile packet subscriptions. In contrast, there are some new entrants who are mindful of cooperative energy development models, actively promoting decentralized renewable electricity. Noteworthy is as they rely on renewable sources, the grid emission factor often refers to a CO_2 emission factor (tCO_2/MWh) to be associated with each unit of electricity provided by an electricity system, is relatively less than the conventional power utilities.

5 Tokyo Metropolitan Government's Priority for Energy and Climate Policy

Tokyo the largest megacities in the world with the estimated population of 14 million is the largest consumer of energy. About one quarter of the Japan's population lives in Tokyo and its nearby areas, while its prefectural domestic product accounts for approximately 20% of the total Japanese GDP [15] thus it has been a challenge for Tokyo as a megacity to secure necessary energy. Since 1950's the electricity demand of Tokyo typically was met by the Tokyo Electric Company: TEPCO, from the power plants located outside of TEPCO premise. The Fukushima Nuclear Power Plants accident influenced the Tokyo consumers' realized the level of their dependency to the hinterland energy supply.

Nevertheless, the progressive measures to address climate and energy concerns TMG took up measures through governance and that is evident in Tokyo's energy consumption that has consistently been falling with a peak at around FY 2010 (Fig. 8). The constant reduction of energy consumption by the megacity has been made possible through a series of policy actions and implementation and continuing.

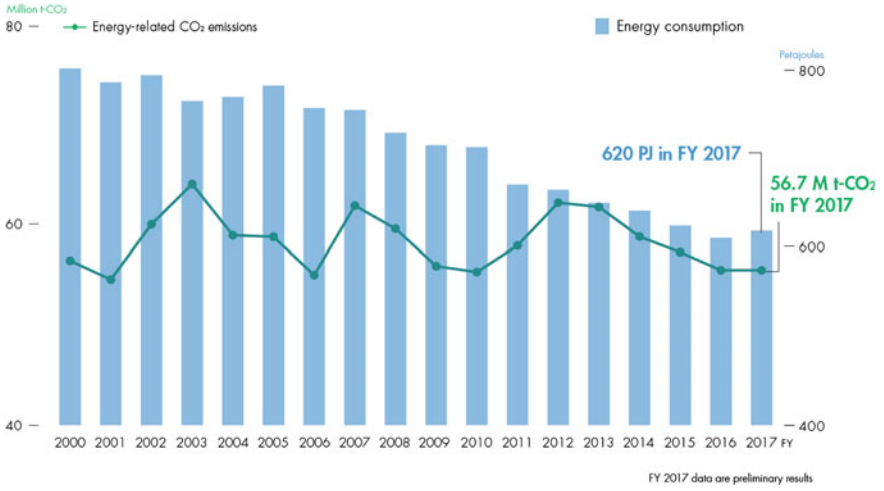


Fig. 8 Trend of energy-related CO_2 emissions and energy consumption in Tokyo. *Source* TMG [16]

5.1 The Tokyo Metropolitan Government: History and Background

The Tokyo Metropolitan Government [TMG] is known for its progressive environmental and sustainability policies, often contrasted with the Japanese national government whose reluctant attitude towards the environment and sustainability issues have been witnessed frequently.

To start with the basic statistics, about 30% [14 million in 2020] of the country's population are concentrated in Tokyo. Its daytime population is multiplied by 1.2 times due to the influx of commuting workers and students from neighboring prefectures of Saitama, Kanagawa and Chiba. The Tokyo Metropolitan Area [TMA], that consists of Tokyo and neighboring prefectures, designated as the world's largest metropolitan area has a population of over 38 million [*ibid*.]. Governor who is democratically elected to metropolitan assembly heads TMG, who holds the office for a term of four-years, with the authority and responsibility for managing the metropolitan administration.

Local governments in Japan are largely classified into two-tier government level: the national and the prefecture entities. Among 47 prefectures in Japan, Tokyo Metropolitan Government, with 23 special wards and 26 cities, 5 towns and 8 villages of the smaller administrative entities, has a very different history and influence capacity from the rest of other prefectures [15] (Fig. 9). By the 1960s–1970s, the postwar economic recovery and rapid industrial expansion, largely depending upon the US policy to let Japan to consume more petroleum products imported through the international giant oil consortiums, triggered severe environmental pollution. The national regulation on domestic industrial practices was responsible for pollution level with Tokyo's Factory Pollution Control Act [1949] and the state-level Air Pollution Control Act [1968] [17].

All other prefectural governments followed the Tokyo's move as well despite the resistance by 1967, 18 prefectures had implemented their own anti-pollution ordinance and by 1971, all 47 prefectures implemented the same. The Tokyo Metropolitan Pollution Prevention Ordinance [1969] grants permission to schemes' and location control of factories for emission standards, for fuel use and factories than the national legislation. Tokyo's pollution legislation became a model for development in sub-national pollution control thereafter [*ibid*].

Governor Minobe [1960] was the pioneer for taking active measures through TMG that enforced regulations against air pollution incidents particularly for sulfur dioxide that was produced by burning of heavy oil in industries, which posed a serious threat to the local residents. Additionally suggested the use of low-sulfur heavy fuel oil to factories especially in major polluted areas in Tokyo including the total amount of sulfur oxides generated from thermal power plants with TEPCO as well. After signing a Memorandum of Understanding for a significant reduction, from 1971 onwards, the regulations of sulfur content in heavy oil in factories were duly regulated.

Fig. 9 Ward map of Tokyo. *Source* http://globalsherpa.org/japan/tokyo-japan/

Air pollution caused by automobiles was taken up by the Tokyo Metropolitan Government, as early as 1970 and established a system with recommendations to install devices that exhausted gas reduction. Since 2003, diesel operated vehicles have been banned that did not meet the particulate matter emission standards. It was the first time in Japan that a plurality of local governments cooperated and regulated the driving of automobiles such, instead of the national regulations [18]. It is said that the attitude of introducing innovative environmental measures ahead of the country when it has been used for work has been passed down to today as the DNA of environmental administration in Tokyo.

6 Sustainable Initiatives for Zero Emission

The historically accumulated experience enabled TMG to strengthen its policy and strategies to address the climate change issue and issued a declaration [2019] to move forward to a Zero Emission. Tokyo, aims to achieve net zero CO_2 emissions by 2050 and attain 1.5 goal as per the Paris Agreement. To achieve the said targets strategies developed with targets i.e. 38% energy consumption reduction in [compared to the level at 2000] and 30% use of renewable energy, nearly double the current level (2030). Formulation of the declaration is a significant milestone, at the same time a big challenge too as Tokyo is one of the world's largest power consumption areas [approximately 78.8 billion kWh power demand], and the ratio of renewable energy power consumption in Tokyo was 15.3% in 2018 [19].

6.1 Energy Management for Commercial Sectors

As the core of Tokyo's sustainable building policy, the Tokyo Cap-and-Trade Program has been in place, since 2010, as the first urban cap-an-trade scheme targeting business entities. TMG introduced the scheme ahead of the national government, in order to leverage the staled climate action at the national level. Together with other conventional measures, e.g. energy efficiency labeling of buildings, tighter control of vehicle emission, TMG has taken the lead ahead of the sub-national governments for climate and environmental mitigation.

Owners of facilities and buildings under the scheme [that are responsible for approximately 40% of the total TMG CO_2 emissions] are required to meet their emission reduction criteria through on-site energy efficiency measures or comply through emissions trading through structured quantitative identification of energy usage and the associated annual reporting, and verification of the reporting are main requirements. There has been a consistent reduction in CO_2 emissions from the built facilities since the system was introduced. These measures have resulted in a substantial decrease of CO_2 emissions (Fig. 10).

For the rest of the facilities, which account for approximately 60% of combined total of the industrial and commercial sectors in Tokyo, TMG introduced the Carbon Reduction Reporting Program in financial year 2010 to reassure owners of small and medium facilities to identify their CO_2 emissions. From 2020, there will be a system to acknowledge and reward those who demonstrate excellent efficiency performance or significantly increase renewable energy use.

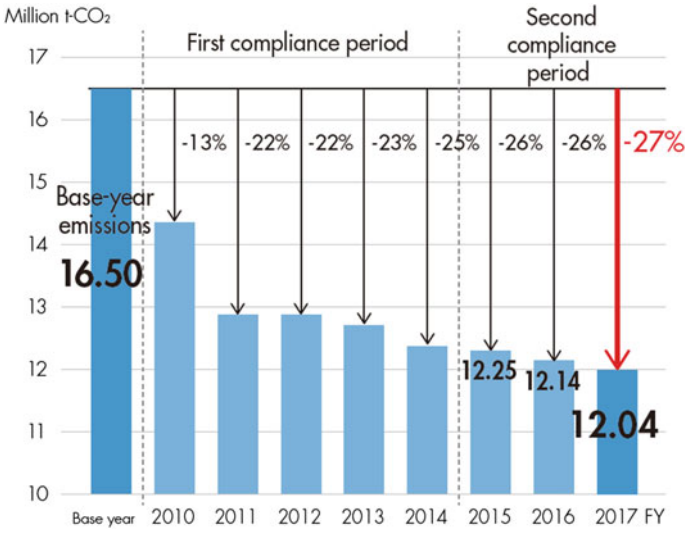


Fig. 10 Trend of total CO_2 emissions from facilities under Tokyo Cap-and trade. *Source* TMG [16]

6.2 Initiatives for Renewable Sources

The Tokyo Metropolitan Government [TMG] has promoted the use of renewable energy, which is the principal element for the Climate policy. TMG's Renewable Energy Strategy was formulated [2006], where the 2020 renewable energy target [20% of its total electricity consumption] was established. After the Great East Japan Earthquake of March 2011, promotion of renewable energy, including regional energy vision, were widely taken up by many Japanese local governments, but TMG was certainly a frontrunner of such moves.

In 2017, renewable energy accounted for approximately 14.1% of the total electricity consumed in Tokyo, marking ten-fold increase compared to 2008. The introduction of solar power generation was accelerated especially after the Feed-in-Tariff [FIT] system, which was initiated by the national government in 2012 (Fig. 11).

Renewable energy is distinctive for the context for Tokyo with its goals and policies translated such for the large consumption area. The 2030 target for renewable energy intended to increase the amount of renewables "used" in Tokyo. Therefore TMG has two overall policy directions: (1) Aiming to achieve the energy efficiency and (2) "Procuring renewable electricity" from outside Tokyo. Being spatially the third smallest prefecture in Japan with an area of 2,104 km^2, covered mostly by urban areas, on-site renewable energy, such as wind power generation, geothermal power generation, biomass power generation, and large-scale solar power generation, is difficult to be installed physically within Tokyo thus influencing its immediate peripheries and close vicinity areas are being explored.

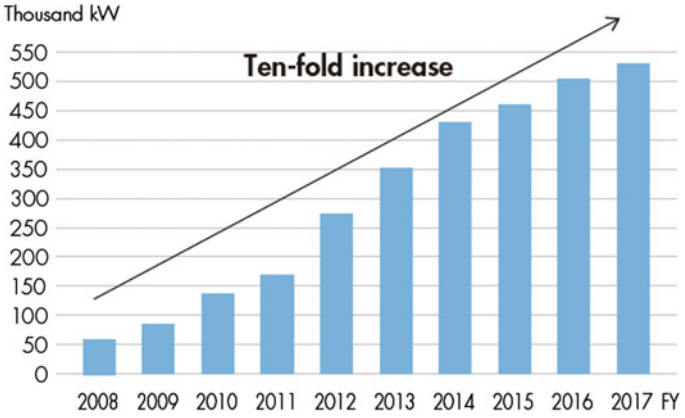


Fig. 11 Trend of solar power generator installation in Tokyo. *Source* TMG [16]

TMG Specifically took up an initiative to integrate renewables for in-house facilities; including the governor's office and water and sewage systems, consumes a huge amount of energy with approximately 30,000 TJ per year. Typically TMG has a decentralized system for procurement of electricity through tenders to respective departments of TMG, who decide independently the suppliers and the kind of electricity they purchase. However, TMG has started to specify a prerequisite for the bid participation criteria based on emission factor and renewable content of 20% for electricity suppliers. Through imposing such criteria, only "renewable conscious" suppliers can be candidate to become TMG suppliers.

As of April 1, 2019, 110 facilities procured electricity from electric power companies with a renewable energy usage rate of 20% or more. Since August 2019, the Tokyo Metropolitan Government's Main Government Building, which consumes approximately 30 million kWh /year, switched to 100% renewable energy power a decision propelled by the idea of RE100 (Renewable Energy 100%), an international initiative that aims to increase institutional use of renewable energy. The decision was evolutionary, in the sense that turned the conventional practice to choose the cheapest bidders, with the new selection criteria that allowed only those bidders that have met a certain environmental and renewable energy standards were in place.

Further to improve the environmental properties of electricity, TMG has constituted stipulations in place for the electricity suppliers having sales in Tokyo area to reduce their CO_2 emission factors, inline with the targets for renewable energy content. TMG specifically adopted "the Energy Environment Plan System", which requires electricity suppliers to annually submit CO_2 emission factors, reduction plans, and targets for expanding renewable energy sources as well. The information thus provided is accessible by the public, so that the societal members can see the degree to which suppliers are responding for climate change and renewable records. This system came into effect in April 2005, only nine electricity suppliers submitted prescribed records, but the number of retail electric power companies increased

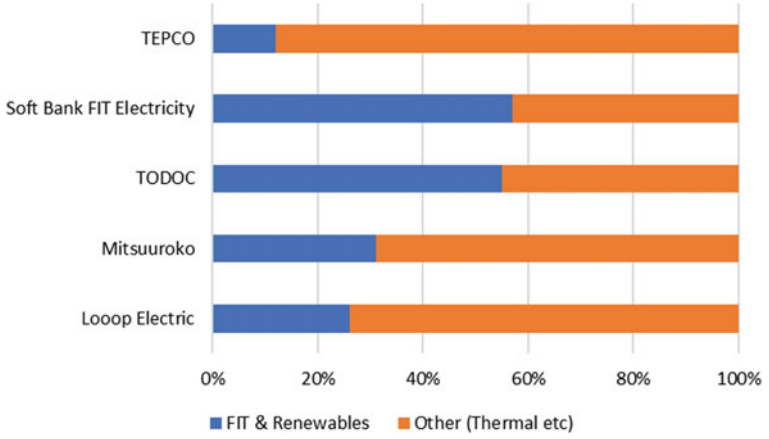


Fig. 12 Renewable energy share of selective retail suppliers in Tokyo

sharply since. In FY2019, 225 companies submitted the information, with the background that part of them have renewable energy ratio exceeding 30% [Tokyo's 2030 renewable energy usage ratio target] (Fig. 12).

6.3 Mitigating Carbon Challenge with Demand-Driven Approach

Tokyo [2019] started Japan's first initiative of group renewable electricity-purchasing scheme, directing household participants and recruits who want to purchase renewable energy power. And by aggregating the participants' demand to negotiate price reduction (Fig. 7) for Community Choice Aggregation [CCA]. CCA, also known as municipal aggregation, are programs that let local governments to procure power on behalf of their residents, businesses, and municipal accounts from an alternative supplier while still receiving transmission and distribution service from their existing utility provider. CCAs are an appealing means for communities that prefer more local control over their electricity sources, more greener power than is offered by the incumbent utility, with/or lower electricity prices. By aggregating demand, communities gain leverage to negotiate better rates with competitive suppliers and choose greener power sources [20]. More the number of participants that join the TMG CCA scheme, better the purchasing power of renewable energy. The household sector accounts for about 30% of the energy consumption in Tokyo, while the CO_2 emission reduction in the household sector lags behind that of industrial-business and transportation sectors.

The total amount of CO_2 emissions from energy sources in Tokyo in FY2017 was 56.74 million t-CO_2, which was a 1.8% decrease from the 2000 level, contrasting to

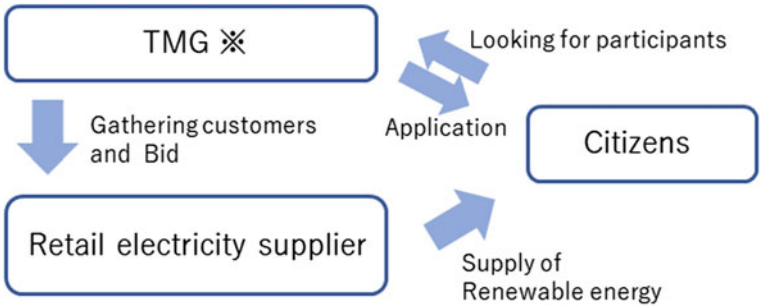


Fig. 13 TMG group purchasing scheme

the household sector's increase by 33.4% [21], suggesting potential policy leverage for the household sector. TMG operates the scheme, jointly with the contracted party, while the CCA, the group-purchasing scheme, is strongly underpinned by the behavioral sciences.

Tokyo also in line with the international inter-city network called C40; an international practices. Besides leaning from the overseas network, TMG had a series of preparatory procedures since 2017 before it launched the CCA scheme: (1) It was difficult to select a good partner to TMG-CCA, with rapid increase in the number of electric suppliers, since the full deregulation of electric power market in 2016. (2) Sufficient economic merit of joining the scheme (e.g. negotiating better rates with competitive suppliers and choose greener power sources) has to be secured if joining CCA, even single-person household being a dominant form of Tokyo. After numerous deliberations Tokyo drafted the CCA, with adequate emphasis to reduce barriers for participation, by providing simple and clear information to the participants (Fig. 13).

TMG-CCA scheme started in June 2019. TMG outlined a contract with business operators who jointly operated essential tasks, responding to inquiries from applicants, effective advertising, and supplying renewable powers, that has a track record of managing group purchasing businesses in Europe, was chosen. The specific procedure for the renewable energy group purchasing business is as follows: (1) Tokyo calls for group purchasing of renewable energy power, applicants register their personal information, and (2) decide a business operator to supply electricity by auction (regeneration). (Required that the ratio of available energy power is 30% or more), (3) Individual quotation is sent to the participants who registered, (4) Those who wish to participate decide to switch to renewable energy power (there is no cost burden even if they decline). The point that the behavioral science for urging the switching of electric power is taken into consideration as the city proposes a simple electric power plan, which systematizes the selection and makes it easier for the citizens to select electric power, and there is no obligation to switch at the time of registration, and it is easy to determine to switch after the power company decides.

The project initiated in December 2019 to January 2020, with the 4,334 households. It is expected that the electricity bill will be reduced by about 10% [about

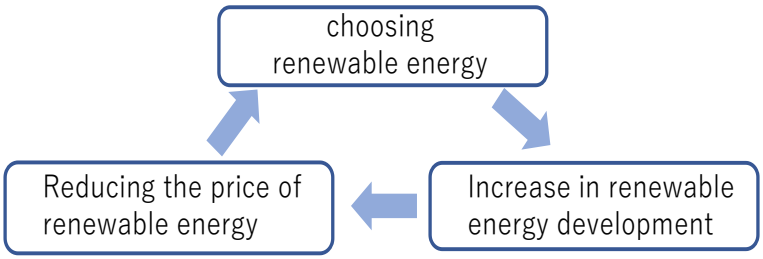


Fig. 14 Positive feedback loop to increase renewable energy development

10,000 yen per year] for the participants. TMG is planning to further increase the number of households those shall join. Through the project, the Tokyo Metropolitan Government will cultivate a system to select renewable energy power, leading to (1) enhance renewable energy development in Japan, and (2) increase of renewable energy, such that the demand expansion will reduce renewable energy power costs, and (3) price declines will stimulate further demand (Fig. 14).

Tokyo pioneering the system other big cities, including Kanagawa and Osaka prefectures have begun similar CCA schemes.

7 The Governance Issue: Institutional Culture of TMG

TMG aims to be a frontrunner to address environmental and sustainability practices, through certain policy formulations and their implementation. In order to attain a desired level of policy performance, a number of supporting factors are required i.e. institutional structure, work ethics and motivation, in addition to its overall abundance of budget and staff numbers and how they affect their officer's to motivate for progressive policy formulation. Particularly, work ethics and motivation can contribute to encouraging or discouraging officer's job performance. Although there could be cases where outstanding performance exists in the middle of unethical and unmotivated practices whereas a sustainable performance can only be achieved through strong work ethics. The following section describes how the institutional cultures are developed, to contribute to the increase of sense of integrity and progressiveness among the TMG members, through the bottom-up participatory approach.

7.1 Budget Allocation and Organizational Capacity Building

TMG's abundance of budget is one of the key-enabling elements for the strong policy presence. The budget size of TMG in FY2020 is about 15,500 billion yen [155 billion US$], equivalent to the national budget of Norway [22]. Of these, the

budget earmarked for climate change is more than 30 billion yen [300 million US$], allocated to support renewable energy [including hydrogen] development, energy conservation, and the system backing for TMG cap & trade system [23].

TMG has approximately 170,000 personal staff, allocated to individual Bureaus and Divisions of TMG, e.g. Bureaus of Education, Police/fire Department, Water and Sewage Systems and Transport [metropolitan buses and tubes] Divisions (Fig. 14), while the Bureau of Environment has nearly 500 staff [FY2020] (Fig. 15); of these,

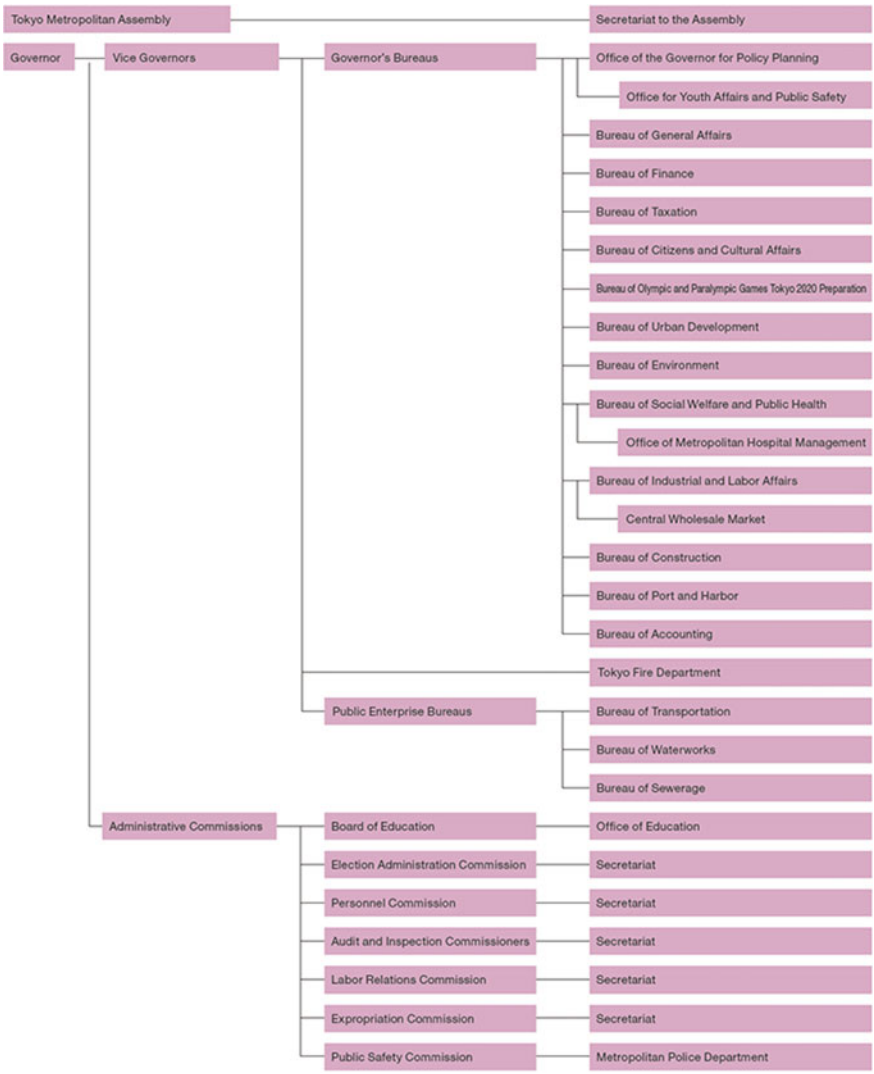


Fig. 15 Organizational structure of TMG [24]

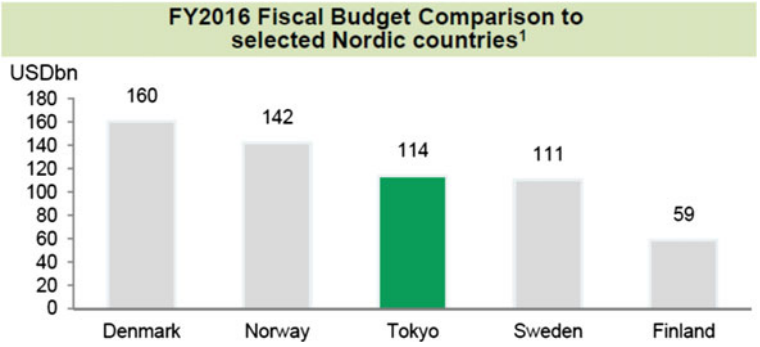


Fig. 16 Fiscal budget of TMG and selected European countries [24]

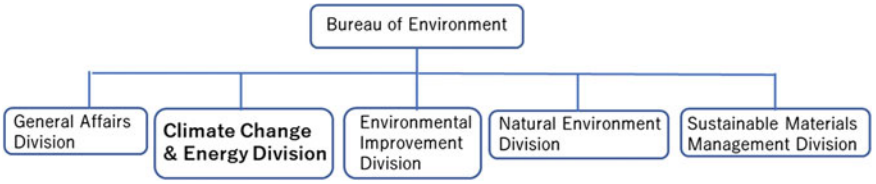


Fig. 17 Organizational structure of TMG

around 80 people belong to the Climate Change and Energy Division. A sound stable budget and personnel of TMG far exceeds the levels of other local governments, e.g. more than 114 billion US$ in 2016, matches the state budgets of some countries (Fig. 16) and thus facilitates various innovative and progressive measures on environment and sustainability issues (Fig. 17).

The syntax between human resource and the management of the Mega city essentially drive the success of institutional Governance within TMG. Largely there are three kinds of recruitment in the Japanese local government; the general administration [Category I, university graduates can apply], technical staff [Category II] and supporting staff [Category III, high-school graduate normally applies to this]. The Personnel Commission holds examination; conventionally the Governor and other officials who have appointive powers employ a combination of written examinations and interviews for the recruitment of new staff, and candidates who pass the examinations. In some occupations like nursing, specially authorized officials, directly conduct exams and employ personnel.

Despite the limited statistics available, however, the overall educational level of TMG Category I officers are generally high, with graduates from reputed Japanese universities. About half of the Category I officers are for the general administration, while the rest have a range of technical expertise i.e. civil engineer, electrical engineer, construction and architecture, landscape management, vets to nutrition study. Further personal growth and promotions especially to positions viz: deputy director and managerial positions is based purely on individual's merit, rather than academic

background or the category where an individual was originally allocated. In principle, it is necessary to pass *supervisor examination* when wishing to be promoted from a staff to upper level, and to pass *manager examination* for the managerial position. The managerial examination includes work evaluation, examination, thesis and interview.

It is tacit knowledge among the staff that the work evaluation has the more weight than the written and oral examination, where diligence and faithful execution of instructions from supervisors are appreciated. It is similar for the higher managerial positions that the ability for smooth execution of the instructions from the highest authority, including the governor, is a major evaluation merit. Also, the staff needs to have a good relationship among the members of the Tokyo Metropolitan Assembly. Furthermore, the pacifist virtue is appreciated if career promotion is indented, not to politically offend anybody within and outside of TMG institution.

Despite the observed indication of the typical "Japanese" obedient culture, there are many staff every year that appear for this competitive process of promotion, with the passing rate of these examination commonly being less than 10%. Interestingly, TMG, as in the other Japanese government institutions, has the seniority-based wage system, with little difference in wages even if promoted or appointed to important positions.

7.2 Capacity Building of TMG Staff

TMG has a set of basic guidelines by responding to the needs of residents, aims to develop metropolitan government personnel's capacity. Within the Japanese local governments, it is an usual practice to make sure the staff are transferred to different branch and division of the organization often to very different division, from environmental to welfare sections' in order to let them experience and acquire different perspective to serve its residents. Although beneficial in some aspect, such the carrier transfer system has been criticized for disrupting development of specialization of professional skills, which is often critiqued through expert judgments. Typically TMG changes its staff every two to three years to make sure the transfer is *organic,* with allocation to the relevant divisions to ensure their continued professional skill development. This TMG organizational carrier development policy is significant to ensure there are sufficient number of professionals in TMG Environmental Bureau to act timely for the climate change policy making and implementation, with sufficient technical understanding and the relevant expertise.

TMG Environmental Bureau encourages bottoms up approach an opportunity open to its members, to enhance their capacity and motivation. In the Japanese local governments, each department submits' an action plan for the subsequent year. In the process of formulating the plan, a variety of members, including junior staff, engineers and technicians, as well as clerical officers, are invited to make a team. By having the bottom-up discussions among staff with the diverse backgrounds, needs and demands of the Tokyo residents and businesses get reflected in the action plan in

Fig. 18 Overseas study trip of TMG officials to have a firsthand knowledge

an effective manner, while contributing to the accumulation of skills and awareness of the staff members, acknowledge individual motivation and recognise work ethics.

Furthermore, travel opportunities are given to the staff, to learn and understand the progressive policies and governance among the cities across the world. Under the TMG travel system, the staff themselves can choose the aims and destination of their field study. During their travel each of the staff has an opportunity to conduct peer interviews with the officials, collecting relevant information on field, which greatly contribute to motivating staff to propose policies to be adopted and tailored into the context of Tokyo (Fig. 18). In this way, TMG has a mechanism for improving the policy-making capacity of its staff, as well as motivating staff and teams to plan and execute the relevant projects, with a welcoming atmosphere for bottom up proposal.

7.3 TMG and the External Organizations

TMG's environmental actions are also supported by its agencies. The Environmental Public Service Corporation [EPSC] is an authorized outfit, and a major player in supporting the city's policy implementation. EPSC holds approximately 360 employees [about one-third of this is engaged in the climate change issues], and is engaged in a wide range of environmental practicalities, including waste management [including waste collection, incineration and recycling], nature conservation projects, in addition to climate change practices.

EPSC was officially appointed as the Global Warming Prevention Activity Promotion Center [All the Japanese local governments are legally required to either establish or appoint such Centre in each prefecture] in 2008, and being responsible for information dissemination and sustainability awareness raising of the general public, in collaboration with TMG and its subsidiary municipalities. In addition, EPSC functions as back-office to TMG, by handling clerical works [assessment and allocation of TMG grants to renewable-energy related projects]. Also EPSC has a technical group, which carries out energy management and conservation diagnostics service to the local businesses and factories. The service is free-of-charge, but professional advice has been provided to the building managers where substantial energy conservation measures were taken up by the instructed businesses.

TMG has a close link with a scientific research institute [Tokyo Metropolitan Research Institute for Environmental Protection], where a wide range of technical and policy studies are carried out. The technical research includes that on hydrogen development, recycling of urban waste treatment methodologies, and air pollution reduction. Their scientific expertise and knowledge form the basis for the environmental recommendations taken up by the TMG policy units (Fig. 19).

The cooperation between local governments with overseas cities is inherent upgrading of the organization at large. In addition to the intra-agency coordination, TMG has an external network, with collaboration with local governments in its vicinity. It has an extensive network with the governor's office of Saitama, Chiba, Kanagawa prefectures, and Mayor's offices of Yokohama, Kawasaki, Chiba and Sagamihara cities, forming the Nine-City Summit once in two years' to discuss

Fig. 19 Energy conservation diagnosis conducted by the public corporation (*Source* TMG [24])

and share the common problems and issues. This platform often functions in the advisory capacity for recommendations at policy level to the Japanese government. TMG has international collaborations with C40 alliance, the International Carbon Action Partnership [ICAP] and the International Council for Local Environmental Initiatives [ICLEI], the city groups that are leading actions for climate change; often such international collaborations' influence the TMG policy formulation however, the Japanese local governments are largely driven by strong domestic culture, where the international stimulation is minimum.

7.4 Collection of Data

The city collects comprehensive data on climate change measures each year. For example, through the Cap and Trade system and the global warming countermeasures report system for small and medium-sized business establishments, the city obtains basic information such as the amount of energy used and the carbon dioxide emissions of about 30,000 business establishments in Tokyo every year. In the "Energy Environmental Plan System", 225 retail electric power companies that supplied electricity in Tokyo submitted basic data such as the emission factor and the amount of power supply. [2019] By analyzing the exhaustive data submitted each year, it is possible to know what kind of measures will be effective and effectively act on climate change countermeasures in the city. The analysis and outcome of the said data play an important role in the external explanation and consensus building in the implementation of the measures.

8 Political Will and Futuristic Vision

Finally, again the political leadership shall be highlighted to discuss the enabling factors for TMG climate policy. Since 2016, to the moment of writing [June 2020], Ms. Yuriko Koike is in the Governor's position. She has a basic, not to say weighty, understanding in the climate change issues, in fact she was former Minister of the Environment of the Japanese government [2003–2005], under the second Koizumi Cabinet.

During her Governorship, she has exercised a certain leadership to act upon the climate issues. The TMG Plan for Zero Emission Tokyo, as mentioned, was one of such examples. She, however, has been criticized for having little achievement than expected, in the sphere of environmental and sustainability policies, as well as of the overall responsibility. Surely, her first tenure was full of challenges, including the costly relocation of a landmark fish-sale market in Tsukiji, the historic postponement of the 2020 Tokyo Olympic Games and the contesting against the COVID-19 pandemic, but she could have done more to increase her political influence and popularity, over the sustainability issues at Tokyo.

On the other hand, the TMG officials as the bottom-up vindication, rather than the top down command largely propose environmental policy formulation; the implementation of the environmental and sustainability policies has been greatly backed by the TMG officials and the relevant institutional staff. As the former chief officer of TMG Environmental Bureau, Ohno [2013] summarizes that the institutional leadership, surely an important portion of policy efficacy, shall not be seen as the sole condition for successful governance, as quote "No matter how strong political leadership is, the policy formulation and implementation cannot be achieved with a single command. Their effectiveness is only ensured when many actors function together."

With the current challenges faced by Tokyo, including threats of earthquakes and other unforeseen calamities such as climate disasters, with increasingly stronger and unpredictable typhoons, the following strategies are the current focus: (1) Actions against the COVID-19, (2) Maintaining and enhancing sustainability of the city, by taking up mitigation and adaptation policies. Against the previous expectation that the Olympic Games [due planned in 2020, but postponed to 2021] to bring economic benefits to the city, it has become an additional burden to TMG, with less expected inbound tourists [meaning less financial merits] and huge postponing and maintenance cost of the delayed Games. Tokyo will face the new and significant challenges, as its international counterparts may also stand.

On discussion of the Future of Tokyo, critics argue whether and how Tokyo can maintain its economic power-train, holding the major share of GDP of Japan with its production, global supply chains. Especially facing the new challenge from China, where a number of influential cities emerging, Tokyo may become just one of the big cities in Asia. Surely, the tighter alliance with the US, Japan and its capital Tokyo has been trying to demonstrate the democratic presence over China. On the other hand, substantial industrial shift towards IT is urgently needed, to "upgrade" Tokyo into the new technological era, otherwise the Tokyo will lose its competitive edge. The "energy and the sustainability" paradigm, in principle, just addresses the field where smart information technology can demonstrate the technological strength that Japan and Tokyo may advance. In order to fully exhibit the technological merit, however, TMG, together with the Japanese Government, has to envision and implement innovative strategies to integrate a various policies to enrich and enhance its performance and the global reach, as the technological integration between the smart ICT and the city's infrastructure has not been fully materialized on the Tokyo ground.

9 Discussion and Conclusion

This chapter enumerates the status of the global mega city of Tokyo reigning as the largest mega city since 1990 onward. Globalization propelled the rate of urbanization with mega cities accommodating a large share of domestic population. Further these mega cities have unanimously accepted for setting thresholds and norms for lifestyles, cultures, strongly underpinned by the global economy and the infrastructure facilities and information technology regulating for innovation and updates frequently and

typically the mag cities are quick to respond such. Conventionally all the global mega cities are the economic power magnets and thus respective stand point and position for global issues like climate change and related environmental concerns being foremost. Due to their economic stability they are the key driver and consumers of resources both natural and manmade specifically human resource.

The case example of Tokyo demonstrates how good governance with robust approach has put Tokyo at the most populated among the global mega cities of the world. Though it is questionable whether it is sustainable, or even possible, to keep the position, and the key observed strength of TMG to date is its resilient nature and quick to respond to the changing needs while addressing the human behavior connotation as well.

With the blessed position of being the hub of economic Centre of the country, Tokyo has been enjoying the affluent fiscal budget, compared to other local governments. The wealthy budget enables TMG to exercise and experiment progressive policies. Recognizing that Tokyo has being the aggregation of energy and electricity demand, TMG addresses a series of policy measures to exercise collective action to reduce, purchase, manage and generate energy.

The checks and balances at TMG are democratic and upgraded regularly irrespective of the time frame. The staff is an integral part of the governance system and with measures starts with recruitment process wherein the best candidates from reputed universities are selected and groomed with the work culture that gives them opportunities like travelling across the globe to observe, know, understand and participate with other staff members delivering similar tasks. Having imbibed the knowledge base they are facilitated at a platform wherein the experiences are shared and debated to add value to the existing systems at TMG and often the outcome are dovetailed within the annual proposal submitted to TMG; where revisions and upgrading process is implemented. Next there is system wherein each of the staff members is to shift roles within the organization and centers' this sensitizes the members for other roles and increases the awareness, which helps in building them a team player with mutual respect that each one develops also gets reflected when they develop the annual proposals'. On the other hand, the TMG officials along with the relevant institutional staff typically support a bottom-up approach, rather than the top down command that proposes environmental policy formulation; the implementation of the environmental and sustainability policies. While drafting the annual proposals being essentially a bottoms up approach, gives opportunity to each member across the hierarchy to participate and put forth the creative ideas and with such process in progress each member developed a sense of self worth which builds their self esteem and self confidence as well. With such a backdrop the personal growth occurs through promotions that recognizes personal initiatives and deliverables for the organization coupled with formal examination as well: written, interview including their hands on work. Such setup has proven to be ideal for sustainable growth with strong sense of belonging to the organization, city and nation at large.

The decision-making is democratic as when the bids are submitted to each department within TMG the respective department has the authority to award the bids based on the framework arrived through consensus. Such an arrangement creates a healthy

environment for competitions amongst various departments. With each member so vigil the thresholds within the organization are up-scaled and improving with time especially for reduction of carbon emission and thrust for maximizing renewable resources. With such a set up TMG has proved to be pioneer for setting standards for other cities within the country and even globally. TMG goes further to work in coordination with external agencies i.e. EPSC that has a technical group, which carries out energy management and conservation diagnostics services to the local businesses and factories and the service is free-of-charge. Tokyo, the global mega city is truly a unique example and to acknowledge as best practice is well earned by the city and its proud inhabitants.

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Mumbai

Smart Mega Global City: A Roadmap of Mobility as a Service for Mumbai

Amit Chatterjee, Premjeet Dasgupta, and Gaurav Vaidya

Abstract Mumbai has attained the attribute of being the global economic hub and financial epicenter of India. Mumbai has emerged as the largest Urban Agglomeration (UA) in India and has 18.4 million in 2011. By 2030, Mumbai will be the fourth largest in the world, as per UN-Habitat statistics. The research focused on Greater Mumbai's economic stature in the context of national and regional economic development, followed by identifying the main actors for its growth story, reviewing the establishment of Mumbai as an economic hub, and finally envisioning it as a smart global megacity. Further, Mumbai already has multiple modes of transports readily available. It already has established the travel behavior of a user dependent on multiple modes of transports as well as governed by the user's spending capacity and willingness to spend. The research also focused on a detailed framework of implementing Mobility as a Service (MaaS) for Mumbai by integrating the technology and the innovation with the help of Information and Communications Technology (ICT). Necessary policy recommendations are also suggested for the long-term economic health and sustainable mobility of Mumbai.

Keywords Global · Economy · Smart · Mumbai · Mobility as a Service (MaaS)

1 Introduction

Mumbai is a flourishing cosmopolitan, global, multi-cultural city, which is also known as the epicenter of the Indian economy. Mumbai has been under continuous growth for the past 500 years, albeit built on seemingly weak foundations of seven islands. According to UN-Habitat statistics, Mumbai will be the fourth largest populous metropolis in the world after Tokyo, Delhi, and Shanghai in 2030 [41]. Mumbai

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has been global almost since its birth. The cotton mills of Mumbai spinning threads knitted many countries accessible through sea routes. The maritime merchandise brought Mumbai to the international trade map in the latter part of the nineteenth century. South Asia still owes to Mumbai for being the most globalized economy in the region. Mumbai is the 12th most interconnected economy at the third tier with Chicago, Moscow, and Sao Paulo as per the most recent analysis by the Globalization and World Cities group [5]. Mumbai also serves as the abode to several commercial and government banks, insurance institutions and investment financial institutions. Examples of such institutions are the National Stock Exchange of India, Reserve Bank of India, Bombay Stock Exchange, etc. India's premier nuclear and scientific institutions are also located in Mumbai, like the Department of Atomic Energy, India Rare Earth Limited, Nuclear Power Corporation Limited, Bhabha Atomic Research Centre, Atomic Energy Council of India, Tata Institute of Fundamental Research, Atomic Energy Regulatory Board, etc.

The presence of Jawaharlal Nehru Port, the largest container port in India, is an added advantage for the State in import and export through the sea [19]. As per the Economic Survey of Maharashtra, the projected manufacturing sector growth was 7.6% in 2017–18. Mumbai and its region contributed significantly to the industrial growth in Maharashtra and that of India as a whole. Recently, the Government of Maharashtra has formulated 'Maharashtra Industrial Policy-2019' with a vision to make 'Maharashtra as a global investment, manufacturing and technology hub, promoting sustainable development' [16]. A 700 km long super communication expressway (Samruddhi Mahamarg) connecting Mumbai and Nagpur is planned, which will traverse through 10 major and 14 other influence districts of Maharashtra. Twenty major industrial areas are planned along this expressway. Delhi–Mumbai Industrial Corridor (DMIC) is India's most ambitious infrastructure programme launched in 2006, aiming to develop new industrial cities as "Smart Cities" and converging next-generation technologies across infrastructure sectors. The government of Maharashtra has developed the Mumbai–Pune Knowledge Corridor, a fast-emerging IT hub of the country. Six major IT parks were set up, 3 in Mumbai and 3 in Pune, providing world-class IT infrastructure. As part of the National Governments DMIC project, the development of the Dighi Port Industrial Area (253 km^2) is also planned. Investment in Delhi-Mumbai, the industrial corridor, will make Mumbai prosper further than experienced earlier.

According to the Software Technology Parks of India (STPI) assessment, Maharashtra ranks second in IT export, accounting for 20% of India's IT export [14]. Further, in recent years, several sector-specific policies have been launched/amended by the Government of Maharashtra with specific policy targets and projects identified for Mumbai and Mumbai Metropolitan Region (MMR). For example, Government of Maharashtra has targeted in next five years' time frame Mumbai to emerge as one of the world's top five FinTech centers [15]. These investment potentials trigger Mumbai to its self-configuration to be smart and more global.

The foundations of Mumbai's current transport system were laid by the British in line with Mumbai's emergence as the most important economic and trade hub of India. But today, with a population of 18 million, which continues to grow, the city

streets and transit systems are one of the busiest and most congested in India. Even though the population growth rate of Greater Mumbai has seen a steady decline from 43.8% in 1961–71 to merely 3.8% in 2001–11 [4], the population of the suburban areas in the Mumbai Metropolitan Region or MMR are increasing significantly. MMR spreads over Mumbai City, Mumbai Suburban and parts of Thane and Raigad districts and includes a conurbation of eight municipal corporations and nine municipal councils. It is the primary city of an emerging Mumbai-Pune-Nashik urban agglomeration. From the mobility perspective, the challenge lies in addressing the large number of trips that transcend administrative boundaries within MMR (LEA Associates South Asia Pvt. Ltd., [28].

The chapter is broadly divided into two parts: the first part focused on an appraisal of the global economy of Mumbai. In this section, the potential of Greater Mumbai's economic stature is assessed, including its evolution as an economic center, followed by the identification of main actors for its growth story, reviewing the establishment of Mumbai as an economic hub and finally envisioning it as a smart global megacity. The second part focused on translating the sustainability criteria while designing and implementing Mobility as a Service (MaaS) for Mumbai.

2 Configuring Mumbai into a Global City

For the past few decades, private investment has flown into Mumbai, leading to massive developmental projects in infrastructure. Mumbai has also become the hub for financial institutions and services for India. Mumbai is sometimes termed India's entertainment capital because the Hindi Film Industry (Bollywood) and the Television Industry are located. This generates an aura of fascination and mysticism around the city, making it the dream city for many Indians and outsiders. Along with its immense growth potential and looking for an opportunity to improve their quality of life, many people migrate to Mumbai from all around, making the city a hotspot for cultural convergence. The transformation of Mumbai from a historic fishing community and provincial trade centre to one of Asia's prosperous cities is worth noting.

3 Evolution of an Economic Center

Initially, the land on which Mumbai stand now was made up of seven Islands-surrounded by swamps, leading to unhygienic conditions. King Ashoka of the Magadh Empire ruled this area in the third Century BCE. From the second century B.C. to the fourteenth century A.D., the islands were under the successive control of several dynasties such as Satavahanas, Western Kshatrapas, Abhiras, Vakatakas, Kalachuris, Konkan Mauryas, Chalukyas, Rashtrakutas, etc. Yadava rulers (twelfth–fourteenth century) established a settlement at 'Mahim', one of Mumbai's original

seven islands in the late thirteenth century, which was some 300 km away from their capital Aurangabad. Later, Mahim Mahim was captured by many successive rulers such as the Muslim ruler of Gujarat, The Portuguese and The British East India Company. The two major events that helped the city's future growth during the seventeenth century were as follows: (i) shifting of administrative headquarters to Mumbai from Surat by The British East India Company and (ii) the construction of seawalls, breakwaters, and reclamation projects that ultimately linked the original seven islands into a single Mumbai Island. Mumbai was lagged behind Calcutta and Madras in importance during the seventeenth & eighteenth centuries. However, a series of events of political instability in eastern and central India in the early and mid-nineteenth century boosted Mumbai to its administrative and economic prominence in India [30].

The growth story of how Mumbai became India's financial capital has deep roots in Mumbai's rich industrial growth and development. A boom in the textile industry in the late nineteenth century gave Mumbai an identity as the nation's industrial hub. The textile industry was a catalyst for growth in many parts of the country and considered the first modern industrial setup in India. The factors that helped the growth of textile industries in Mumbai are (i) availability of JN Port for export of finished goods, (ii) well-connected rail and road links with cotton-growing areas, (iii) humid coastal climate, and (iv) availability of manpower and finance [24]. Greater Mumbai has undergone an economic transformation with a remarkable rate of 9% from manufacturing activity to services activity. Post-implementation of economic reforms in India, under the changed economic momentum by initial years of millennia, around 70% of funds were shifted from industrial activities to the services sector [7].

Central and State (provincial) Governments created an environment of effervescent economic momentum through aggressive industrial promotion and development policies, easy land acquisition process, fast provisioning of support infrastructure and by opening various no. of skill development centers in the Mumbai region. Mumbai offers decisive advantages for the present development of the manufacturing sector that includes robust demand with growing middle-class population, increasing domestic and foreign investments, policy support and competitive advantages such as Increasing share of the young working population [22].

Apart from the manufacturing industries, other sectors, like; finance, IT & ITES and other service sectors, entertainment & film sector, tourism sector, port & logistics sector, real estate sector etc., also play a vital role in economic development Mumbai. At the same time, Mumbai of twenty-first century advanced towards the approach of "smart economy", which is the need of the hour in changing horizon of the new global era. The idea of smart economy is basically a transformation of the old economy to the new economy that brings together several features of the new economy in an innovative sustainable and eco-economic approach: high productivity, digital economy, competitive economic progress, economic innovation, sustainable jobs, global economic growth & prosperity [2].

4 Establishment as an Economic Hub for India

In the beginning of the third decade (1970–80s) post-independence of India, Mumbai (that time called as Bombay) had already established its identity as the financial capital of India and the city again re-emerged with new potential by the beginning of the 90s after the adoption of economic liberalization by India and implementation of country-wide economic reforms. Of course, the manufacturing Industry was the flag bearer of this rising motion of Mumbai, but avenues were opened for new sectors as well. By that time, surrounding areas of the Mumbai region also came under the heavy influence of Mumbai city's growth and development. With time, the 'Pandora of Economic Momentum' of Mumbai city transferred the vibration to the whole region and created its identity as Mumbai Economic Region. The presence of the active Mumbai Port was also one of the reasons for industrial development in Mumbai, which further strengthened with the development of Jawaharlal Nehru Port and supported logistics activities. But after the commencement of various manufacturing industries, other sectors were also started their rise as major contributors in the economic development of the Mumbai region, and these are like financial sector, media & entertainment industry, tourism sector, Gems & Jewelry industry, IT & ITES industry, etc.

4.1 Growth of Manufacturing Industries

Mumbai is home to various Large, Medium and Small-scale manufacturing industries. Mumbai region is an attractive location for foreign investments in the manufacturing sector because of its favourable position on the western coast and availability of two major ports of India, i.e., the Jawaharlal Nehru Port Trust and Mumbai Port Trust. Manufacturing Industries in Mumbai can be classified based on the scale of their work and production. Table 1 shows the total number of manufacturing Industries of different scales in the Mumbai region.

Some of the most prominent large-scale industries of India have their headquarters in Mumbai. These industries have huge market capitalization and they contribute a significant role in the economy of the country. These industries are also responsible

Table 1 Details of manufacturing industries with employment and production

S. no.	Category	No. of industries	Employment generation	Production capacity (in lakh units/t)
1.	Micro	2191	27,193	871,205
2.	Small	1635	46,744	789,777
3.	Medium	69	4230	303,745
4.	Large	234	75,843	4,664,727

Source [21] (based on data of March-2012)

Table 2 Prominent MSME industries in Mumbai

S. no.	Category	No. of Mfg. Industries	Employment generation	Investment (In Lakh)
1.	Agro based	95	2025	2939
2.	Textile industry	250	6435	8688
3.	Wooden furniture	13	176	313
4.	Paper & Paper products	69	832	2196
5.	Leather products	72	1659	1531
6.	Rubber & Plastic product	562	7019	138977
7.	Metal fabrication	684	8168	55800
8.	Engineering Units	250	2779	1971
9.	Electrical machinery	549	7164	20107
10.	Repairing	68	691	1449

Source [21] (based on data of March-2012)

for the production of numerous job opportunities and hence results in in-migration, which includes daily floating population as well. Some of the prominent MSME industries in Mumbai are listed in Table 2.

"Medium scale industries" are comparatively less than the other two categories of industries in Mumbai. Mumbai has 69 Medium scale industries under functional conditions. Medium-scale industries have a production capacity of about Rs. 3000 crores annually and they are responsible for the employment of about 4230 individuals. Whereas, "Micro and Small-Scale Industries" are the major job-producing fields and hence, there are various Policies and Programmes being run by Central Government as well as State Government for welfare and development of MSME Sector in Mumbai. It is evident from the above-stated facts that the manufacturing industries at different scale, contribute significantly to the economic growth of Mumbai along with the production of employment opportunities [22]. At the same time, these industries promote in-migration into the city from the surrounding suburb areas and satellite towns which also includes daily floating population influx. This in-migration, in turn, results in an increase of demand for real estate for habitability and demand for transport infrastructure.

4.2 Presence of Mumbai Port

Mumbai Port has been considered as one of the principal gateways to India and is playing a pivotal role in the development of the economy, trade & commerce of country and Mumbai city in particular. Out of the total country's sea-borne trade handled by all Major Ports of India, Mumbai Port caters to 8.61% of business in

terms of volume [33]. During 2017–2018, the Mumbai Port Trust handled a record high level of cargo, amounting to 63.05 million metric tonnes, a 3.17% increase from the previous year. In the same year, Mumbai Port handled slightly more than 16% of the total Petroleum, Oil and Lubricants traffic of India [36]. Jawaharlal Nehru Port Trust (JNPT) has the largest shipping container terminal in India, located in the south-east of Mumbai. JNPT has proved to be the gateway of economic growth through foreign trade because of such a huge container handling capacity. JN Port handled 5.03 million TEUs of container traffic during the financial year 2019–20. The containers handled at JNPT constitute about 50.37% of total container traffic handled by all Indian Major Ports [25].

Delhi–Mumbai Industrial Corridor (DMIC), a planned industrial development project, connects India's capital Delhi and its financial hub Mumbai. The estimated total project cost is $100 billion, making it the biggest ever infrastructure project by the Government of India. This project aims to promote and instigate industrial development across six states of India, which will in turn encourage economic development in the region [8].

4.3 Special Economic Zones

Special Economic Zones (SEZs) are introduced as one of the new concepts in India in the era of industrialization. Every SEZ is divided into a processing area where only the SEZ units would come up and, the non-processing area where the supporting infrastructure is to be created. The SEZ Rules ensure simplified procedures for development, operation, and maintenance of industries, setting up units and conducting business in SEZs area, single window clearance for setting up units in SEZ etc. There are total of seven Special Economic Zones are developed Mumbai region; two in Mumbai, two in Navi-Mumbai and three in Thane. Out of seven, SEEPz Special Economic Zone, Andheri East, Mumbai, is the biggest one; it is a hub for electronics hardware and gems & jewelries, whereas most of other SEZs are known for IT & ITES companies [36]. A list of SEZ and industrial areas within the Mumbai Metropolitan Region is mentioned in Fig. 1.

4.4 Finance, Media and Entertainment Industry

Mumbai is an undoubted leader once coming to performance of financial services in India from the last-half century. Mumbai accounts for 14% share in deposits mobilization and 21% share in the deployment of credit of scheduled commercial banks. Mumbai's share is three-fourths of the total clearances in the transactions of the banking sector and the presence of Mumbai is overwhelming both in the domestic money market as well as in foreign exchange market transactions. Mumbai, being home to the Bombay Stock Exchange and the National Stock Exchange, dominates the turnover and total market capitalization of the stock markets of India [24].

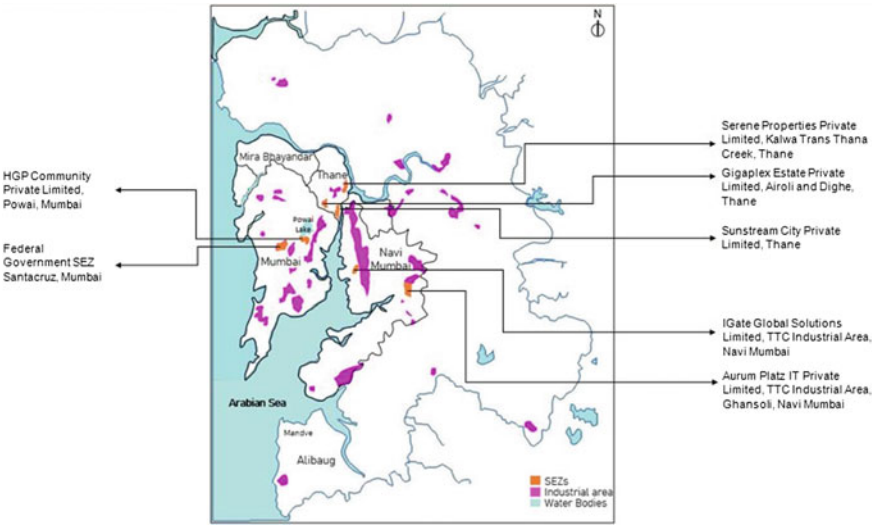

Fig. 1 SEZ and industrial areas within Mumbai Metropolitan Region. *Source* Prepared from MMRDA [31]

A large number of players in the financial markets make Mumbai a financial hub, such as foreign institutional investors (FIIs), credit institutions, merchant bankers, etc. Registration of almost 80% of mutual funds, more or less all FII investments and over 90% of merchant banking transactions, are strengthening the claim of Mumbai as financial capital. Two main regulatory agencies are headquartered in Mumbai, i.e., the Reserve Bank of India and Securities and India's Exchange Board. Mumbai has a significant number of highly trained/skilled English-speaking professionals and a reputation for recruiting the best managerial workforce. The city has many MBAs, chartered accountants, legal advisers and research practitioners [24].

The Indian Media and Entertainment (M&E) industry is a sector of economic sunrise and is making great strides. Internet revolution transformed its accessibility to large masses and media and entertainment industries are highly influenced by the dimensional change. The Indian media and entertainment market will cross Rs. 2.35 trillion by 2021. India is ranked at 15 globally in the music industry and is expected to enter the top 10 music markets by 2022 [20]. Mumbai based Indian film (movie) industry, popularly known as Bollywood, rightly accounts for the 0.5% of GDP to the nation in 2013, whereas out of total annual production of Indian films, Bollywood shares 40% of India's income from the movie business and, unexpectedly, the annual growth rate ranges from a decent 10% to an outstanding 20%. Numerous critics have marked this sector as the second most useful domain for India's growth. Back in 2009, Bollywood accounted for 15% of India's overall income. Reports say that Bollywood is the largest exporter in the U.S. entertainment industry, with popular films running on up to 75 screens in the United States [26].

4.5 Tourism Sector

The tourism industry of Mumbai accounted for 5.4% of India's total travel in 2016 and employed 2.4% of the total workforce of the country. Heritage Buildings of Mumbai have been the centre of the main attraction for travelers and adventurers since time immemorial, being a port city. Popular tourist and heritage buildings of Mumbai are; Gateway of India, Bombay Castle, Mount Mary's Basilica Church, The Town Hall, Haji Ali Dargah, The Taj Mahal Palace, The Imperial Tower, The Global Vipassana Pagoda, Mumba Devi Temple, etc. [7].

Mumbai is one of the fastest-growing medical tourism destinations in India and is known as the second most popular destination in the country after Chennai to attract foreigners to avail best health services at an affordable rates. Mumbai has several super-specialty hospitals, Research and Diagnostic center for orthopedic, and weight-loss surgeries. Mumbai is famous mainly for its cosmetic surgery treatments. Mumbai's Top-notch treatment facilities and presence of several private hospitals like; Fortis Healthcare, Hiranandani Hospital, P D Hinduja Hospital, Max Healthcare and, Tata Memorial Centre etc. have made Mumbai the fastest growing destination for medical treatments [18]. More than 5 lakhs foreign patients visited India in 2018. A total of 27% of medical travelers visited Maharashtra in 2018, out of which around 80% preferred Mumbai [29]. According to Master Card Global Destination Cities Index [17], the arrival of tourists increased to 113.3% from 2009 to 2013, while that of Singapore inflow tourists decreased to 63.50% (Table 3). Figure 2 highlights global top 10 cities based on growth rates of international visitor Arrivals from 2009 to 2013.

Table 3 Domains and sub-domains of MaaS

Level	Domains	Function/Role
Macro	Governments	Facilitator
	National	Vision, Legislation, regulation and financial support
	Regional	Plan preparation and implementation
	Local	Development of the services and monitoring
Middle	TSPs	Provision of services
	Private	Market and brand improvement. Profit oriented
	Public	Focused on providing services to all. Profit making is not necessary
	IPT	Can exhibit functional characters of both public and private operator based on the type of vehicle
Micro	Customer/User	Traveller, one who can opt between available options. Exercises options based on willingness to pay (WtP) and capacity to spend

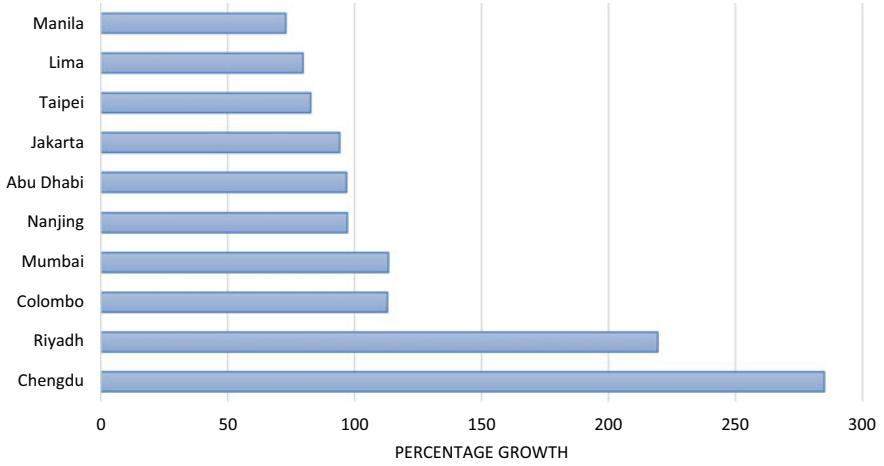

Fig. 2 Global top 10 destination city based on growth rates of international visitor arrivals (2009–2013). *Source* Prepared from [17]

4.6 IT and ITES and Other Service Sector

The major growth of the IT service industry in Mumbai was marked in 1967 when the TCS industry was set up. Later in 1973, the first software export zone (SEEPZ) was set up in Mumbai, where more than 80% of India's software exports were carried out before the rise of IT & ITES companies in Bengaluru [13]. Mumbai is the house for more than a thousand IT & ITES companies, out of which 177 companies are considered as major and medium scale companies. Few of the major companies are known as; Accenture, Infosys, IBM, L&T Info-tech, TCS, Tech Mahindra, i-Gate etc. There are four major IT parks that exist in Mumbai, these are called as Technology Knowledge Park, Ivory Towers, Magnus Towers and Fourth Dimension Park. Pune came second in India after Bengaluru in the software exports in 2014-15, whereas in Maharashtra, Mumbai recorded the second-highest software exports after Pune. The Mumbai–Pune Knowledge Corridor is fast emerging as the IT hub of the country. It is a six-lane, dual carriage expressway built to link the two cities of Mumbai and Pune [35].

5 Global Reach and Global Performance

Mumbai is the business fulcrum of India. Various Indian Corporate Conglomerates, including but not limited to Larsen and Toubro, LIC, Godrej, Tata Group, State Bank of India and Reliance Industries, have their headquarters in Mumbai. Five out of the top Global 500 companies enlisted by Fortune Group are based out of Mumbai. Many financial institutions and foreign banks have also opened their

subsidiaries and offices in Mumbai. World Trade Centre is the one that stands out the most. CITI Bank, Deloitte Haskins & Sells LLP, Hong Kong and Shanghai Banking Corporation, Ingram Micro India Pvt. Ltd., ISS Facility Services India Pvt. Ltd., Mondelez India Foods Pvt Ltd (Cadbury), Johnson & Johnson Pvt. Ltd., Standard Chartered Bank, Volkswagen Group Sales India Pvt Ltd are the top 10 MNCs established in Mumbai. Mumbai has offices of almost 500 companies with an annual turnover of more than INR 5000 Crs, more than 400 companies with a turnover of INR 2500–5000 Crs and more than 2700 companies with a turnover of INR 500–2500 Crs. Prominent Banking Institutions established in Mumbai are Axis Group, HDFC, ICICI, IDBI, IDFC, CRISIL, Kotak, LIC, SBI, TATA AGI, Capital and Investment Corp, Deposit Insurance and Credit Guarantee Corporation, General Insurance Corporation of India, Indian Railway Finance Corporation, L&T Mutual Find, OTC Exchange of India, Reliance Capital, Export Credit Guarantee Corporation of India, Life Insurance and Securities, etc. Important Mass Media outlets based in Mumbai are Reliance Entertainment, Sony, Jaico Publishing House, Hungama, Gaana, Fun Cinemas, The MobileStore, Contiloe Entertainment, Eros Music, Zee Entertainment Enterprises, The Times Group and various Film and Television production companies and Broadcast initiatives. At the same time prominent software companies include Microsoft, Blue Star Infotech, DMACQ Software, Cynapse, 3i Infotech, Oracle Financial Service Software, Rediff.com, Godrej Infotech, Tata Consultancy Services, and Siemens Technology and Services, etc. Hindustan Unilever and Aditya Birla Group have head quartered in Mumbai. Mumbai also has offices of Nestle and Google.

Numerous cities are listed in four categories of "advanced producer services": banking/finance, law, advertising, and accountancy for their global connectivity by the Globalisation and World Cities Research Network. Economic factors of the city are the focus area in this study rather than their cultural or political factors. They divide all the global cities into three main levels of Alpha, Beta and Gamma and several sub-ranks like Apha++, Alpha+ and Alpha. It has ranked Mumbai in its third Category of the first level as an Alpha City [11].

Yet Mumbai is nowhere to be seen in the top 10 Rankings of prominent indices like—Global City Competitiveness Index (published by the London based The Economist Group), Global Cities Index (published by the Foreign Policy, American Journal), Global Cities Initiative (published by the New York based Brookings Institution for Social Research), Global Economic Power Index (published by the Atlantic), Global Power City Index (The Institute of Urban Strategies, Tokyo), Schroders Global Cities Index (England), and Global City Lab ranking of Global Top 500 Cities based on Brand Value award. Mumbai scores just one-fifth of what London and New York achieved, marking the huge gaps Mumbai needs to improve its brand value.

The Wealth Report made by the CITI Private Bank and Knight Frank LLP, London evaluates cities based on their importance in the eyes of the planet's High Net Worth Individuals, each owning an investable asset's valuation of over 25 million USD) including a projection till 2025. The report infers that the Prime Residential Market

Performance of Mumbai is forecasted to fall 5% in annual price because of the deteriorating economic environment, which also influences the market liquidity. Despite the weak market conditions, the interposition of the government in the mode of the leeway provided to the stressed asset funds and GST averted a complete downfall. The report identifies Wadala as the most upcoming area in Mumbai. The 288-acre Wadala truck terminus is getting relocated and the land is proposed to get into a prominent real estate landmark on the lines of the Bandra Kurla Complex located in the central business district of Mumbai. If this project becomes as successful as Bandra Kurla Complex, then an estimated 50 million ft^2 of real estate would become available for supply, which would be well connected to all the major nodes of the city.

In a research conducted by ING Media House of London named "the World's Most Talked About Cities", 250 global cities were ranked based on the amount of total online mentions they get on all the various social media platforms and online news outlets. The study identified Tokyo (Japan) as ranked first, followed by New York City (USA), London (England), Paris (France) and Madrid (Spain), respectively, as the world's top five super brands and ranked Mumbai in the 37th position whereas Delhi was ranked 21st.

The Global Power City Index (GPCI) evaluates and ranks the major cities of the world according to their modality or their comprehensive power to attract people, capital, and businesses from around the world, given the global competition between cities. It does so by measuring a multidimensional ranking of 6 functions: Economy, Research and Development, Cultural Interaction, Livability, Environment, and Accessibility. The GPCI is capable of understanding strengths, weaknesses through studying various components. These 70 parameters are calculated for various cities around the world and a ranking has been formulated based on it. London is ranked the best city in the world, and Mumbai is 48th [12].

6 From Mass Transit to Mobility as a Service (MaaS)

Based on a Government of India initiative, more than 50 Indian cities with a population of more than 1 million are focusing on improving rail-based transport infrastructure in the form of metro networks [31]. The attempt is to reduce the use of private vehicles and reduce pollution by providing mass transit options. BRTs have also been introduced in many cities towards the same goal. Out of the top ten million-plus Indian cities with a maximum number of private vehicles registered in 2016, more than five cities have operational metro systems for more than five years, along with other mass transit options. Still, the annual increase in private vehicles has not shown any signs of decline [40]. Five of these cities are amongst the top ten cities with deaths due to traffic accidents [39]. As per CPCB, vehicular traffic is the second highest contributor to air pollution in India. Twenty-five out of fifty most polluted cities of the world are in India [23], and half of them are million-plus cities.

The question arises: why is mass transit failing in its goal of moving people away from personal transport? Are the goal-setting for individual transit systems too optimistic? Is it possible for different mass transit modes planned in isolation to contribute towards urban transport sustainability? A crucial gap in the planning of transit systems is related to interconnectivity with other means of transport: is the user able to have an easy and seamless transport experience without depending on private vehicles? In the Indian urban scenario, the interactions between the city and rural and peri urban areas are catered by a huge variety of modes and operating systems, spanning public and intermediate public transport, including informal transport, paratransit in the form of rickshaws, cycle rickshaws, e-rickshaws, privately owned buses, vans, minibuses, etc. All this plays an instrumental role in completing a local as well as regional transport ecosystem [37]. In many cases, the alternatives to organized public transport are not planned. Most of these need strong policy level and institutional backup if they are to be integrated in the transportation networks for the cities in the development plans. In addition to the above, disruptive industries are taking advantage of growing internet and smartphone accessibility in India. The transport sector is now among the top three industrial sectors to embrace the shared economy model with digital platforms like Ola, Uber, Rapido, etc., having successfully penetrated the urban markets. But considering that it is a majorly car-centric economy with minor additional options of rickshaws (Ola Auto, Uber auto, etc.) or Rapido (Two wheeler sharing/pick up and drop), more research is required into looking for opportunities to use this established demand and turn it toward options that are more environment-friendly as well as desirable [37].

This is where the rules and regulations, business models, service consumption from the user end needs to be focused along with integrated planning of various modes of transport while preparing a comprehensive mobility plan in the future [34]. Smart solutions providing Mobility as a Service or MaaS in India is thus being looked forward to as a system that can achieve those goals, by making it extremely easy for a user to opt for mass or shared mode of transit over private vehicle; upgrading modes of transit to a level that is more environment friendly and less energy consuming along with contributing to a better user experience and eventually reducing vehicular pollution. With a number of definitions emerging globally, MaaS encompasses a system of planning, booking and paying for an end-to-end journey, enabling seamless multimodal integration of trips through a single platform. By creating a digital platform, with the help of smart devices and internet penetration in the farthest of the corners of the world, theoretically, it is easily accessible to multiple service providers and consumers at the same time to carry out their respective functions of transport. Yet, while studying pilot projects like UbiGo, the transition from a pilot to a commercial structure had to face obstructions because of various institutional barriers [34].

7 Understanding the Potentials and Challenges Towards MaaS

In this section, an attempt will be made to synthesize the current research on MaaS. The stakeholders involved in the implementation of MaaS include transport operators and aggregators, internet service providers, local authority (including facilitating and planning) and tech businesses providing services like integration and payment, and of course, end-users. A broad understanding of the issues is attempted here.

7.1 Transport Operators' Perspective

It is highly necessary to understand the apprehensions and expectations of transport service providers in relation to the notion of MaaS aggregators or an intermediary body acting as an intermediary between user and service provider. A study in Sweden [38] found that both the private and public transport service providers agreed upon two points. One, that the linked modal package delivery will result in a shift towards shared transit and will decrease private ridership. Two, that they will be able to gather a better understanding of the travel behavior of their user group for future plans. Yet, the concern raised was that it might not improve revenues even if there is a shift from segmented modes towards multimodality facilitated by MaaS. Another area of concern is related to the potential lack of compatibility between public and private service providers. The public sector has an intensive focus on regional and rural connectivity and connectivity for all masses and classes. Its main concern is to incorporate MaaS into a development planning exercise which is highly spatio-economic in nature and bound by the existing legislative framework. On the other hand, private players focus more on branding. Another point was that each service provider's organizational and functioning structure differs from the other and bringing all on a single platform would require a paradigm shift in policymaking and regulations. Here too, it is accepted that more research on dimensions of policy, politics, finance, management, etc. is required for understanding the potential and acceptability of service intermediaries or integrators.

7.2 User's Perspective

Mobility packages that are convenient and attractive to users, as well as beneficial to service providers, need to be developed considering case specific-parameters such as demographics, cost of living, weather, transit modes, and modal splits, and most importantly, environmental impact. A study of 15 European cities was carried out on these parameters, and the most suitable package recommendations were suggested. Subscription-based packages were suggested for cities with higher dependency on

mass transit modes. The trend of pay as you go was found, bike and car sharing was suggested and car sharing and carpooling were suggested with an hourly payment option. For taxi and paratransit, 10–20 km rides were assigned. For the further detailed spatial study, it was suggested that factors such as land-use, age group and personalized user experience can also be incorporated. In the end, it was insisted that the more detailed surveys covering maximum qualitative data and evidence-based approach are needed for precise and successful designing of packages [9].

7.3 Concerns of Implementation and Regulation

Keeping tab on all service providers and users' interests and establishing a self-sustainable system needs institutional and regulatory changes. A similar project was launched in Kochi, India by KMRL as 'Seamless transportation in Kochi' based on the 'ASI' or 'Avoid-Shit-Improve' model [6]. The model suggests avoiding or decreasing the need for travel through a planning process that includes external factors such as landuse, demography, etc. Shift refers to the modal shift towards low carbon modes of transport and improve refers to the technological improvements towards a more environmentally sustainable system. The core characteristics of this system include integration of transport modes on one platform that provides multiple service providers options, with multiple tariff options, one-time registration, pay-as-you-go tariff plans and trip customization as per individual needs. This new transport system integrates up to eight modes of transports together, including pedestrian infrastructure. This is one of the examples where various institutional changes such as enabling common institution handling operations and administration of all modes of transport (in this case Unified Metropolitan Transport Authority), the inclusion of IPT modes, understanding the issues of service providers, especially IPT, related to financial security, etc. [37].

7.4 Concerns of Environment Friendliness

The modes of transports need to be environmentally efficient and should perform in terms of reaching maximum distance with minimum time. While balancing these variables with a single mode of transport is difficult, it is least desirable to trade off environmental efficiency for either distance or time. Yet from an economic point of view, often the latter is more important in terms of its efficiency. In a case study of such a project in Zurich, it is stated that sharing systems combined with public transport may reduced energy consumption and become an environmentally sustainable options to private vehicles when assessed its impact on macro-level [3]. This research also suggests that energy consumption can be reduced up to 25% based on modal choice only. It also suggests that if the operations of such a system are subsidized and regulated, the desired system levels impacts can be achieved. Now,

this is established that choice and combination of different modes will be crucial in planning an environmentally sustainable transit system through MaaS, a study done with types of modes and its combination shows existing and future scenarios along with a least desirable scenario based on the spatio-temporal efficiency of the mode, which dictates user or service providers choice for the mode [43]. The spatio-temporal analysis in this research of different modes of transports is plotted against each other for their efficiency. It is basically the ability of each mode of transport catering to the number of users over space and time. Both spatio-temporally efficient modes are IPT and mass transit modes with bike sharing to a certain extent. Active modes such as walking and cycling are most efficient spatially but do not make it to a temporally efficient case. Shared taxies, cars and vehicles are temporally efficient but spatially, their efficiency limits down due to their carrying capacity. All types of private vehicles are spatially as well as temporally inefficient as per the criteria discussed.

8 Why Mumbai Needs MaaS

The foundations of Mumbai's current transport system were laid by the British in line with Mumbai's emergence as the most important economic and trade hub of India. But today, with a population of 18 million which continues to grow, the city streets and transit systems are one of the busiest and most congested in India. Even though the population growth rate of Greater Mumbai has seen a steady decline from 43.8% in 1961–71 to merely 3.8% in 2001–11 [4], the population of the suburban areas in the Mumbai Metropolitan Region or MMR are increasing significantly. MMR spreads over Mumbai City, Mumbai Suburban and parts of Thane and Raigad districts, and includes a conurbation of eight municipal corporations and nine municipal councils. It is the primary city of an emerging Mumbai–Pune–Nashik urban agglomeration. From the mobility perspective, the challenge lies in addressing the large number of trips that transcend administrative boundaries within MMR [28].

From 2001 to 2015, the private vehicle ownership increased from 66 to 178 vehicles per 1000 people in the city, respectively [28]. The rapid increase in private vehicles during this period can be attributed to convenience with travel time flexibility, easy and abundant finance opportunities, overcrowding in suburban railways and bus services and delay in implementation of other mass transit systems such as metro, monorail and expansion of suburban rail. Mumbai still is one of the very few cities in the country where more than four mass transit modes are actively working, yet the increasing population in suburban areas within MMR constantly puts stress over the transit capacities. The bus ridership was estimated to be 33–36 lakh passengers per day in the year 2015. As per 2011–12 data, suburban railways, which are known as the lifeline of Mumbai, carried 7.81 million passenger trips per day. The total number of IPT vehicles is also seen increasing with the increase in population, 0.16 million in 2001 to 0.19 in 2015 [28].

As per the trends discussed in a household interview survey analysis from the report on Comprehensive Mobility Plan for Greater Mumbai, most of the trips are multimodal, with one main mode having the highest trip share in terms of distance and time. The highest share of trips is by suburban railways (46%) and bus (18%) from the public transit category. The share of auto-rickshaws (in IPT category) is 10.3%, putting it in third position. Next to it is private transit: the share of car and two-wheelers is 9.8% and 7.1% respectively. Taxi (in IPT category) has a 5.8% share and is in the sixth position. The remaining 3% share of trips is by metro, monorail and any other means. Even the trend of expenditure on travel with increasing income category was also established in the same survey [28].

The above information shows that in Mumbai, the trend of multimodal trips is already established. There are options for mass transit and IPT in various forms and still, the ownership of private vehicles is increasing. One of the major factors for this is opting for convenience and spending capacity, which rules in favor of private vehicle ownership over other means of transport. It shows that the potential change in income directly impacts over travel behavior, as usually seen in cities like Mumbai. Coupled with the difficulty in changing residential location to suit a change in workplace location, this changes travel demand pattern. This process often is instantaneous and dynamic, which is a major obstacle from a spatial, economic and transportation planning perspective, as matching a dynamic demand scenario and to introduce more options of shared or mass transit to address the dynamic demand is not possible with the traditional planning system, especially with the limited resource of land and finance. This calls for innovations to addresses the travel demand dynamics, approaching it as an opportunity. Keeping a user centric approach, integration of transport resources on a single platform is desirable especially considering the change in travel behavior. It is easier and convenient for a user, to make decisions suitable to their spending capacity or willingness to pay for travel. This makes a case for the rollout of MaaS in Mumbai, which already has a strong supply of multiple modes of transport.

With the help of ICT at service provider's ends and smart devices at user ends to aggregate multiple modes of transports on single application platforms, putting the user at the centre of mobility services can address this dynamic change in demand in real-time. In the case of Greater Mumbai, applications like M-Indicator have already been functioning and are popular in tracking suburban railways and buses. Private operators such as Ola, Uber and various other applications to book a car, or taxi or rickshaw have gained popularity over the past decade. Such platforms allow a passenger to opt and balance between time and convenience for various trips with real-time information. Some of them enable personalized payment and ticketing for particular trips as per user's preference with suitable available options for individual ticketing and payment system.

For the time being, these applications are individual services, but if combined on a single platform, it promises other benefits, including higher levels of connectivity, a secure and cashless payment system, dynamic real time information of the transit mode options and updates, etc. from a user's perspective. Adopted on a large scale, it holds the potential for inducing a switch from private vehicles and a reduction in

emissions. A beneficial indirect effect would be the reduction in on street parking [28]. Also, it generates big data that can enable service providers and other cotions between these domains ncerned agencies with a better understanding of the travel behavior of the masses and better data collection for the future planning exercises and for improving the quality of services to precisely match the dynamic demand. Ultimately, it can make the city more livable for future and realize the 'comprehensive mobility' that is envisioned as a part of building resilient infrastructure, promoting inclusivity and fostering innovation, as part of sustainable development goals [42].

9 Envisioning a MaaS Ecosystem

The future MaaS ecosystem can be conceived of as a network of levels and domains with clearly defined functions emerging at each intersection. Based on the available literature, functions are identified with respect to the different domains. We can also divide them into three levels that are equally important with increasing levels of role and complexities. Users can be seen at the micro level, which is the receiving end of the service. At the middle level, various transport service providers (TSP's) can be kept. At the macro level lie the facilitating bodies and governing bodies. As per the present scenario, these functions at different levels can be explained in Table 3.

All these domains are different from each other, and there are differences within the domains themselves. The differences in terms of their working, functioning, agendas and authority make MaaS a complex network of actors dependent on each other. The role of integrators assumes great importance in this context for enabling smooth interactions between these domains [43].

The role of Government in India has undergone a shift in the last decade from service provider to facilitator based on the 73rd and 74th Constitutional Amendments. In view of this, for a MaaS ecosystem to emerge, the responsibilities at different levels of Government will have to be clearly understood, discussed and finalized. At the national level, government may look after policy, visioning and financial or other incentives. At the regional level, the state government may look at MaaS as an opportunity for promoting inclusive development of rural and urban areas. At the local level the urban local bodies may focus more on facilitation. Legislative backup, regulations (or deregulations), institutional arrangements and establishing levels of control can be decided at these levels.

The Swedish study on the aspirations and expectations of TSP's regarding MaaS [38] mentions the difference between the fundamental visions behind each type of TSP. Since the fundamental difference is profit-making versus maximum coverage, the working, administration and organizational structures of different TSPs differ from each other. Most importantly, the target groups of TSPs also differ because of this from public to private to IPT modes of transport. The differences in user groups also can be studied separately from the point of decision-making explained by other motives e.g., opting (or not opting) to walk for fitness reasons (disability reasons) and the willingness to pay or capacity to spend on transport. All these factors are

directly or indirectly related to each other [27]. Generalizing them and ignoring these differences may lead to an over-simplified approach and there is a need for detailed study at each level.

The relationship between the user, TSPs and the government can be explained as shown in Fig. 3. The demand generated at user's end is fulfilled by the TSPs with an exchange of fares and charges. The government directly in case of public modes or indirectly in case of other modes has control over the TSPs with the help of service contracts and/or regulations, respectively. This is where the integrators or aggregators will play an important role (Fig. 4). They not only act as intermediaries between the government, TSPs and the end users but also bring in suitable packages which take care of interests of the both sides (Providers and customers). In this process, new relations are formed between the government, TSPs and aggregators [43]. The role of the aggregators is more than just managing the other parties. It includes the design of

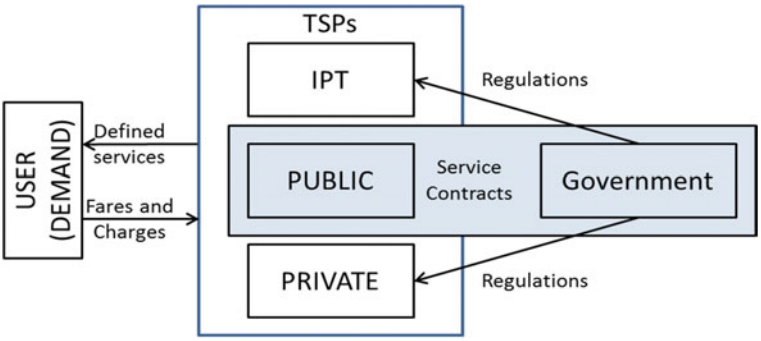

Fig. 3 Current scenario. *Source* Karlsson et al. [26]

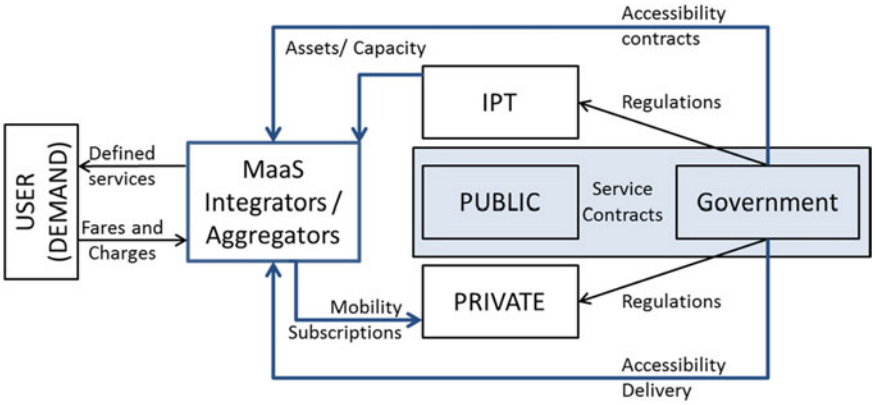

Fig. 4 MaaS with integrator/aggregator. *Source* Karlsson et al. [26]

a more inclusive system by bridging the gap between TSPs as well as managing and studying the dynamic demand from the user end. The government's role becomes facilitating the integrators and TSPs with suitable legislative backup.

10 Roadmap for MaaS in Mumbai

Since the beginning of this study, one of the focal points has been how to translate the sustainability criteria while designing and implementing MaaS for Mumbai, we can divide the roadmap of 'MaaS in Mumbai' into the following goals:

1. Making a system that is user centric—'the user' is a very important word and hence the optimistic but necessary aim should be 'to design a system that is suitable to all kinds and sorts of users.' Hence user study has to be a part of the beginning and end of the system. The part of the user study at the beginning is for understanding the trends. It will include establishing travel behaviors based on economic classes, ages, abilities and genders, etc. This can include OD surveys, sample surveys and personal interviews, which highlight the user need and travel behavior and multimodal trip patterns can be inferred from them. The most important and challenging part here is to study each and every user group, including private vehicle owners. This will be important for the second level, which will be crucial in terms of marketing of the system, which comes later.
2. Establishing a system of integrators—The system needs to be worked upon two fronts, technology and governance, and innovation in existing setups. This part is the most important since practically the entire foundation and working of the MaaS will be dependent on this system. The role of the government will be to provide the legislative and policy level back up whereas the role of ICT will be to facilitate a platform user and TSPs end with innovative smart services that arrange, transact and deal between a user and multiple TSPs. While the major role of the integrator will be to design and provide different packages for different users, understanding and appreciating the individuality of the TSPs and other existing digital platforms of smart shared mobility, integrators role will also include arranging suitable service deals from TSPs end by various means MOUs, legal contracts, etc. which is fair to the individual businesses too.
3. Sustainability criteria—this is the ultimate goal and has a role for all domains discussed previously (User, Integrator, TSPs and Government). This includes objectives which are as follows:

    a. Turning the existing private vehicle user towards shared mobility to effectively reduce the number of private vehicles that may result in spatio-environmental sustainability.
    b. Upgrading traditional vehicles and carriages (including all public, private, IPT, Mass) to an environment-friendly technology to reduce pollution and make it environmentally sustainable.

c. Upgrading and equipping existing vehicles and carriages to a smart technology that gives all sorts of real-time information that may result in overall sustainability (spatio-socio-economic-environmental) and will contribute to realizing 'Mobility as a Service' practically in terms of user experience as well as service delivery (Fig. 5).

The case studies before have certainly put some flags stating studies that need to be carried out before designing MaaS in Mumbai. A detailed evidence and case based study needs to be undertaken. As discussed before, Mumbai already has multiple modes of transports readily available. It already has established the travel behavior of a user dependent on multiple modes of transports as well as governed by users spending capacity and willingness to spend. Thus to start with, deciding the scope of MaaS and detailed study of the transport ecosystem suitable to the scope is the first step. The second step would be figuring out an integration platform at the technology and the innovation front with the help of ICT. The study of the transport ecosystem will also derive the user groups and respective TSPs that function in this ecosystem.

From the planning perspective, the transport ecosystem of MMR is spread over multiple cities and is not restricted to specific local jurisdictions; in fact, it is a regional phenomenon. Thus, the right kind and amount of data generation and analysis are most important. This same data can be generated from an integrators perspective and the newly formed relationships, which include User-Integrator relationship, TSPs-Integrator relationship and Government-Integrator relationship. Even though integrating multiple TSPs, with different operations and operating systems and trying to equate these services with probable packages for all target groups is a mammoth of a task, from these relationships perspective, it becomes easier to study this. As shown in Table 4, different transacting outcomes of these relations with a TSPs end and Users give various challenges (highlighted in green) to form unified transport governance and challenges (highlighted in orange) from integrators side for creation of mobility packages and finding suitable MaaS provider that may arise while implementation of MaaS in Mumbai.

From a very basic level, user groups can be studied from two angles; one is a motive based study of activity-time of travel, and the other is a willingness to travel by shared mobility over private mobility for the same. This study can be conducted for all types of users. The former will be helpful in creating mobility packages, whereas the latter will be helpful in formulating marketing strategies for the promotion of MaaS. Data generated from this user integrator relationship can be beneficial for Service quality improvement and actions and user based study for creation of mobility packages (universal and specific, e.g., time-based, hotspot based, gender based, ability based, etc.) in perpetuity as explained in Fig. 6.

Based on the demand from the user side, in the case of Mumbai, possible multimodal scenarios can be studied and based on that TSPs can be filtered through categories suitable to their position in the multimodal chain and their full or part

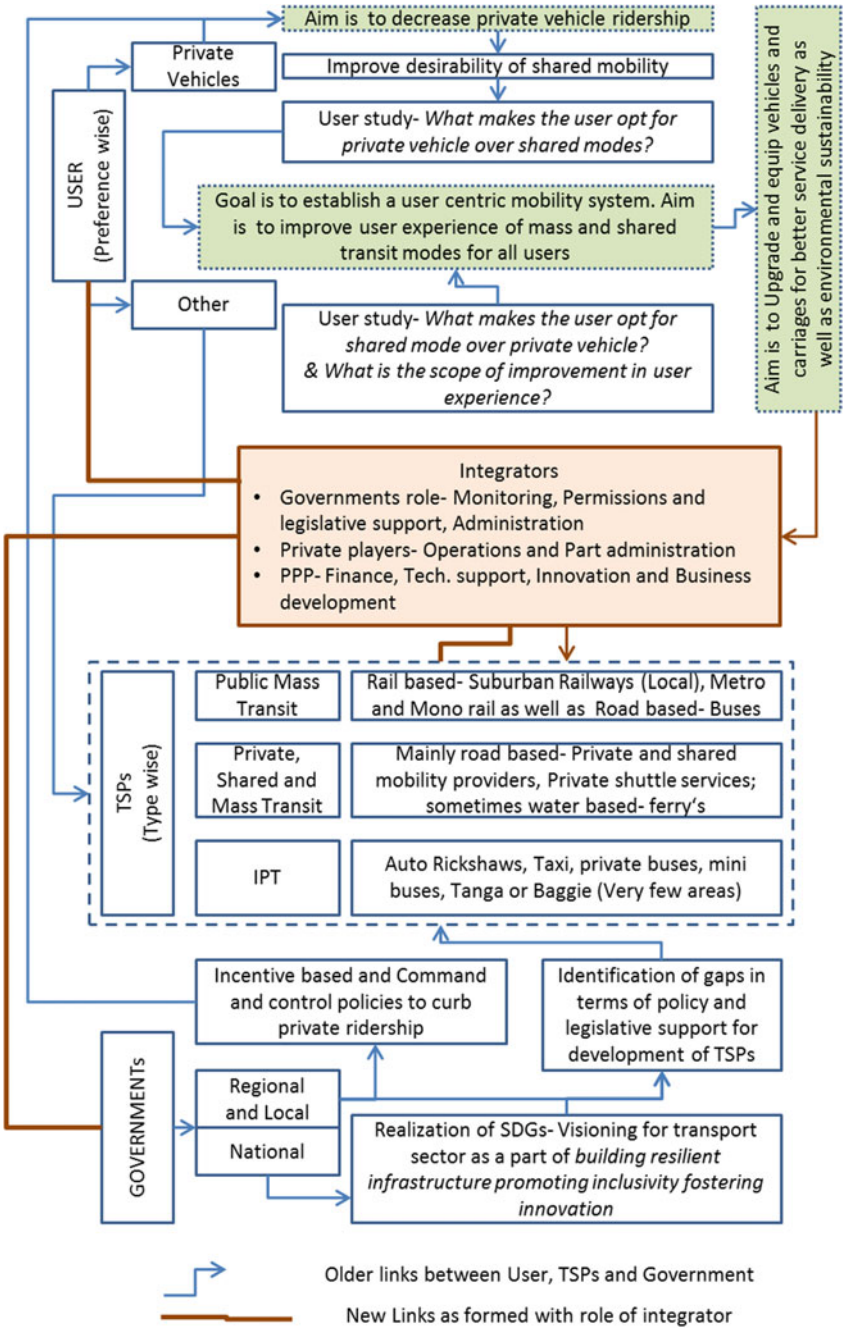

Fig. 5 MaaS for Mumbai and integrators position. *Source* Author generated

Table 4 Challenges and domains of new integrator relationship

Integrator	User	TSPs
User-integrator	Service quality improvement and actions	Full or part integration of mode
TSPs-integrator	Finding suitable MaaS provider	Improvement in service availability and delivery as per demand—network integration
Government-integrator	Fare integration and legislative backup	Institutional Integration for management and administration

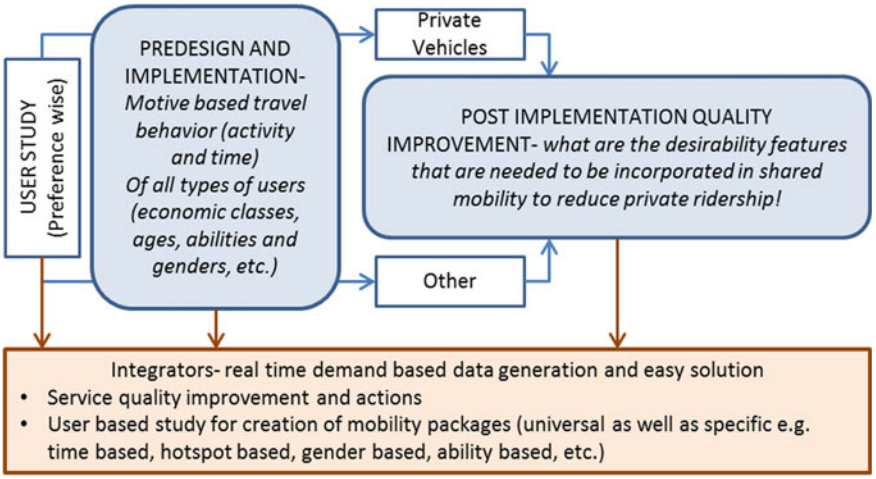

Fig. 6 User-integrator relationship. *Source* Authors generated

involvement into MaaS explained in Fig. 7 to find suitable MaaS TSPs. Once this is decided, digital integration of planning, booking, ticketing, payment, and other utilities can be developed.

11 Conclusion

The Government-Integrator relationship will be the support system of the governance and administration in MaaS for Mumbai. Parallel side, this needs attention while designing and implementing the MaaS because the attributes of functioning and finance highly demand the legislative support on direct functioning of MaaS. For example, if IPT is to be integrated as a part or full into MaaS, the legislative backup is insufficient, which may affect either integrator or TSPs or the service as a whole if disputes related to finance or function arise. Secondly, government-integrator relations will have to look after promoting and preparing marketing strategies for MaaS

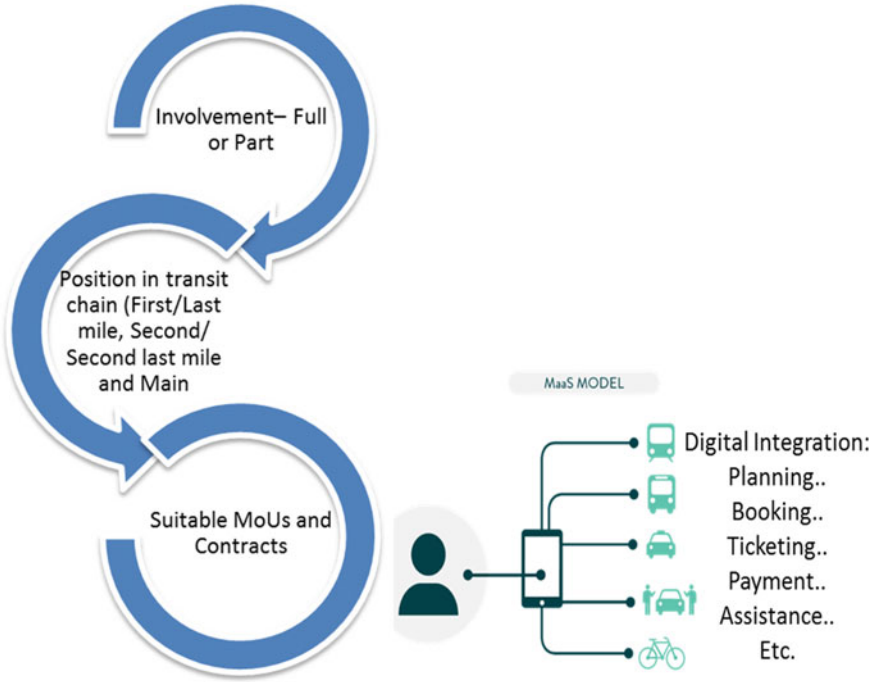

Fig. 7 MaaS TSP selection filters and digital innovation in networking system. *Source* Authors generated

against private ridership. As of now, completely eliminating private ridership is a near impossible target to achieve, but only state or central government can have this as a vision and take firm command and control or incentive based policy or legislative actions against private vehicle ridership.

Infrastructure is the backbone for any developing economy and hereto in Mumbai, continuous efforts of infrastructure development since 1980s are one of the main reasons behind its economic standing at the national level. But to compete with the global standard of Megapolis, Mumbai requires another Rs. 200,000 crores ($40 billion) investment over the coming ten years in physical and social infrastructure, mostly from the private sector [1]. Mumbai Development Fund (MDF) can be one of the financing options that would draw on central and state government funds and minor levies on Mumbaikars. The city's land assets can be leveraged to boost revenue, i.e., converting leaseholds to freeholds and utilizing the transferable development rights (TDR) of buildings can also be another option. The MDF should be a separate line item in the Government of Maharashtra's overall budget, which should be ring-fenced by law, reserved for city development. Public-private partnership (PPP) must be encouraged by lucrative incentives and well-defined implementation apparatus to drive the intention of PPP [10].

Boost economic growth to 8–10% per annum by focusing on employment opportunities from high-end to low-end and, developing hinterland-based manufacturing and making Mumbai a consumption centre. Improve and expand mass and private transport infrastructure, including linkages to the hinterland. Make governance more effective, efficient and responsive by corporatizing key departments and streamlining important processes such as development permissions, clearances [1].

Restoration of manufacturing excellence is necessary for Mumbai, because in recent years, high labour and infrastructure costs have hurt the sector. Manufacturing industries should focus on smart approaches for revitalization, like; technological interventions, effective grid development to maintain product service chain and logistics management, use of alternative energy sources and captive power plants, efficient multi-modal transportation, and multi-dimensional financing mechanism (within the country and from abroad), progressive labour laws and SEZ-like incentives in a manufacturing zone. It is a need of the hour to take tangible steps, like; revamping high-end services, implement the standing information technology and IT enabled services policy, developing dedicated Special Entertainment Zone, and encouraging trade with other international financial centre, to accelerate the economic momentum of Mumbai Megapolis [1].

Apart from the interventions required for future economic growth and advanced infrastructure development, some other aspects also demand immediate attention. Mumbai city and region is experiencing a miraculous spatial and demographical amplification rate and as a key learning from all previous efforts of development here, governance (including, inter-coordination of public agencies) and local innovations are main challenges. 'Approach of Smart' (i.e. Specific, Measurable, Achievable, Relevant, Time-bound) can answer the ground challenges and play a key role in availing sustainable and growth-oriented development for Mumbai City-Region. Modern and progressive local governance is essential to ensure the accountability of concerned associated public organizations to achieve desired results, at the same time, sustainability of achievements are equally important. Centrally framed coordination through "e-Governance" practices should be adopted but with decentralized management approach. A reliable and efficient e-Governance system will offer ease in regular remote monitoring, time-bound effective citizen's redressal, improved public services and equitable access to the users. And of course, at the people's end, to address the purpose, formation of a Citizen's Action Groups approach can be adopted, where members of the group will be made up of eminent citizens of Mumbai to strengthen local participation to achieve a collective vision for the development of Mumbai as a "Smart Global Megacity" [10]. The long-term economic health of Mumbai depends on whether it invests only in value-added jobs or also in its less privileged population by proposing measures to spur employment in low-end services and medium and small-scale manufacturing enterprises.

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Assessment of Mumbai to Serve as a Smart Global Mega City

Priya Mendiratta and K. V. R. K. Ravi Kumar

Abstract This chapter performs the SWOT analysis for Mumbai to evaluate its preparedness to serve as a smart global mega city. It suggests how its strengths could be leveraged to rise to the opportunities while its weaknesses and threats need to be overcome. The available opportunities could be utilized to help the megacity emerge as the key player not only in the country's but also the global economy by redefining its role as a financial and tourism hub, while reviving its industry in the key sectors. It goes on to discuss how the Mumbai Port Trust plans to redevelop the lands with it on the eastern front accordingly. Further, the infrastructure in various service verticals needs to be augmented to serve its populace better by deploying ICT and IoT. Its agglomeration with other metrocities in the Mumbai Metropolitan Region, supported by a second sea port and airport in Navi Mumbai, is positioned to emerge as a global economic hub.

Keywords Infrastructure · Sustainability · ICT · Mumbai Metropolitan Region

1 Nature of Cities

An urban area, as per the Census of India 2011s, is defined as all places with a Municipality, Corporation, Cantonment Board or notified town area committee, known as statutory towns; and all other places satisfying specified criteria with respect to their population, its density and male, main working population being engaged in non-agricultural pursuits for livelihood, known as census towns. An urban agglomeration is a continuous urban spread constituting a town and its adjoining outgrowths, or two or more physically contiguous towns together [11].

As discussed in the opening chapters, demography is the globally accepted criterion for classification of the size of a city, and mega city is one having a population of more than 10 million. Owing to the wide array of economic activities, cities, per se, are considered to be the economic drivers in a growing economy. Besides, it is commonly held that there is access to better employment opportunities as well as

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physical and social infrastructure, and thereby better standard of living, in cities. The perception remains that staying in cities pays richer dividends; and even if an urban dweller has to put in more efforts, these are marginal and well-compensated.

Characteristically, cities comprise dense networks of artificial structures and are characterized by a trend of permanent expansion and growth [19]. While a relatively small part of this growth occurs naturally, a larger share stems from immigration from rural areas due to the lack of livelihood opportunities back home. In developing countries, a majority of these immigrants are unskilled and semi-literate, landless labourers who have no employment during the non-crop season but to engage in informal activities, and live in un-serviced areas in the city that turn into slums. The city administration has little role to play either in providing them employment or shelter.

An urban area is a typical example of a human habitation with extremely high consumption rates of all basic components like water supply, electric power, fossil fuels; with challenging rates of waste generation in the form of sewerage and storm water, emissions, solid wastes—so much so that it requires significant undeveloped areas around to significantly contribute to their absorption. Urban growth consumes 'the surrounding land along with its air, water and food resources in a non-renewable manner [25]. This is conceptually sought to be balanced by a region that provides not only the essential inputs like water and energy, wood and vegetables; but also to absorb the various wastes (in all solid, liquid and gaseous forms) generated in the city.

The spatial configuration of cities, particularly residential density and transportation networks, affects travel demand as well as energy consumption through available transportation mode options [32]. Cities are also the point-source of the majority of the anthropogenic pollution [29]. Various studies have tried to establish the extent of urbanization on the earth's surface and the estimates range from 0.5 to 5% [3, 31].

1.1 The Change of Scenario

Over time, every Region has its own identity, which reverberates through its history, culture and tourism. In this emerging scenario, every region may have its own industry whose products are known globally, whereby the local produce and crafts retain their own domain. Thus, industry taking root at a specific location would have its own causative, like the raw materials and/or the skilled manpower.

In today's world, with globalization and economic liberalization, trade knows no geographical boundaries; where selective manufacturing comes to be localized and marketing thereof becomes globalized [23]. The global arena turns into a stage where the products can be displayed and traded, be it a microchip or an automobile. Cities, therefore, have an additional role to play, an additional niche to carve, to create an identity for themselves, of not only being smart but also global. Planning and development therefore have a new meaning and dimension to serve. This concept has

emerged with industrialization itself, but has come to full fruition with the emergence of ecommerce.

This is largely enabled by the advent of Information and Communication Technologies (ICT) and Internet of Things (IoT). This changed paradigm for trade and commerce through online transactions, without having to bear the rigmarole of currency exchange and bank queues, has opened up an expanse of opportunities for employment and wealth creation.

It has now come to be accepted that the urban agglomerations continue to attract more people and consume more land and energy, owing to their economies of scale and other pull factors. Further that despite their immense environmental impact, the cities will continue to expand particularly along the transportation corridors and hence, the urban form is here to stay. The urban periphery witnesses the conversion of agricultural and other ecologically valuable lands, with or without the planning interventions by the local bodies [19]. However, as per the physical laws of nature, there is a limit beyond which these economies turn into diseconomies, and the cost of servicing and maintaining these cities surpass the benefits therefrom.

1.2 Scale of Urbanization

Only 16 million-plus cities existed at the turn of the twentieth century, according to the United Nations, while their number exceeds 400 today. Similarly, only one thirds of the world's population resided in urban areas in 1950, while it is estimated that this would be almost two thirds in 2030. Although 50% of the world's population came to reside in urban areas in 2009, this milestone was reached in Asia only in 2018. One in every 8 urban dwellers today lives in a megacity, of which the largest are now located in the developing countries.

It is projected that Asia will account for 52% of the world's urban populace by 2050, with about 3.5 billion people living in urban areas. Along with Africa, this would be three quarters. Of all the new urban inhabitants during this period, 88% will be in these two continents [35].

India has three mega cities among which demographically the Greater Mumbai Urban Agglomerations (UA) leads the pack at 18.4 million, followed by Delhi and Kolkata Urban Agglomerations at 16.3 and 14.1 million respectively. However, as with all UAs, the rate of population increase in the study area has substantially declined from 30.47% in 1991–2001 to 12.05% in 2001–2011 [11].

2 Mumbai Metropolitan Region (MMR)

For the economic capital of a diverse nation, delineation of the Region would have been challenging, given its varied topography with the Arabian Sea on its west and the north–south trending hills.

2.1 Geography

The MMR, spread over 6640 Sq.Km geographically, is a low lying land with its coastline stretching 270 kms, but being dotted by hills, displays significant elevation features, interspersed by creeklets and rivers (Mithi, Ulhas and Vaitarna) merging with the Arabian Sea and a couple of Creeks (Malad and Manori) making inroads into the land mass. The Metropolitan Region comprises the densely populated Mumbai and Mumbai suburban districts, which form the territorial jurisdiction of the Municipal Corporation of Greater Mumbai (MCGM). Besides, it also encompasses parts of the Thane and Raigad districts apart from the newly formed Palghar district [22].

2.2 Regional Planning

The Mumbai Metropolitan Region is witnessing its third of Regional Plan (RP) since 1970's, each one characteristically stretching over a couple of decades.

The first Regional plan (1973–93) advocated the connectivity to the mainland and the decentralization of the business districts. Land for a new city was notified for acquisition on the mainland, as per the recommendations of the Gadgil Committee. Apart from the existing industrial pockets being developed by the Maharashtra Industrial Development Corporation (MIDC), the wholesale Agricultural Produce Market Centre (APMC) and the Iron and Steel market as well as certain government offices were relocated from the island city to develop an employment base in the new city. Besides, an alternate port better equipped to handle container transport, known as the Jawaharlal Nehru Port (JNPT), was developed on the mainland and commissioned in 1989. A good amount of the cargo is now being handled through this more technically advanced port [22].

The second RP (1996–2016) reflected the objectives of the economic liberalization in 1991 through the establishment of the Bandra Kurla Complex, Jogeshwari and now Aarey milk colony away from the uni-centric southern tip of the island city. It removed the blanket ban on the setting up of industries and offices in the island city, while permitting office use in commercial and industrial zones and promoting investments in transit connectivity to other parts of the Region to promote multi-nucleated development. It also embodied the 74th Constitutional Amendment empowering local governance through the foundation of the Metropolitan Planning Committee. It emphasized on 'growth management', moving away from 'planned and controlled growth', and looked towards regional development in consonance with the resource availability [22].

Consequently, the Bandra Kurla Complex emerged as an alternate Business District as industry moved away from the Region. Further, the island city registered negative growth for the first time and urbanization did not take place along the transport corridors, as envisaged in the plan, but around the periphery of the exiting towns and the suburbs.

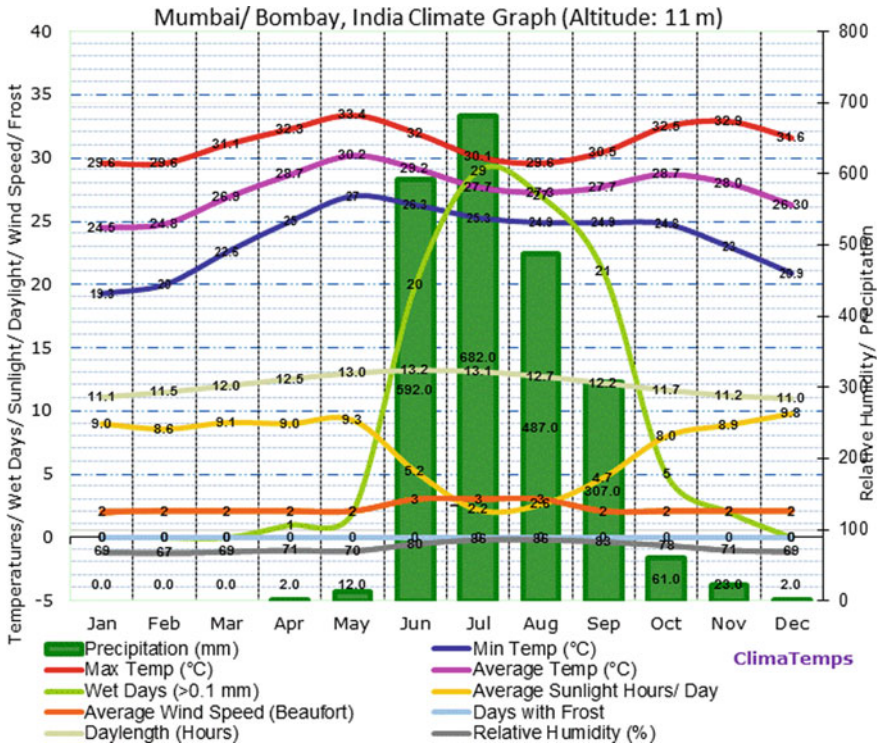

Fig. 1 Climate graph, Mumbai, India Source: https://www.mumbai.climatemps.com/mumbai-climate-graph.gif

2.3 Climate

The climate of Mumbai and its surrounding area is fairly equable due to the moderating effects of the nearby sea and the high relative humidity in the atmosphere as shown in Fig.1. The average annual rainfall in the Region is over 2000 mm.

2.4 Regional Connectivity

Mumbai is the headquarters of two Indian Railway Zones: the Central Railway and the Western Railway. The former connects it to the administrative capital of the country and further, while the latter connected it to the eastern and southern states. Additionally, in the last two decades, the Konkan railway has linked it to Kerala and Karnataka through Goa, a scenic coastal stretch along the Western Ghats.

By road, the megacity is well linked to the national capital on the north by the NH3 (Old number), southwards to the hinterland to Karnataka by NH-4 (New NH-48), to

Gujarat along the Arabian Sea on its immediate north and thereafter to the national capital by the NH-8 (New NH-48) and southwards along the coast to Goa by the NH-66 (Erstwhile NH-17). It is also connected to the cultural capital Pune by the Mumbai Pune Expressway.

Mumbai Port Trust (MbPT) and Jawaharlal Nehru Port Trust (JNPT) are the two major operational ports in the MMR that together provide the largest port facilities in the country. The main aviation hub in Mumbai is the Chatrapati Shivaji International Airport, which is already functioning at its full capacity. A second green field airport in Navi Mumbai is thereby underway and likely to be commissioned in the next couple of years [14].

2.5 Governance/Administration

The MMR is part of the North Konkan Region and was delineated for the first time in 1967 and then admeasured 3965 km^2. Subsequently it was expanded to 4355 Sq.km. Now the MMR comprises 6640 Sq.Km with the addition of Alibaug and part of newly formed Palghar district. Physically, the Mumbai city, with its area of 437 km^2, covers less than 7% of its Metropolitan Region. It is bound by the Arabian Sea on the west, the Vaitarna Creek and the Tansa river on the north, the eastern limits of Bhiwandi, Kalyan and Ambarnath tehsils and along the Ulhas river to the eastern limits of the Khopoli Municipal Council and extends to its south along the Patalganga river, the eastern boundary of the Pen Municipal Council and part of Alibag Tehsil [22].

The number of Municipal Councils, Census towns and villages in the Metropolitan Region has subsumed to form new Municipal Corporations, between different Census years, for administrative reasons.

Census year	Municipal corporations	Municipal councils	Census towns	Villages
1981	1 (Greater Mumbai)	13	24	1166
1991	3 (Thane and Kalyan being new additions)	12	12	1013
2001	6 (Mira-Bhayandar, Ulhasnagar, Navi Mumbai being new additions)	14	17	1023
2011	9 (Bhiwandi, Vasai Virar and Panvel being new additions)	8	35	994

Source: MMRDA Regional Pan Report, 2016–36

In addition to the above areas under the jurisdiction of Municipal Corporations and Councils, seven pockets admeasuring about 1245 km^2 are identified to be planned and developed by parastatal bodies like Mumbai Metropolitan Region Development Authority (MMRDA), City and Industrial Development Corporation

(CIDCO) and Maharashtra State Road Development Corporation (MSRDC) as Planning Authorities.

3 Municipal Corporation of Greater Mumbai (MCGM)—The Heart of the Region

3.1 Genesis

Mumbai has been famous as an archipelago of seven islands of Mumbai, Parel, Mazagaon, Mahim, Colaba and Old Woman's Island (also known as Little Colaba) as shown in Fig. 2 which was coalesced into a single wedge shaped peninsula in 1784, between the Arabian Sea on its west and the Thane Creek on its east. Historically, the harbor and the islands remained under Portuguese rule till 1662 before they were transferred to the British through a marriage treaty in 1873. Post-independence, while it became the state capital in May 1960, the city witnessed a phenomenal surge in population and a number of suburban towns northwards were incorporated within the city limits, by virtue of both the western suburban line along the sea and the central and harbour lines along the creek-side and towards the mainland respectively. The immigration to the city was fuelled by the search for employment. The morphology

Fig. 2 The Seven Islands of Mumbai *Source* MCGM website

of the city has emerged from its topography of the low lying coastal lands interspersed by north–south trending hills.

Mumbai on the western coast of the Indian peninsula has been unique both topographically and characteristically. Like most coastal cities, it has retained its identity over ages as a prominent center of trade and commerce, and is well known for its reverberating energy, the social consciousness and thereby its governance.

Out of 437.7 km^2 of Greater Mumbai Municipal Corporation area, the island city, situated at the southern tip is only 67.79 km^2. Mumbai as an urban agglomeration has a total area of 603.4 km^2 which include Port Trust lands, Defense and National Park at Borivali.

The island city has limited potential to expand horizontally owing to its peculiar island configuration between the Arabian Sea and the Thane Creek, The low lying lands are however interspersed with mostly vegetated north–south trending hills, part of which are and conserved as the Sanjay Gandhi National Park, and encroached by shanties at some locations.

3.2 Topography Defined City Morphology

Both the road and rail transportation networks run parallel to these waterfronts in the city. The north–south trending Sahyadri hills divide the linearly inhabited lands. Connectivity between the linear habitations exists at specific locations only. While there were only two link roads between the western and eastern corridors earlier, another two were built subsequently. The Bandra-Worli Sea Link, together with Mahim Causeway, links the island city to the western suburbs [14].

3.3 The Land Use Zones

The land use planning and preparation of Development plan for Mumbai 2014–2034 is a formal and conventional exercise carried out to comply with the statutory procedures and processes. Considering that the area is fully developed and there is less scope for revamping the city, limited options left out will be redevelopment schemes, slum rehabilitation schemes, infrastructure development and upgradation, conservation and preservation of wetlands/mangrove areas to increase the open spaces etc.

The erstwhile cotton industries in the city located at prime locations with very high land values, have made way for residential and commercial development.

There is often a discussion on conundrum of underutilized FAR/FSI in Mumbai, especially comparing it with the cities like Manhattan and suggest that the FSI norms have to be revisited to boost the economy and solve the issues of slums. It was

countered with a strong argument that the built up area per person in Manhattan was about 55 m^2 while Mumbai has about 5 m^2 [28]. It is widely accepted that Mumbai slum issues require a comprehensive approach, which has a character of its own.

The open spaces in Mumbai are grossly inadequate compared to its population (@1.0 m^2/person). Locations of Mangroves/wetlands along its long coastline have to be integrated with the land use plans, as has been done in MCGM in its Development Plan to protect them as well as making them an integral part of the city eco system [8]. There was nonetheless, substantial public participation, including environmentalists, NGOs in the preparation process of Mumbai development plan. Growing public awareness, extensive use of ICT/IoT to make the plans/data availability to the public helped plan making process more iterative and pragmatic, though there would always be exceptions.

3.4 Central Business District—South Mumbai and the Decentralization of the Business Hub

Paradoxically, the Central Business District (CBD) is situated at the southern tip of Mumbai. Being the seat of power of the state and the hub for several regional, national level offices and even major tourist spots in Mumbai, this area attracts people across the state, nation and even the international business, tourists. During the daytime there will be north–south bound traffic and the evening it will be the reverse. It is for the imagination the kind of traffic that flows to this highly business centric affluent area.

The peninsular area is restricted geographically to expand east–west. That led to linear north expansion. The need was felt during the mid 1900s to decentralize the activities in south Mumbai to disperse the not only the traffic and impart evenly development across the region.

Opening up of the waterfront held by the Mumbai Port Trust (MbPT)/Development of the port lands is being discussed. The MbPT, one of the major ports n India, has several undeveloped lands on the eastern waterfront, which are not put to any use. In order to make bet utilization of its location, the MbPT has prepared a Development Plan, opening up lands for residential, commercial, and recreational and tourism purposes.

3.5 Transit Oriented Development (TOD)

The city's morphology is testimony to the fact that the city developed with due regard to the existing topography as per the principles of Transit Oriented Development.

The country's first railway line connected Mumbai to Thane in 1857 and hence, not surprisingly, Mumbai became the first city to have suburban rails with the Bombay Electric Supply and Transport (BEST) providing the feeder services from the suburban stations to the neighbourhoods in the vicinity. However, as the trams closed down in 1964, the suburban rails were unable to sustain the demographic pressure by the 1980s.

The suburban Western rail runs along the Arabian Sea on the west and the Central Rail along the Thane Creek on the east, flanked by both commercial and residential premises, separated by the national park spread between them.

However, the Central Rail bifurcates midway to form the Harbour line that leads towards the mainland. Besides, a rapid transit system to reduce traffic congestion in the city, in the form of 8 high-capacity metro lines, is under construction in three phases over a 15-year period. The first of these began operating six years ago in 2014 and the others are expected to be completed by 2025. The metro is designed to be spread over 235 kms touching about 200 stations. Besides, the country's first mono rail system opened its phase 1 in July, 2014.

3.6 Traffic Flows

Consequently, unidirectional home-work-home traffic flows are created twice every day, during the office hours. Traffic snarls are a part of road travel, while the majority of everyday trips for those in the middle and lower income groups are carried out by the suburban rail.

Mumbai is also well known for the large share of the trips generated in the city being covered through public transport. It remains the first Indian city to have been historically served by its suburban railway serving as its lifeline. Its further development has been envisaged through the Comprehensive Transport Study financed by the World Bank that recommended the connectivity between the Central and the Western links which are being developed through the metro and monorail.

3.7 Demography

The population size of India more than tripled since 1950 to 1.35 billion and the level of urbanization nearly doubled, reaching 34% in 2018.

Globally, Mumbai with a population of 2.9 million was demographically the eighteenth largest city in 1950. However, in the next four decades, with its population growing over four-fold to 12.3 million, it rose to being the fifth largest city in the world. Mumbai is now projected to be the second largest with its population at 26.4 million, after Tokyo with 36.4 million, in 2025.

Today, with a total population density 76,790 per mile^2, Mumbai is the most densely populated cities in the world, as reported by an American daily on the World Population Day, last year (2019). It is followed by Kolkata and Karachi with 61,945 and 49,000 persons per square mile respectively [15].

3.8 Economy

Owing to the port driven economy, the megapolis today has been mono centric with a major employment hub at the southern tip of the island city. This Central Business District is home to important financial institutions like the Reserve Bank of India with its mint, the Bombay Stock Exchange, the National Stock Exchange of India; the seat of the judiciary like the High Court, District Courts and the different Sessions Courts; the Mumbai University, the bedrock of the public sector, the Western Naval Command of the Indian Navy, the Police Headquarters, the Bombay Port Trust and the Indian Railways; along with all the leading corporate headquarters of many multinational and Indian companies. The thriving industries in the city are related to gems and jewelry located in the city's SEZ, entertainment, automobiles and the research centres.

Besides, about a hundred textile mills formed the core of the city's economy which were closed down during the 1980s only to be replaced by the emergence of the tertiary service sector in the 1990s [34]. However, given the prime locations of these mills, the extensive land holdings are eventually being replaced with landmark commercial estate, prominently shopping malls.

3.9 Sustainability

The level of wellbeing in a city may not be fully reflected in its economic size as measured by GDP, as the other important parameters like income disparity, environmental indicators such as air and water pollution, the quality and quantity of leisure time, long-term effect of climate change are not considered. Better performance with respect to many of such indicators may make smaller cities more attractive to the entrepreneurs and investors.

As the urban areas consume a large share of the natural resources and energy and cause the largest quantum of pollution to the air and water and degradation of the soil cover, it would not be erroneous to state that the management of urban areas would determine the sustainability of the development on our planet. Further, since 90% of the growth in urban dwellers is likely to occur in Asia and Africa, it is inevitable that the management of this growth sector will play a vital role in ensuring that the development is sustainable in all (economically, socially and environmentally) aspects. In other words, the mismanagement of this quantum of the imminent urban expansion is likely to jeopardize the sustainability thereof.

4 SWOT Analysis for Mumbai

Having discussed the defining features of the metapolis, this Section analyses the strengths and weaknesses of the infrastructure and Regional Plan features in the MMR to identify and focus on the opportunities that could be leveraged and those that need to be strengthened to overcome the threats.

4.1 Strengths

The city has a wide range of employment base in its industry as well as the financial and service sectors. From planning perspective, the city has the advantage of having the richest Municipal Corporation (MCGM) today that was established almost a century and a half ago in 1872, and the Region has had a development authority (MMRDA) in place over the last five decades. Besides the strong institutional setup, the megacity also has the privilege of being home to the premier education and health infrastructure, like the Mumbai University IIT Bombay, Tata Institute of Social Sciences (TISS), JJ College of Architecture, Government Law College, King Edward Memorial (KEM) Hospital, Jamsetjee Jeejeebhoy (JJ) Hospital, Nair Hospital, the the Bombay or the Tata Memorial Hospital. The city is also well known for its heritage buildings and sea line, besides the efficient public transport network, particularly the suburban railway, commonly known with a tag as "the life line of Mumbai". The national park is also an unique feature in a megapolis that serves as the essential lungs for the city.

4.1.1 Financial and Commercial Capital

Among all states in India, Maharashtra is the largest regional economy with a GDP of $350–400 billion (~13% of national economy) in 2019. According to Maharashtra state report, the metropolitan area of Mumbai accounts for INR 368 billion (US $5.2 billion) of the state's gross domestic product (GDP), which is approximately 87% share in the state's economy [14]. In 2017, it contributed to about 10% of the country's factory employment, 60% of custom's duty collection and 30% of income tax collections [5]. Mumbai is therefore considered to be the financial center, economic powerhouse, and industrial hub of India.

However, India's GDP growth rate has slipped from 8.26% in 2016 to 6.12% in 2018 while even Bangladesh, Nepal and other African countries have a higher GDP growth rate [16].

4.1.2 International and National Connectivity—Two Sea Ports and Airport

Mumbai is the headquarters of two Indian Railway Zones: the Central Railway and the Western Railway. The former connects it to the administrative capital of the country and further via Gujarat and Rajasthan, while the latter connected it to the eastern and southern states of Andhra Pradesh, Karnataka, Kerala an Tamil Nadu. In the last two decades, the Konkan railway has linked it to Kerala and Karnataka through Goa, a scenic coastal stretch along the Western Ghats.

At the national level, the megacity is well linked to the national capital on the north-east by the NH3, southwards to the hinterland to Karnataka by NH4, to Gujarat along the Arabian Sea on its immediate North by the NH8 and southwards along the coast to Goa by the NH17. It is also connected to the cultural capital Pune by the Mumbai Pune Expressway, and further southwards into the hinterland extending to the state of Karnataka by the NH4 and by the NH17.

Mumbai Port Trust and Jawaharlal Nehru Port Trust are the two major ports that together provide the largest port facilities in India. They handle more than a third of the country's total foreign trade. Mumbai Port, a natural harbor, has extensive wet and dry dock accommodation facilities, and it is also an important base for the Indian Navy [14]. It is the second oldest Port of the country that has been handling the largest cargo for many years. During 2017–2018, the Mumbai Port Trust handled a record high level of cargo, amounting to 63.05 million metric tons, a 3.17% increase from the previous year. In addition to these, both MbPT and JNPT are contemplating Coastal Economic Zones under Sagarmala programme.

Juhu Aerodrome was India's first airport, although today it functions only as a heliport and hosts a flying club. The main aviation hub in Mumbai is the Chatrapati Shivaji International Airport, which is already functioning at its full capacity. A second green field airport in Navi Mumbai is underway and likely to be commissioned in the next couple of years [14].

4.1.3 Industry

The prominent industries in the city include gems and jewelry located in the Special Economic Zone with an annual expected turnover of (US$ 5.8 billion); Entertainment being led by the Hindi movie industry and as an vibrant creative arts centre that plays host to several national and international events; Automobiles having manufacturing base at Pune, Nashik, Aurangabad and Nagpur; and numerous national level research centres like the Bhabha Atomic Research Centre (BARC), Tata Institute of Fundamental Research (TIFR) and the National Environmental Engineering Research Institute (NEERI) [14]. Mumbai houses the headquarters of a large number of major Indian companies like Tata Group, Reliance Industries, Aditya Birla Group, Larsen & Toubro, Godrej Group and Hindustan Petroleum, among others [5]. However, of late, it is observed that probably due to the high value of real estate in the city, the

manufacturing sector is receding and being replaced by IT and ITES and other financial, commercial activities industry, thereby competing with Bangalore, Hyderabad and Pune.

4.1.4 Regional Authority in Place for 5 Decades

In India, the practice of delineating a Metropolitan Region came into being in the 1970s, with Kolkata being the first to be followed by Chennai in 1972. However, Mumbai was not far behind and the Mumbai Metropolitan Region was delineated in 1975 [22]. This is one of the essential strengths of Mumbai that a comprehensive planning paradigm has been in place for over four decades now, with the third sanctioned Regional Plans in force to guide the development in the Region.

The Metropolitan Regional Development Authority has been able to carry out the necessary studies with respect to its overburdened transportation infrastructure, particularly the Expressways and the suburban rail. The two Comprehensive Transport Studies have projected the population and employment growth in various parts of the region in the years to come and helps to channelize the international funding from the World Bank to strengthen the transportation links through metro rail corridors and expressways between the emerging hubs.

4.1.5 Premium Educational and Health Infrastructure

Commensurate to the requirements of the industry, business and trade activities, Mumbai is fortunate to have established primary, secondary, educational, higher technical educational facilities including training institutes of international standards, such as IIT and other engineering colleges, medical, Arts, science and social sciences (TISS), JJ College of Architecture, Government Law College, serval Management schools, public private and international schools, industrial training institutes (ITIs). Apart from them the famous University of Mumbai, Indira Gandhi National Open University (IGNOU) and several deemed universities exist in MMR. The megacity also has the privilege of being home to the premier health infrastructure, like the Jaslok, the Hinduja, the Nanavati, the Apollo, the Fortis.

4.2 Weaknesses

Mumbai is a congregation of seven islands, made into a single land mass by reclaiming areas between them.

4.2.1 Geography—Limited and High Housing Values

The limited supply of land resulted in high land values and affordable housing was beyond the purchasing power of many. This gave rise to a large section of the population (@42%) residing in slums, particularly the informal sector that formed a bulk of the workforce. This situation has also resulted in horizontal expansion along the major transportation corridors (ribbon development) and conversion of agricultural lands for non-agricultural purposes. The land values and the geography of Mumbai are a big threat to the coastal eco system. The built up area of Mumbai spread horizontally and several areas have been reclaimed to make the way for growing land demand. The intervention of the Environment and Climate Change Ministry, Government of India with the promulgation of stringent coastal regulations and active role of green activists, Courts protected the coastal stretches from being encroached and reclaimed.

Mumbai is situated on a seismically active zone III, with 23 fault lines and may prone to earthquake of up to a magnitude of 6.5 on Richter scale.

4.2.2 Slums

Extensive literature is available on slums of Mumbai. In fact they are closely associated with Mumbai and have become a metonymy for Mumbai. As per 2011 census records, about 42% of Mumbai population lives in informal settlements commonly known as slums. The population of these areas is seen as a human resource at cheaper rates and contribute to a great extent to the work force requirement and economy of the city, leaving aside their living conditions. Mumbai slums at Dharavi is one of largest in the world with more than a million people residing on about 200 ha of land. It has several small scale industries [30] providing livelihood to many residents and has an ecosystem of its own with several NGOs operating to impart education, health facilities etc. to the slum dwellers.

There was a paradigm shift in Government of Maharashtra stand on these slum areas since the 70s, from declaring them as illegal settlements to rehabilitating them. In the mid-80s slum upgradation scheme was implemented with the help of World Bank.

Quite a few schemes have been devised and attempts have been made to address the slum redevelopment issues [33]. Slum Redevelopment Authority (SRA) has been established with the vision of “Slum free Mumbai”. There are about 2400 clusters of slums in Greater Mumbai. About 1500 slum rehabilitation schemes are being executed. SRA has been mapping slum locations, as shown in Fig. 3 and created database of the same. Special development control regulations have also been framed for this purpose. Serious attempts have also been made to take up redevelop Dharavi through tendering process. Identification of beneficiaries is however, a challenging task. Despite having legal, institutional framework, there is conspicuous absence of political will to address the slum issues of Mumbai.

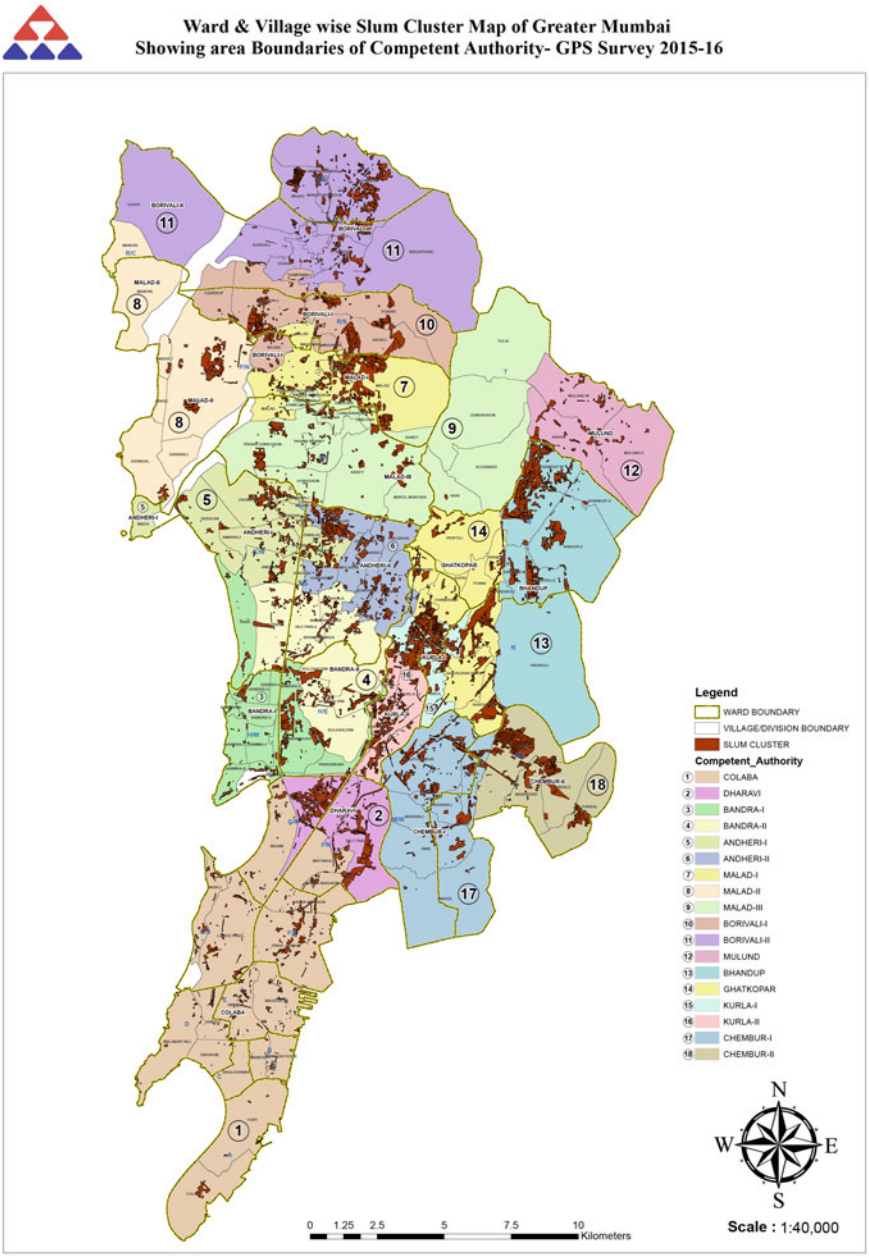

Fig. 3 Locations of slum areas in MCGM *Source* SRA, Mumbai website

4.2.3 Dilapidated Structures

Being a historical city, many of the buildings here are old and dilapidated, and therefore ready for redevelopment. The housing stock in the Island City is an ageing stock with several buildings over a hundred years old. The Bombay Buildings Repair & Reconstruction Board (BBRRB) was created under the BBRR Act, 1969 to deal with dilapidated buildings in the Island City of Bombay and make them safe for habitation. A repair cess was levied on rent controlled residential buildings as per the BBRR Act. Consequently, these buildings are called 'cessed buildings'. According to MHADA there were 16,104 cessed buildings in Mumbai. Various FSI concessions have been extended to promote redevelopment of cessed buildings [17].

4.2.4 Traffic Congestion, Emissions

The geographical features of the city have constrained it to have linear traffic flows, whereby the supply of developable land is limited, giving rise to high land and real estate values and congested roads. Initially, the Central Business District (CBD) was located at the southernmost tip of the city at the Nariman Point, Fort or Colaba, while the residential areas are towards the north. The five main north-south roads in the suburbs are not fully developed to the planned width, have many bottleneck points and constraints due to large number of intersections with major and minor roads. Similarly, the major east-west links have not been finalized. During the last 4 decades vehicular ownership in Greater Mumbai, particularly in the suburban areas, has increased several folds resulting in immense pressure and increasing bottlenecks. The vehicular population in the last four decades increased from 1.5 lakhs in 1971 to 1.29 million in 2001.

Similarly, the suburban railway is overcrowded at all times of the day, and need to be augmented to retain acceptable service levels. This has aggravated the traffic woes and vehicular emissions and noise pollution.

4.2.5 Overburdened Infrastructure

The increasing population and the private vehicle ownership in the Region leave the transport infrastructure inadequate, causing traffic jams on road. Similarly, the efficient suburban rail is also congested [10]. This necessitated a Mumbai Urban Transport Project (MUTP) with the Indian railways, State Government and MMRDA as the stakeholders in 2002.

The consequent unplanned rise in built up areas in order to accommodate this rising population increases surface runoff, particularly during the heavy monsoons experienced in this part of the country, thereby causing urban floods whenever the

high tide coincides with spells of high-intensity rainfalls. Further, inadequate solid waste management leads to clogging of drains and natural water courses.

This is also true of the city's infrastructure, particularly the roads and the storm water drains that are unable to service the high population, particularly during the high tides in the heavy monsoons experienced in this part of the country.

Although the island city has good power supply grid and lakes to fulfil its water requirements, electricity and potable water distribution in the suburban areas fall short of the specified standards. Other services, particularly solid waste management through landfill sites also needs to be revamped. In other words, the augmentation of the infrastructure networks has been unable to keep pace with the rising demand, despite several vertical-specific studies, owing to practical issues of land ownership, rehabilitation, environmental clearances and litigation.

4.2.6 Poor Ranking with respect to other smart, global cities

With all these things put together, the city though a desired destination for many, has a low world ranking, both with respect to the Quality of Life Index and the Ease of Doing Business, thereby facing stiff competition from other upcoming cities in the country. Unusually for a geographically large and economically vibrant country, India has no regions with sizeable economies. Mumbai needs to expand the size of its economy to retain its position as an eminent global city, on the back of its pre-eminent role in service industries, especially finance. To compete with other cities, it would also require regulatory changes.

4.3 Opportunities

4.3.1 Opening of Port and Railway Lands

The increase in ship size and the emergence of container traffic, along with the development of a second port by the JNPT across the bay in Nhava Sheva brought the Mumbai Port to a stage of metamorphosis where it needed to reinvent itself. It has many precedents like Baltimore, Miami, Barcelona and London.

The city's port occupies about 900 Ha along the prime eastern waterfront, is becoming available as the shipping and allied activities are moving to the technologically advanced Nhava Sheva Port on the mainland that is better linked to the hinterlands. Redevelopment plans for this area include cruise ship terminal and has the potential to flourish as a financial powerhouse at par with the best in the world.

By comparison, the city of London occupies only 290 Ha, whereas the Canary Wharf where the financial services firms are located is spread over only 40 Ha and provides 160,000 jobs, generating economic output of over $50 billion annually. In

Asia, the Central Business District of Singapore is built on 184 Ha and the Dubai Financial Centre on 45 Ha. Going by the revival of the London Docklands in the 1980 and 90s, Mumbai too has an opportunity to incorporate a dedicated development authority to revamp the entire area to emerge as the National Financial Capital Region. However, this choice of path will be riddled with difficulties related to federal structures, overlapping jurisdictions and limited state capacity. The lease of these lands could be well utilised to fund infrastructure for the future economic growth. The new zone shall do away with rigid zoning to have a much more flexible plan permitting mixed land use, with dense transportation networks being the key. If this works as a pilot project, similar endeavours could follow in other cities, giving a boost to the economy [10].

Development of the prime lands occupied by the defunct mills, port and railway lands by linking to the city's transportation networks and providing the necessary social infrastructure and open spaces in the city will go a long way to its emergence as an international financial and tourist centre. Designing of the eastern waterfront as a marina, and operation of cruise ships therefrom, will give boost to the tourism potential of the city. Further, there is an opportunity to develop water transport between Mumbai and Navi Mumbai and other suburban areas. Growing demand for IT and ITES will also add to the city's economy and result in the decentralisation of its CBDs throughout the Region, particularly the MIDC pockets in Andheri and the Thane Belapur belt.

4.3.2 Second Airport

To counter the growing demand of existing Mumbai International Airport (MIAL), a new International Airport has been planned at Navi Mumbai (NMIA). It is Public–Private Partnership Project (PPP), with 74% stake owned by MIAL and the 26% stake by City and Industrial Development Corporation (CIDCO) of Maharashtra Limited, the development authority of Navi Mumbai who owns the lands of the NMIA project. It is a green field airport, being developed at the heart of Navi Mumbai. The existing and proposed airports will be connected by metro lines for seamless transfers and connectivity. The Mumbai Trans Harbour link (MTHL) connecting Mumbai and Navi Mumbai is under construction and expected to increase the mobility between the cities of Mumbai and Navi Mumbai and well connected to the proposed International Airport.

In contemplation of development due to NMIA, the area beyond Navi Mumbai is being planned and regulated by CIDCO on the principles of aerotropolis, through its Navi Mumbai Airport Influence Notified Area (NAINA) project. Navi Mumbai (344 km^2) and NAINA (500 km^2) are the upcoming megacities within MMR.

4.3.3 Improved Regional Connectivity

The upcoming second airport in Navi Mumbai will ease the air passenger overload on the existing international airport in the city. The road and suburban rail traffic is being augmented through a number of grade separators, interchanges, and the mono and metro rail linkages connecting the western and the eastern inhabited corridors in the city. Also, the improved ship berthing and cargo handling capacity of the modern Jawarharlal Nehru Port Trust (JNPT) on the mainland with better road and rail connectivity in the state and other parts of the country through the Multi Modal Corridor (MMC) linking to the NH8 leading to Ahmedabad, the transharbour bridge connectivity from the southern tip of the city at Sewri to Nhava (MTHL) and the Dedicated Freight Corridor (DFC) linking to Dadri (Punjab) in the north expected to reduce the transportation time and improve the trade and commerce in the Region as well as the country. Further, Maharashtra State Road Development Corporation's (MSRDC) proposal of Smruddhi Corridor connecting Mumbai and Nagpur by road is in much advanced stage of implementation. Likewise, the High speed rail corridor between Mumbai and Ahmadabad in Gujarat, is being executed by National High Speed Rail Corporation Limited (NHSRCL) with technical and financial assistance from Government of Japan [26].These linkages are expected to consolidate the economic potential of the MMR and further strengthen the status of Mumbai as the financial hub both nationally and internationally.

4.3.4 Improved Public Transport—Metro and Mono Rail

The World Bank funded MUTP focuses mainly on strengthening of mass transport particularly improvements in suburban railway services in terms of efficiency and capacity, with very few proposals of road improvements. The five main north–south roads in the suburbs are not fully developed to the planned width, have many bottleneck points and constraints due to large number of intersections with major and minor roads. Similarly, the major east–west links have not been finalized. During the last 4 decades vehicular ownership in Greater Mumbai, particularly in the suburban areas, has increased several folds resulting in immense pressure and increasing bottlenecks. The vehicular population in the last four decades increased from 1.5 lakhs in 1971 to 1.29 million in 2001. MMRDA with a view to supplement MUTP, initiated the process for an ambitious project known as Mumbai Urban Infrastructure Project (MUIP) [21].

Under Mumbai Urban Transport Project (MUTP), MMRDA followed up with the earlier Comprehensive Transport Study (CTS) in 1994 covering all modes of transport in January 2005. Its objectives were to formulate long term transportation strategies for the MMR in 2031 and evolve a phased investment and management programme for 2016 through a comprehensive transportation model to test alterative land use/transportation strategies.

Mumbai is well known for its local trains famously called as "life line of Mumbai", with over 8.0 million people travel everyday by this mode. Mumbai Rail Vikas Corporation Limited (MRVCL), a joint venture public sector company of Ministry of Railways and Maharashtra Govt. is responsible for implementation MUTP and to look after the operations of sub-urban trains in MMR [36]. The other well established public transport is BEST. The local municipal authorities have their own public transport departments such as Thane Municipal Transport, (TMT); Navi Mumbai Municipal Transport (NMMT); Kalyan Dombivali Municipal Transport (KDMT) etc. The public transport network in Mumbai Metropolitan Region (MMR) has been very successful.

The thirteen metro lines planned and being executed in Mumbai and suburban areas are under three authorities namely MMRDA, Mumbai Metro and Mumbai Metro Rail Corporation Limited (MMRCL). Apart from these lines, another three metro lines are being planned and executed in Navi Mumbai. It is not clear how these new lines Navi Mumbai will be operated. Although several operators are established for different routes, for better co-ordination it is necessary to have a single authority for the entire Mumbai Metropolitan area and the same is on board of the government agenda. Also, single and smart ticketing system enable hassle free travel to the passengers shifting from one route to another.

These public transport initiatives, to a great extent, would ensure smart mobility and in addressing the bottle necks and travel demands.

4.3.5 Tourism: Coastal Stretches, Heritage Structures, National Park

Mumbai, made of seven small islands by filling the area between them, has a long coastline of about 114 km, excluding the small creeks. Out of this approximately 50 km is directly facing the Arabian sea and the rest is along creeks. The Coastline of the city has numerous creeks and bays emanating from Thane creek on the eastern front to Madh (Island) Marve on the western side. The eastern front has vast stretches of mangroves rich in biodiversity, while western coast is mostly rocky or sandy barring few stretches of mangroves in the northern part [6]. Mumbai is also an architectural treasure house with its neo-Gothic buildings, a heritage of the British era. Developing these appropriately will add value to the MMR's attractiveness.

4.4 Threats

4.4.1 High Intensity Rainfall and Floods

Being a coastal city, Mumbai experiences heavy monsoon between the months of June to September every year. The city's high intensity rainfall, especially when coupled with the high tide, causes floods during the monsoons those stretch over

a good four months, disrupting the routine life in the megacity every year. During this season, the city faces urban flooding every monsoon, during which the services of the public transport through the suburban trains are disrupted. At the same time, traffic jams due to the potholed roads in the season, are also commonplace. The initial storm water drainage system designed to serve a much smaller habitation at that time, bears the brunt for it. Besides, as the historical city comprises north–south trending hills, many of which have illegal shanties, the monsoon also sometimes witnesses landslides and collapse of dilapidated buildings. As the city has a history of four decades, it not only comprises heritage structures for which conservation measures are regularly undertaken, but also others that lack continuous maintenance.

The suburban rail service as also the road traffic is therefore, adversely affected during this period due to bad road conditions. The collapsing of shanties in the slums on the encroached hills and the dilapidated structures also result in casualties during this season.

Of the 19 coastal megacities in the world, Mumbai is one of the three located in India, besides Kolkata and Chennai. South Mumbai, being the reclaimed land, most of the area is flat, just above the sea level with an average elevation of 14 m. The natural calamities like the floods of 2005 and the recent cyclone Nisarga have shattered the public life. Several areas have been inundated, buildings collapsed. The north Mumbai however, is at a higher elevation with hills including the Borivali National Park. The main reasons for flooding in Mumbai may be attributed to the tidal variations, flat gradients, vast coastal stretches, obsolete drainage system, siltation, and garbage dumping and choking in the drainage outlets.

Only about 15% recommendations of the Brihan Mumbai Storm Water Drain (BRIMSTOWAD) project report were implemented. The explanations for non-implementations were lack of financial resources, multiplicity of agencies, CRZ restrictions, and encroachments.

4.4.2 Air and Noise Pollution

The rise in ownership of vehicles is causing consumption of more fossil fuels and release of high emissions and noise pollution, apart from leading to woeful traffic snarls and increased travel time, especially during peak hours.

4.4.3 Water and Power Shortage

Present water supply is 3850 MLD. The demand is expected to reach 5910 MLD by 2030. This additional demand is expected to be met through a new water resource, Gargai project (440 MLD) and also recycled water (1350 MLD) [18] and other measures like rainwater harvesting, reuse of treated grey water. Increasing migration trends and the growing population demand for basic services, like drinking water, shelter, power supply. The water and power supplies to the Region therefore, need to

be augmented in the future through sustainable measures like rainwater harvesting, recycling methods, which is being incentivised by the Municipal authorities; rather than through construction of dams requiring land acquisition and rehabilitation that has become tougher through new legislation.

4.4.4 Terrorism

Several terrorist attacks during 2003–2008 period, bombing on public transport services especially, local trains and crowded areas have devastated the city life. Terrorism has also raised alarm as another potential threat in the megacity, having been affected therefrom on more than one occasion, particularly in crowded transportation routes relating to the suburban rail.

4.4.5 Urban Periphery—Expansion and Conversion of Agriculture Lands

The rise in private transport has also led to the disintegration of the compact and efficient urban structure for which this megacity was famous and appreciated. The rise in per capita income and decrease in familial liabilities has given rise to high spending capacity, the trend of investing in second and weekend homes, further straining the infrastructure networks and ecological stability of the vulnerable Western Ghats. Last but not the least, it is causing the conversion of agricultural lands on the urban periphery, adversely affecting the self-sustainability in the Metropolitan Region, in absence of scientific inputs and stringent measures for conservation of agriculture lands.

5 Mumbai as a Smart City

Any city is considered to be smart when information technology is used to run different infrastructure and services efficiently.

A smart city is an urban area that uses different types of electronic Internet of Things (IoT) sensors to collect data. Insights gained from that data are used to manage assets, resources and services efficiently; in return, that data is used to improve the operations across the city (Wiki).

In today‘s age of smart urbanization, with phenomenal advancement in information technology and extensive computing power, the urban planning profession expects to reap the benefits of available real time data to serve the common man in particular and the society, at large. Further, with growing environmental concerns about carrying capacity and global warming, the urban planners are bound to utilize

real time data to assess the peak capacities of the different systems that comprise an urban area, and suggest suitable alternatives with SWOT analysis of various scenarios suggesting the means of their replenishment/augmentation, without significantly altering the ecological balance.

However, the existence of business hubs and good connectivity between them facilitated by public transport is a basic requirement for any city to be smart and global.

5.1 Smart Mobility

Use of 'integrated ticketing system' using smart cards for different modes of transport is seriously being considered for Mumbai and the MMR [4]. It is expected to reduce time and ticketless travel and facilitate authorities to enhance their revenues. Also, this will enable people to use public transport seamlessly.

5.2 Smart Environment

5.2.1 Pollution Monitoring for Reduction of Emissions

Health influences the indicators of Happiness Index and Human Development Index. Intensified development and increased use of vehicles, fossil fuel, energy consumptions in megacities lead to increased emissions. It has an impact not only on natural resources but also on health of the residents.

Urban form also has a role to play in air pollution in megacities. The three quantitative indicators developed based on Ai Pollution Index (API) of the area namely, Mean Air pollution Index (MAPI), Air Pollution Ratio (APR) and Continuous Air Pollution Ratio (CAPR). Expansion of urban areas and Polycentric urban forms may help to reduce pollution levels [37].

MCGM collects about 6700 tons per day (TPD) solid waste, which itself is reduction from over 9000 TPD previous collections. Several initiatives have been taken to reduce waste generation and reduction, including waste separation at source, treatment and recycling. Additional measures are being taken to reduce solid waste to 5000 TPD by 2030. It is anticipated that by establishing waste to energy plants, 1800 TPD of garbage will be utilized. Likewise, additional 1200 TPD construction and demolition waste will be reused [18]. These measures are expected to boost circular economy, as well.

Use of GIS and GPS technologies would help regulating the vehicular movements and optimize the fleet of vehicles for collection of garbage. At the same time, public awareness is essential in dealing with solid waste management.

5.2.2 Flood Monitoring

The recommendations of fact finding Committee, appointed by the Government of Maharashtra, post July 2005 floods include de-siltation of storm water drainage systems, rivers; provision of pumping stations at various outfalls; provision of flood gates at outfalls owing to tidal effects during heavy rains [9].

Administratively, formation of coordination committees to deal with multiplicity of authorities; adequate fund allocation for cleaning and upgrading the storm water drainage system; devising mechanism for removing the encroachments, rehabilitation of slums would, to a certain extent, address the flood issues.

Technologically, public participation through the use of IoT needs to be harnessed. Details of rainfalls and flood can be sent through their smart phones. Use of sensors for monitoring the high tide and flood waters during the emergencies is a step forward in this direction [27].

The spirit of the public to bounce back from such threats demonstrates the resilience of the city. While it is appreciated that the city has exhibits a great resilience, it is necessary to have a Disaster Management Plan ready for such events, especially the natural disasters.

5.2.3 Coastal management—CRZ, Wetlands and Mangrove Mapping

Mapping mangrove stretches along the coastline using latest satellite images, geo tagging them for conservation and preservation and to protect the biodiversity.Similarly, the wetlands identified as per the National Wetland Atlas have been mapped by the MRSAC and these are being verified at the district level for inclusion in the State Wetland Atlas.

Due to high economic potential for the land parcels in the megacity, there will be drivers, pressures, responses and impacts from various sections of the society for development of these coastal stretches. They have to be dealt with appropriately with due ground verification of facts, assessment of technical needs and requirements to deal with floods and by integrating the economic values with the social and environmental needs and to ensure sustainable development.

5.3 Smart Government

Integrated GIS map base, Unified data repository, Unified Unified Development Control and Promotion Regulations (UDCPRs), Land records, Mahabhulekh, Infrastructure Assessment and Augmentation require consistent effort and data updation. However, it would result in the mart governance of the megacity.

6 Challenges for Mumbai as Global City

Majority of the services and businesses today, particularly multinational corporations, have developed their own website and portals to display and advertise their products and services. Consequently, their outreach is now beyond the physical extents of habitation, along with tie-ups with national and international level delivery services. Generally, a global city has a culmination of multi-faceted identities or dimensions like trade, commerce, businesses, financial transactions, governance, tourism and culture. They are a nation's windows to the rest of the world. A city is considered to be global particularly when its trade, commerce and financial services are connected across the geographical boundaries [1]. The location of a stock exchange for foreign investments in the city is advantageous for transactions. Such a city, by default, would be equipped with a robust network having high capacity servers and requisite infrastructure for data security. Most megacities have already developed efficient infrastructure in this regard. In addition to the economic dimension, a global city also has a cultural one, with introduction of new lifestyles and values.

6.1 The Economic Angle

As the primary economic driver has shifted from Agriculture to Manufacturing to Services to now Information Technology, what Friedman has referred to as Industrialization 4.0, the economy in Mumbai has moved from fishing and trade to textile mills, industry and pharmaceuticals to a predominance of the financial, service and institutional, largely medical, sectors. This transition from the primary to the tertiary sector of the economy also signifies a rise in the literacy and the per capita income levels of the populace, as also the GDP of the region.

Population, however, gives only a uni-dimensional view of a city's world ranking. Other dimensions that provide a better indication of their role in the global, national and regional scenarios than just looking at population data are the size of their economies, as measured by GDP and average income per capita. GDP, typically measured as the monetary value of goods and services produced, is a considered as a measure of economic growth. The world's GDP, according to the International Monetary Fund (IMF) is $91.98 trillion in 2020. Nominal GDP is an assessment of economic production in an economy, but it includes the current prices of goods and services in calculation. India, with $2.72 trillion (~3% of the world economy), closely follows at the seventh position after France ($2.78 trillion), United Kingdom ($2.83 trillion), Germany ($4 trillion), Japan ($4.97 trillion), China ($13.4 trillion), and America ($20.49 trillion) [7]. It is one of the fastest growing economies in the world with a 500-plus million middle class viewed as potential customers [2], and it is projected that the country's GDP could top $10 trillion by 2030 to become the world's fifth largest economy [10]. However, in terms of Purchasing Power Parity (PPP) India is the third largest country with a value of $9.49 trillion in 2017.

The following statistics as per a study by the Price Waterhouse Coopers in 2008, underlines the concentration of global economic activity in the world's largest cities [12]. The top 30 cities alone account for around 18% of world GDP while the largest 100 cities account for almost 30% of global GDP at Purchasing Power Parity (PPPs). Noticeably, while 22 of the top 30 cities by population are located in the emerging/developing economies, only 7 of them figure in the top 30 GDPs.

Further, 23 of the top 30 cities listed by the highest GDP per capita in 2008 were from the US, although Tokyo remained at the top with New York catching up, in 2005–2008. The economies of each of these cities were worth $1.5 trillion in that year, significantly higher than certain national economies like those of Canada, Australia and Poland. This underlines the economic significance of the urban agglomerations and how they are poised to become major economic focus in the near future, by virtue of the digital technologies.

Mumbai is the sole Indian city to make it to this list at the 29th position, projected to rise to the 11th position by 2025, with an estimated GDP of $594 billion at 2008 PPPs at an average real GDP growth of 6.3% per annum. Delhi is the other Indian city to jump from the 37th to the 19th position with an estimated GDP of $482 billion at 2008 PPPs at a higher average real GDP growth rate of 6.4% per annum and. It is observed that with lower GDP growth rates of 1.4–2%, many cities of Europe are being replaced by the emerging economies in this list. Kolkata and Bangalore are other Indian cities showing significant economic leap from 61st to 37th and 84th to 55th position respectively [13].

Further, there are no advanced economies represented in the top 30 fastest growing cities, as per the projected average real GDP growth in 2008–2025. Among these, 12 are in India, with Surat, Jaipur, Lucknow, Kanpur, Pune, Ahmedabad, Bangalore, Hyderabad, Chennai, Delhi and Kolkata with projected average real GDP growth rates up to 6.7% being ahead of Mumbai at the 28th position.

Significantly, when the cities are classified on the basis of the size of the national economies; in the Lower–Middle Income countries, Mumbai takes the second place after Shanghai. However, Mumbai with a 185% cumulative economic growth rate, at second position behind Shanghai with 197%, is projected to achieve significant economic growth during 2008–2025, while advanced economies display an average projected GDP growth rate of around 35% only. Projections in this study show that India currently having two and 6 cities in the list of top 50 and 100 respectively, will add one and three more cities to these two lists by 2025; being in the same league as China.

6.2 The Sustainability Angle

In the long term, a global city needs to be ecologically sustainable. The United Nations set forth the 17 global Sustainable Development Goals (SDGs), integrating social, economic and environmental dimensions of development, in 2016 with about

169 targets and a set of 32 global indicators. Although the SDGs are not legally binding, they may reorient the priorities of the domestic expenditure in the next 15 years [24]. Countries are expected to become accountable for the same, and establish a national framework to achieve these goals Data with respect to these SDGs may be monitored through the IoTs, so that infrastructure augmentation scenarios may be worked out to achieve these.The treated water from the various STPs constructed in the Region may be recycled and reused for non-potable domestic uses like flushing or gardening or industrial use, so that a huge share of the treated water may be recycled, to fulfill the SDG 6.

Considering the air pollution due to emissions from fossil fuels, water transport is one of the available public transport alternative for Mumbai. Water transport between Mumbai and Navi Mumbai through passenger transport has been contemplated. Also, creation of Coastal Economic Zones (CEZs) under Sagarmala programme of Government of India, is another initiative to unlock the potential of coastal stretches and to boost the economy and also address the emissions issues. This programme is also expected to reduce transportation and logistics costs, improve exports and optimization of time and cost [20].

6.3 The Governance Angle

As mentioned above, the MMR is governed by a number of Municipal Corporations and Municipal Authorities. Besides there are other specific organizations to cater to the specific transportation needs, like the Maharashtra State Road Transport Corporation (MSRDC) for road development and Mumbai Rail Vikas Corporation Limited (MRVCL) for execution of new rail corridors, and MMC for operation thereon after commissioning thereof. In other words, there is multiplicity of jurisdiction, not only territorially, but also for different verticals.

Similarly, some verticals like the Ministry of Environment, Forests and Climate Change as well as the Civil Aviation, under the jurisdiction of the Central Government have their counterparts in the State Government which regulate the various Authorities connected to them, synthesize their feedback while representing the matter to the Central Government while seeking for some relief. In other words, there is multiplicity of jurisdiction, not only territorially, but also for different verticals. Besides, the common citizen today is empowered through the Right to Information (RTI) Act and the filing of Writ Petitions (WP) or Public Interest Litigations (PIL) suo moto before the High Court for protection of public interests. For smooth and efficient governance in the circumstances, specifically in times of disaster management, it is essential that the different authorities use the same base map, where all the infrastructure networks are accurately mapped.

7 Conclusion

Mumbai, one of three costal megacities in India, located along the Arabian Sea, has had a unique place in the country's economy by virtue of its being the financial and commercial capital. Historically having originated as a port city from its southern tip, wherefrom international maritime trade flourished especially after the opening up of the Suez Canal in 1869, it has moved from being a city of textile mills to a manufacturing and pharmaceutical hub to a financial centre with IT centres. Post-independence, the city witnessed large immigration, both national and international, as a centre of employment and business hub and thereby, spread northwards and towards the mainland, along the suburban rail corridors, encompassing many existing towns. It is spread over an area of about 603 km^2 between the sea and the creek, interspersed with north–south trending hills, having moderate hot and humid climate. The need for a second sea port in 1989 and a second airport in the last decade is testimony to the urban agglomeration's sustenance as a thriving economy, and its launch into a new growth trajectory.

The Metropolitan Region was delineated in the 1970s after the Government decision to decongest the island city by linking it to the mainland, today comprising a total of nine Municipal Corporations and Municipal Councils each in addition to over a 1000 villages in Thane, Raigad and Palghar districts; with a total population of 23.6 million, as per the 2011 Census.

7.1 Strategy as a Smart Mega City

The all-pervading effects of the shift in the mode of trade and commerce has also transformed the urban lifestyles, with easier access to information. The hitherto essential queues in banks and transport hubs, be it railway stations or airports, have eased out, giving way to digital transactions and identification through credit cards and ATMs, unique photo ids and fingerprints respectively. Cities have come to be smart.

ICT and IoT technologies have the potential to leverage the opportunities and strengths of the Region and to comprehensively address the weaknesses and threats therein. Urban areas across the world have turned to the digital platform and are focussing on compiling a database with respect to different service verticals with the aim of 'ease of doing business'. The development of mobile applications at the global and local levels, like Google Maps to know the route between two locations, along with the traffic intensity thereon; and m-indicator for information on the timings of available suburban rail services on the different rail corridors and the stations between the origin destination points, also enabling purchase of tickets thereon, using real time data has facilitated the everyday routine for the common man. Besides, the use of ICT for online payment processes and money transfers through user-friendly Graphical User Interface (GUI) has now become commonplace. This has gone a long way to

reduce the trips generated, enabling the common citizen to save on both time and energy. However, the data security issues have led to cybercrimes, and impinged on individual privacy.

In the MMR, different organisations are responsible for providing an array of public services. Considering the multiplicity of organisations functioning here, a unified data repository of their respective domain is essential. Access to such a data repository would facilitate coordination for improved services to the citizens. Creation of a unified base map including the infrastructure networks using GIS, and linking of the land records and other attribute data using ERP solutions to form a comprehensive database with respect to public amenities and resources forms the bedrock for the smooth functioning of the multi-institutional framework created for the smooth functioning of the Region. The integration of the data-rich GIS maps with building plan approval systems can streamline the entire demand-supply chain through a single window, and ensure that the investments by the citizen in real estate is protected. Further, being a coastal city, it is also essential for Mumbai to have a Coastal Zone Management Plan (CZMP) and share it with the citizens through the websites of the Municipal Corporations.

The rising land values in the city and increase in private vehicle ownership have led to the unabated urban agglomeration. This has led to a decline in the population density in urban areas, whereby the advantages resulting from the economies of scale are lost. It will therefore be essential to monitor the conversion of agricultural and forested lands as well as wastelands at the urban periphery. However, being a limited resource, land utilisation needs to be considered comprehensively, and not as per the market values thereof. The analysis of temporal changes in the urban morphology changing needs to be analysed through the continuous supply of satellite images for appropriate and timely policy interventions.

The State Government's timely initiative in early 2000s to promote Information Technology in the state led to the immediate formulation of policy framework and the corresponding provisions in the development process led to emergence and establishment of several IT corridors in and around Mumbai. The establishment of the Dhirubhai Ambani Knowledge City (DAKC) along Thane Belapur Industrial belt has attracted young and talented workforce across the nation and globe. Similarly, many organisations have established their IT centres in these IT corridors and controlling several operations across the globe.

Specific transportation planning software is used to store, display, manage and analyse transportation data for travel-demand modeling, planning and logistics functionality for improved performance of complex road networks. Similarly, traffic simulation is also used for route identification and design. CCTVs installed at traffic junctions help to generate real-time data and monitor traffic lights. Coupled with sensors, they are also used to regulate the flow of traffic.

However, it is not enough for the Region to be smart alone, as long as the entire urban system is not integrated smoothly to be sustainable. Different software is therefore deployed to design, build and efficiently operate the various infrastructure verticals, not only to sustain the consumption of natural resources but also to abate air and water pollution resulting therefrom. One such chain extends from the tapping of

water from the source to the reservoir for supply to the different end users, followed by its segregation at source, and treatment for re-use or disposal. Water-metering and monitoring pilferage by installing sensors; flood monitoring and developing disaster management techniques are application areas for water conservation. The green certification of projects comprises similar chains in solid waste and storm water management. An integrated system can model the respective sub-systems and document workflows across verticals for projects of any size and complexity. So far, each of these sectors has been successful in adopting the IoT solutions in Mumbai to different extents. However, the integration of different utility verticals is essential to ensure resource conservation and enable transparency in decision making.

Uninterrupted power supply and data connectivity is challenging. The power sector in Mumbai is handled by more than one operator like the BEST, MSEDCL, Reliance and the Tatas. In the domain of power, its generation, distribution and consumption can be monitored through SCADA (Supervisory Control and Data Acquisition), a control system architecture comprising computers, networked data communications and (GUI) for high-level process supervisory management at the urban level. Such measures help to reduce losses and power thefts.

Last but not the least; public awareness and participation is essential in making Mumbai truly a smart and resilient city.

7.2 Strategy as a Global Mega City

As the ICT has enabled trade and commerce through paperless currency in the last decade, transcending geographical barriers, the influence of cities too has expanded manifold and the national boundaries have ceased to exist. Cities have come to be global.

The economic liberalisation for globalisation policy of India at the turn of the century has further aligned Mumbai in the spotlight to the world as a centre for several key businesses and trades, competing with various other countries. The formation of Special Economic Zones (SEZs) and Foreign Direct Investments (FDIs) have changed the entire fabric of the city by proliferation of multinational companies for establishing their regional offices. This was augmented by the ICT and the Business Processing Offices (BPOs). Further, the city adapted by becoming multi-nucleated to overcome this shortcoming the fanning out of the industry and offices to other parts of the city and the development of the Bandra Kurla Complex, SEEPZ and other pockets of the MIDC.

The Special Township policy further enabled the developers to consolidate the private land parcels and build gated communities away from the centre of the city along the prominent transport corridors, taking cue from the Western world. This was further abetted through FDI and the easing of housing finance options both for the developers and the buyers, so that the double income in the new generation enabled it to think of second homes or weekend homes on the urban periphery. However, the lessons to be learnt here in terms of the environmental losses through the ghost cities

in China are yet to tickle in and percolate. Recently, the Government of India under Sagarmala programme, has established Coastal Economic Zones (CEZs), opening up sea fronts for more business activities.

Disclaimer This write-up is carried out in the persona capacity of the authors, and is in no way connected with their official position.

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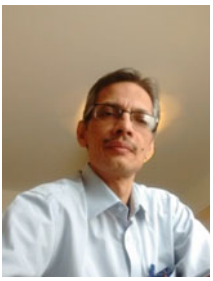

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New York

An Overview of Climate Protection and Resiliency Planning in the New York Megacity Region

Sudeshna Ghosh, Sweta Byahut, and Calvin Masilela

Abstract The megacity of New York has increasingly emphasized on sustainability, resiliency and climate protection goals in its urban policies and planning initiatives since the turn of the 21st century. Hurricane Sandy in 2012 became a major tipping point in the city's initiatives for proactive climate adaptation and mitigation planning. New York has not only continued its global economic dominance by fostering innovation, entrepreneurship, cultural diversity, and inclusion; but also has pledged to protect its residents, built up areas and critical infrastructure from rising sea levels, coastal flooding, and storm surges by investing billions of dollars in the coming decades. The strategic plans, *PlaNYC* and *OneNYC* embrace New York's unique assets and aim to promote an inclusive governance to achieve its sustainability goals. The strong political and community will to build a resilient city is demonstrated through its ambitious commitment of reducing carbon emissions with technological, social and behavioral changes, advancing climate risk assessment technologies, integrating climate protection measures in every aspect of local and regional planning, and adopting technologically advanced as well as natural adaptation measures to protect the region from climate risks. This chapter presents an overview of New York metro region's multifaceted urban policies and planning initiatives since the 2000s that extensively engage public agencies at local, regional and state levels with multiple stakeholders, and local communities to achieve urban resiliency. While this megacity has indeed demonstrated many success stories; the extent to which it can address equity, affordability and inclusiveness issues will determine the success of the city in the decades to come.

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Keywords Urban resiliency · Climate adaptation planning · Climate mitigation planning · New york megacity · Strategic planning

1 Introduction

The urbanization process of the late 20th and early 21st century is characterized by growth and dominance of megacities across the world; hence, considerable research in urban studies and the planning discipline has increasingly focused on the challenges, opportunities, and sustainability of these megacities. While Asia currently has more megacities than the rest of the world combined, New York and Tokyo are the oldest megacities. In the 1950s, New York and Tokyo were the only two megacities in the world with a population greater than 10 million people [1]. The New York metropolitan region, which is officially known as the "New York-Newark-Jersey City, NY-NJ-PA Metropolitan Statistical Area," remains the largest megacity in North America spanning over 8,294 square miles in area across 3 states: New York, New Jersey, and Pennsylvania. It comprises of 25 counties and more than 20 cities with an estimated population of 19.2 million in 2019 [2].

With a total population of 8.5 million, New York City, popularly referred to as NYC, remains the largest city in the metropolitan region and serves as its dynamic, financial, economic, population and geographic center. NYC includes five boroughs: Brooklyn, Bronx, Manhattan, Queens, and Staten Island. The city has historically been one of the most progressive cities in the world in terms of urban policies and planning; being the epicenter of innovative and revolutionary urban planning, design ideas, and initiatives that have informed planning theories and knowledge since the 18th century. Several major urban planning ideas and movements, such as urban sanitation, public parks, civic arts, city beautiful, garden cities, and parkways either originated or were implemented in this city-region from their early conceptual stages. While many older industrial cities in the western world declined due to deindustrialization since the mid-20th century, New York has successfully transformed its economy to evolve into a modern megacity of the 21st century. This has brought about a significant shift in its focus on urban planning and policies. Since the turn of the 21st century, New York City, as well as its metro region, have explicitly demonstrated their pledge towards the environment, sustainability, equity, and resiliency as a response towards increasing climate risks.

For this chapter, we assess numerous urban and regional policies, planning documents, and reports since the 2000s from New York City, New York metro region, as well as the State of New York to focus on resiliency and climate protection planning initiatives. These have formed the dominant planning agenda in New York metro region in the time after hurricane Sandy. Hurricane or Superstorm Sandy was one of the deadliest and most destructive Atlantic hurricanes that hit the region in October 2012. It caused billions of dollars in economic loss and became the tipping point in climate resiliency planning in many cities across the US east coast, and was a particularly crucial event for the New York metro region. Resiliency and climate

Fig. 1 Map of the US showing New York Metropolitan area [3]

protection planning initiatives are being implemented in an engaged and collaborative manner at all levels involving multiple jurisdictions with public agencies, private stakeholders, research institutions, and community members. We follow a descriptive approach and provide a critical review of some of these initiatives in the New York metro region (Fig. 1).

2 Background of the New York Metropolitan Region

Our region of study is the New York metropolitan area, henceforth referred as the New York metro region, which has 25 counties. The City of New York is comprised of 5 counties: New York (Manhattan borough, NYC), Kings (Brooklyn borough, NYC), Queens (Queens borough, NYC), Bronx (Bronx borough, NYC), and Richmond County (Staten Island borough, NYC). It has a combined population of 8.34 million people and a population density of 27,819 people per sq. mile. While the Brooklyn and Queens boroughs are the most populous with a population of 2.56 million and 2.25 million in 2019 respectively, Manhattan had a population of 1.63 million, Bronx 1.42 million, and Staten Island 0.48 million in 2019 [3]. Other than NYC, Long Island (spanning over Nassau and Suffolk counties, NY) had a 2.8 million population, and Jersey City (located in Hudson County, NJ) had a population of 0.67 million. Figure 2 shows the 25 counties and the population density distribution within the New York metro region. It is obvious that much of the population is densely concentrated in and around NYC, Long Island and Jersey City. Therefore, a majority of the urban and regional policies and planning initiatives related to climate resiliency we discuss in this chapter are targeted towards these core areas.

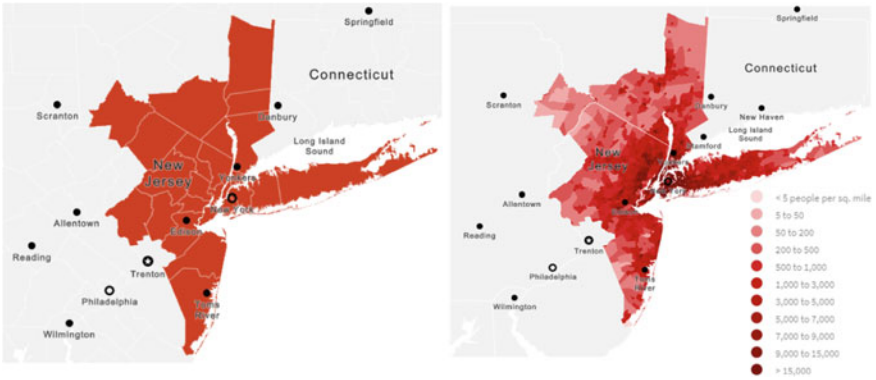

Fig. 2 Map of New York Metro region counties and their population density distribution [3]

3 New York: Historic Urban Planning Evolution

New York was first settled by Dutch immigrants during early to mid-17th century, and the city grew rapidly from the lower tip of present-day Manhattan (Fig. 3). The evolution of the grid patterned street layout on the Manhattan island can be traced to the concept of maximizing the use and value of land in American cities through rectangular land parcels. Rapid growth, congestion, and epidemic disease outbreaks during the industrial revolution period led to extension of public services, public transportation, water supply, sewage disposal, drainage, and power throughout the 18th and 19th century. New York City became one of the pioneers in the Western world, where many of the early urban planning movements were conceived and implemented to improve the quality-of-life in a growing industrial metropolis [4].

Fig. 3 Historic maps showing growth of Manhattan island and landfills into the Upper Bay and Hudson River (left) and the Central Park in 1879 (right) [5, 6]

Besides major urban sanitation projects, New York City was also instrumental in the Urban Arts and City Beautiful movements that led to the construction of many European-style architectural landmarks and public squares in the 19th century, establishing NYC as a leading cultural center in the US. The creation of public parks such as Central Park by Olmsted and Vaux in 1858 exemplified the city's commitment to urban greening since the 19th century (Fig. 3). In 1916, New York City became the first US city to enact a comprehensive zoning ordinance, written by Edward Bassett, for regulating the rapidly densifying urban form and alleviating poor health and safety conditions [7].

The 1920s was marked by experimentation with garden-cities. The City Housing Corporation of New York and the architects Wright and Stein built new communities such as the Sunnyside gardens in Queens and Radburn in New Jersey. In the post-world war era, New York witnessed rapid suburbanization like other American cities and growth and development spread out throughout the region. This period also witnessed Robert Moses in planning and building major transportation corridors, expressways, and parkways in the region, numerous urban renewal projects aimed to clear slums and blighted neighborhoods, as well as influential ideas from Jane Jacobs challenging these top-down planning approaches. New York City continues to cherish the planning legacies of Jane Jacobs, Robert Moses and others, as it transforms into a modern megacity of the 21st century (Fig. 4).

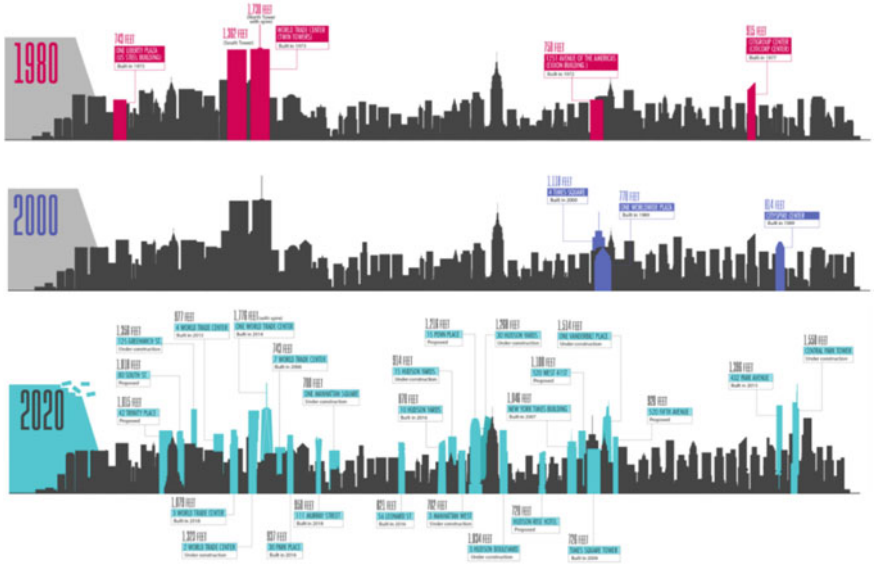

Fig. 4 Changing Skyline of New York City [8]

4 Economic and Urban Transformation in the 21st Century

Since the 1970s, the post-industrial American economy defined new roles for its major industrial cities. Beyond its long history of urban dominance in the US, the New York metro region has been an important global command center in the organization of the new world economy driven by advanced and specialized service firms [9]. In the 21st century global economy, New York has consistently ranked among the top Global Cities, both by academics and the corporate sector [10]. According to the Bureau of Economic Analysis (BEA), the region was estimated to have a GDP of $1.3 trillion in 2016, making it the second in the world economy after Tokyo, which has a GDP of $1.6 trillion [11]. Indeed, the economic dominance of megacities justify the notion that cities are the new centers of global power. With its expanding economy, New York emerged as a global city that encourages innovation, entrepreneurship, diversity and inclusion, cultural dynamism as well as sustainability [12].

The changing economic structure of New York and its sustained global dominance also led to transition of its urban and population structure, becoming more distinct during 1980-90s. New York's population has steadily grown over the past decade to reach over 20 million in 2017, and it currently has a diverse population base with immigrants from different parts of the world (Fig. 5) [13, 14]. Drawing from a rich planning tradition spanning two centuries, the New York metro region has continued to plan innovatively in the 21st century to maintain its competitive position in the world economy and create an attractive environment for global elites and specialized service firms. While the 9/11 attack, 2008 economic recession, and 2012 hurricane Sandy triggered significant social, economic, and financial impacts in the region, over the years it has been able to bounce back with transformative revitalization focusing on economic growth, inclusiveness and diversity, and environmental sustainability. Beginning in the mid-2000s, the region adopted a strong commitment towards climate protection in its urban and regional policies. Hurricane Sandy, particularly, became a strong impetus for the region to reinforce climate resiliency and adaptation for protecting its vulnerable areas and communities (Fig. 6).

5 Towards a Smart Megacity: Recent Planning Initiatives

New York's rich planning tradition has continued in the 21st century with many planning initiatives that encourage smarter, more innovative, and more sustainable developments. In recent times, New York has emerged as one of the pioneer cities with regional planning initiatives to address urban challenges. NYC's strategic plan, *PlaNYC 2030: A Greener, Greater New York* was first released by Mayor Bloomberg in 2007 and was updated in 2011. The plan was again updated in 2015 when it was renamed as *One New York: The Plan for a Strong and Just City*. It was then most recently updated in 2019 as *OneNYC 2050: Building a Strong and Fair City* [16–19]. All of these plans envisioned future economic growth with sustainability and

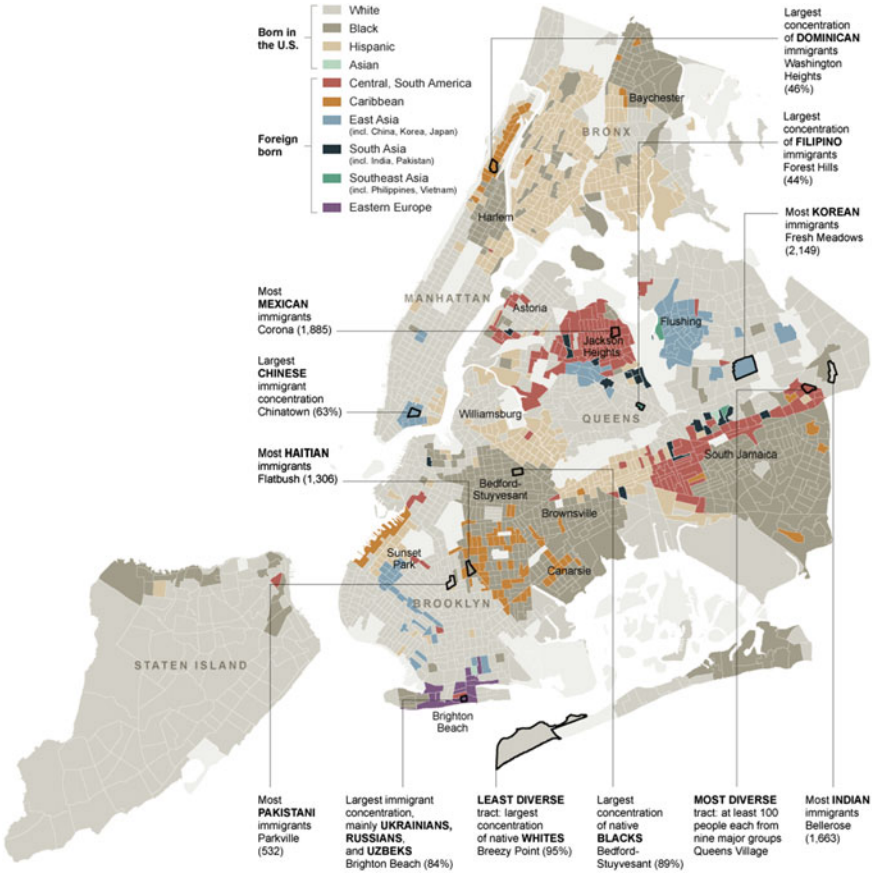

Fig. 5 Concentration of population by ethnicity [13]

resiliency to deal with climate change. The specific elements included in *PlanNYC* were housing and neighborhood, parks and public spaces, brownfields, waterways, water supply, transportation, energy, air quality, solid waste, and climate change [16]. The 2019 update of *OneNYC* articulated commitment towards a sustainable future for the region with four distinct visions: vision of a growing and thriving city, vision of a just and equitable city, vision of a sustainable city, and vision of a resilient city [19]. It builds on New York's unique assets of diversity and aims to create a more inclusive government that can effectively and equitably serve the diverse residents of New York metro region.

Both the *PlaNYC* and *OneNYC* plans are examples of successful participatory approaches that brought 25 city agencies to envision common goals for the future of the metropolitan area, emphasizing sustainability policies, urban resiliency and inclusive development. As part of these plans, the cities within the metro region are developing pro-active design guidelines, zoning regulations, housing, urban

Fig. 6 The New York City of the 21st century [15]

greening, urban agricultural, and infrastructural projects that promote sustainability. The Mayor's Office of Resiliency in New York City recently formulated new *Design Guidelines for Climate Resiliency* that highlight climate resilient building designs to mitigate urban heat islands and encourage zoning modifications to reduce impacts of future flooding, hurricanes and other natural disasters [20] (Fig. 7).

Some of the recent planning and redevelopment projects in the New York metro region have received worldwide acclaim, such as the completed Highline Park and the ongoing Hudson Yard project, only two of the multiple transformative projects that New York City has implemented to maintain its competitive image in the 21st century.

Highline Park is an urban greening project that transformed an old, elevated and unused railroad into a 1.45-mile-long linear urban greenway. The project was completed in three phases during 2009-2014. The project cost for the first two sections exceeded $150 million, and the third phase was approximately $70 million. The project has attracted billions of dollars in investment in areas along the park, spurring tremendous economic benefit for the surrounding neighborhoods [21]. Upon completion, Highline Park became an iconic project that integrated innovative urban design, urban arts, landscape architecture, and ecological knowledge, and inspired many cities throughout North America to revitalize obsolete infrastructure and transform them into vibrant public spaces [22] (Fig. 8).

Transformation of Highline Park not only added economic and social value to the city, but it also provided environmental value by showcasing NYC's commitment towards a greener, sustainable, and resilient city. However, the project has

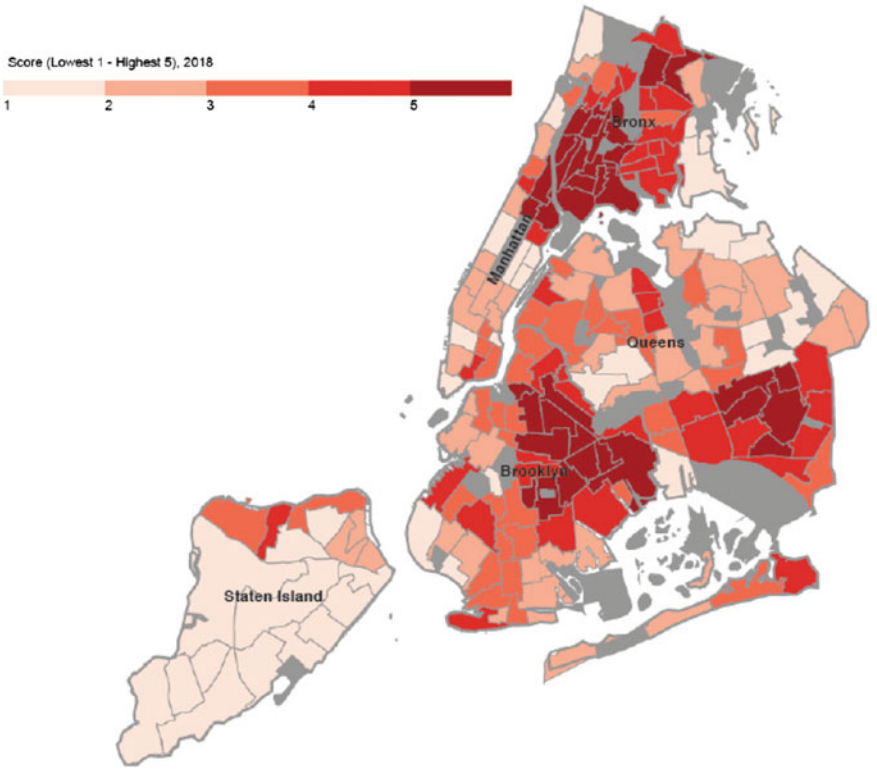

Fig. 7 Mapping of Heat Vulnerability Index across NYC neighborhoods [20]

Fig. 8 The High Line Park, New elevated park and old railroad image [22]

Fig. 9 Hudson Yard project, The Vessel on the left opened in March 2019 and The Edge on the right that will be completed soon [25]

been criticized for ignoring equity and affordability. In the decade, the tremendous success of the Highline has led to rapid transition of the real-estate market in the surrounding neighborhoods, with construction of elite apartments, exclusive luxury condominiums and residential towers. This has caused a sharp increase in property values, rents, and spurred gentrification.

Hudson Yards redevelopment project aims to create more mixed-use and green development in the Hudson Yard area of Manhattan. It is the largest private real estate project in the US. The first phase, Eastern Yard, opened in March 2019 and included 8 buildings and green spaces, which host residential and commercial units, public gardens, shopping mall and an exemplary cultural center [23]. The second phase, Western Yard, is scheduled to be completed by 2025. The project cost is estimated to be more than $2 billion and is expected to add about $19 billion to NYC's GDP annually and raise more than $500 million in tax revenue upon completion. This project gained popularity not only because of its massive scale and cost, but also for its iconic contemporary architectural and landscape designs. It is also deemed to be a pioneer for smart city planning model in the 21st century [23, 24]. The project boasts environmental-friendly green and smart buildings that depend on renewable energy sources, and it is expected that all buildings will be certified LEED gold. While this project boasts sustainability and resiliency; the socioeconomic impact on minority and low-income population, inclusiveness, equity, affordability, and gentrification remain debatable and need further assessment (Fig. 9).

6 Sustainability, Resiliency and Climate Change Planning

While smart planning initiatives are epitomizing the 21st century planning in the New York metro region, planning for climate protection is at the top of the planning agenda, and it is estimated that billions of dollars will be invested in the coming

decades. Located on the meeting point of Hudson River and the Atlantic Ocean, with over 600 miles of coastline, the region is among the top 10 most vulnerable cities worldwide in terms of coastal flooding due to natural disasters. In addition to rising sea levels and increased coastal flooding risks, the New York region is estimated to witness hundreds of billions of dollars in damages with a direct hit by a major hurricane. In 2012, hurricane Sandy led to approximately $19 billion in damages across the New York City alone, and destruction of 600,000 housing units in NYC and New Jersey [26, 27].

Climate change adaptation and mitigation planning was strongly emphasized since *PlaNYC*, well before Sandy. In 2008, Mayor Bloomberg formed an advisory panel to focus on climate change, specifically on adaptation plans for the region's five critical infrastructure: transportation, energy, communications, water, and waste. Climate adaptation for these critical infrastructure required a comprehensive approach as the interconnected infrastructural network spanned regionally beyond individual urban jurisdictions. The New York City Panel on Climate Change (NPCC) was established, consisting of academics from multi-disciplinary backgrounds to provide stakeholders with required information and adaptation techniques for management of critical infrastructure. The NPCC acted as an advisory group to the Mayor's Office as well as the New York City Climate Change Adaptation Task Force, a group of 40 public agencies and private stakeholders responsible for management of the critical infrastructure [28].

Earlier in 2004, the New York City Department of Environmental Protection (NYCDEP) created a Climate Change Task Force to understand effects of climate change on the planning efforts undertaken by NYCDEP, which is primarily responsible for planning and management of NYC's water supply, sewer, and wastewater treatment systems [29]. Over time, the task force evolved into a Climate Change Program, adopting a comprehensive approach to develop a risk management plan that evaluated mitigation and adaptation strategies based on climate change forecast scenarios, including sea-level rise, storm surges, inundation zone estimations etc. [30, 31].

Climate change adaptation and mitigation planning has been integrated into almost every aspect of local, regional, and state level planning within the New York metro region. In 2015, Governor Cuomo released "Climate Smart NY" for the State of New York, which incorporated assessment of future climate risks for all state agencies. The state enacted the "Community Risk and Resiliency Act (CRRA)" in 2014, which resulted in state agencies developing their own climate action planning implementation guidelines and review procedures. The CRRA included five major provisions that required public agencies to (i) adopt science-based sea-level rise projections, (ii) assess climate risks for future projects, (iii) develop guidelines on use of natural resources and processes to promote resiliency, (iv) develop model local laws to increase community resilience, and, (v) it added mitigation measures to smart growth criteria. The 2019 Climate Leadership and Community Protection Act (CLCPA) amended the CRRA to increase the scope of these five provisions [32].

These agencies included the Department of Environmental Conservation (DEC), Department of State (DOS), Department of Agriculture and Markets (DAM), Department of Transportation (DOT), Office of Parks, Recreation and Historic Preservation (OPRHP), Department of Health (DOH), Energy Research and Development Authority (NYSERDA), Environmental Facilities Corporation (EFC), Dormitory Authority (DASNY), among others. As part of this program, a climate change assessment report was published outlining specific challenges of temperature, precipitation, lake-effect snow, and sea-level rise, as projected from observed datasets and trends, for the entire state of NY. The consequences of these risks and challenges, vulnerabilities, and resiliency strategies were also stressed for all state agencies, which led to mandates for NYC's local and regional agencies such as the NYC Department of Environment Protection (NYCDEP), NPCC and other agencies [33].

In 2018, the State DEC also drafted flood risk management guidance at the state level for implementation of CRRA and provided guidelines for structures and buildings located in tidal and non-tidal areas, specifically for one and two-family residential and small-scale non-residential structures, multi-family residential and large-scale non-residential structures, water and wastewater facilities, and both critical and non-critical transportation infrastructure. The DEC applied smart technologies such as Lidar to collect flood risk data, updated FEMA flood maps, reviewed existing floodplain regulations and standards, reviewed building code standards and outlined standards for future resiliency in these areas. The DEC stressed that existing flood risk guidelines have the potentials to reduce flood damages significantly, due to precipitation, storm surges and sea-level rise; however, the updated guidelines were necessary to adapt to future uncertain climate risks so that buildings and structures can be sustained for 50 to 100 years [34, 35].

6.1 Climate Mitigation Planning

New York first committed to greenhouse gas (GHG) reduction by 30% by 2030 in 2007 in its well-known *PlaNYC 2030: A Greener, Greater New York* plan [16, 17]. In 2014, New York City became one of the first cities to pledge an ambitious target of reducing the emissions by at least 80% by 2050 [80 × 50], with an interim target of 40% reduction by 2030 [40 × 30] leading up to the Paris Agreement to limit global average temperature increases to 1.5 degrees Celsius. This was followed by the inclusive *One New York: The Plan for a Strong and Just City* (*OneNYC*) in 2015, and updated in 2019, focusing on growth, equity, sustainability, and resiliency [18, 19]. *OneNYC* updated the target to 80 × 50, but the *Roadmap to 80 × 50* is the Climate Action Plan (CAP) that presents a comprehensive vision for New York City to achieve a low-carbon future by 2050 [36]. It is based on the best available science and most recent GHG emissions modelling and proposes new investments in renewable energy, electric vehicles, and solid waste management for improving air quality and shifting away from fossil fuels. The plan feasibility was evaluated in the *Pathways to Deep Carbon Reduction* report which concluded that an 80 × 50 target is achievable by:

adopting an integrated set of strategies (across energy, transportation, buildings and waste sectors); technological innovation; social and behavioral changes; and strong political will power; as well as emphasis on sustainability, resiliency, growth, and equity [37].

NYC already has the lowest per capita emission in the country, with the average resident emitting just 1/3rd of the average American's GHG emissions. As per its business-as-usual scenarios, New York City is working ambitiously to reduce GHG significantly relative to the baseline year 2005. With a low carbon intensity scenario and the strategies outlined in the roadmap, the city seems to be on track to achieving its interim goal of reducing the emissions 40% by 2030 and reaching the long-term goal of reducing GHG emissions by 80% by 2050 (Fig. 10). The following are some of the key mitigation strategies included in the *Roadmap to 80 × 50* [36].

(i) ***Energy***: The main driver to GHG reduction in NYC is the ongoing shift to a cleaner electric grid due to a shift in power plant fuel sources from oil and coal to natural gas, which emit lesser GHG. This has spurred construction of new and efficient powerplants and improved operations. The NY state renewable energy targets mandate state utilities to meet at least half of their electricity with renewables by 2030. NYC is also increasing local renewables through photovoltaics, investing in solar energy on all city-owned buildings, and facilitating the same in private properties through group purchasing and community-shared solar PV projects.

(ii) ***Buildings***: 68% of NYC's total GHG emissions are from energy used to power, heat, and cool buildings (including power-generation). GHG reduction has

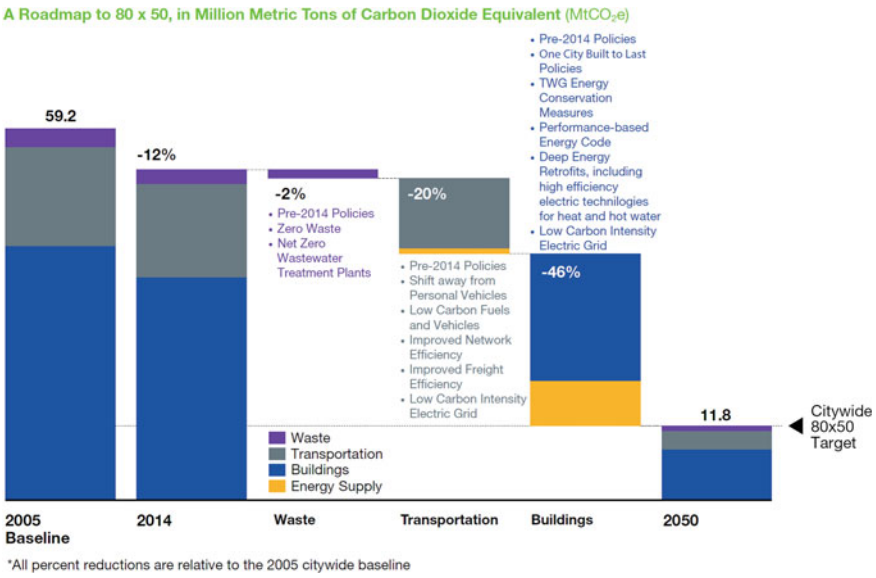

Fig. 10 Climate mitigation strategies, Roadmap to 80 × 50 [36]

been due to shifts to cleaner fuels, conversion to cleaner fuels from heating oils, and improving energy efficiency. Building emissions are mostly from use of natural gas and oil for heat and hot water and use of electricity from the central grid. The city is leading by example and retrofitting every city-owned building to reduce energy consumption, and installing solar energy equipment to achieve a 35% reduction by 2025. Since 2017, all new city buildings are being designed to consume less than half energy than before. The city has implemented policies to encourage or require private owners of large buildings to invest in energy efficiency and switch to cleaner energy sources by phasing out fuel oil and providing access to their energy data and needed efficiency improvements. These policies have helped achieve an 8% GHG emission reduction in large buildings, and about 6,000 buildings have converted to cleaner fuels through the NYC Clean Heat program. The city is working with thousands of property owners (NYC Retrofit Accelerator, Community Retrofit NYC, the NYC Benchmarking Help Center, and NYC Carbon Challenge) to implement energy efficiency projects and improve operations and maintenance. It is also updating building codes with more stringent energy efficiency and sustainability requirements, including the 2016 update to NY City Energy Conservation Code, which is expected to lead to 8.5% reduction in energy consumption of new commercial buildings and 25% reduction in residential buildings.

(iii) ***Transportation***: New York has an extensive public transit system with the highest percentage of transit commuters in the country. Currently, 90% of transportation emissions related GHG are still from on-road vehicles, a majority of which are personal vehicles. NYC is making transit, walking, and biking more accessible and has partnered with the state to increase bus speeds through the Select Bus Service, and expand transit systems like the subway to increase frequency, reliability, and efficiency. It is also investing in walking and biking infrastructure by adding bike lanes and is trying to make streets safer for pedestrians towards the goal of "vision zero." It has purchased over 500 electric vehicles as part of the city fleet through the NYC Clean Fleet initiative to reduce emissions. The NYC Department of Transportation (DOT) *Strategic Plan 2016: Safe·Green·Smart·Equitable* is committed to sustainable transportation, traffic safety, public health, and to increase transportation choices for people, as well as maintenance of roads and bridges and efficient parking management [38]. It aims to significantly reduce the number of vehicle miles driven and move people away from single-occupancy vehicles, while transitioning vehicle trips to electric and clean fuel vehicles.

(iv) ***Waste***: The goal is to achieve "Zero Waste" to landfills to reduce methane emissions from food and other organic matter, and from processing wastewater at the 14 treatment plants, which are together responsible for 4% of total emissions. This will be achieved by waste reduction, reuse, and recycling, and diverting organic waste from landfills to wastewater treatment plants for digestion and reuse. The strategies do not rely much on conventional waste-to-energy processing plants, instead focus on highest and best use of materials in

the waste stream. Curbside collection of organics has been expanded to over 70,000 households and in over 1,600 public housing buildings. The city has also made it easier for businesses to recycle, has enabled residents to opt out of unwanted junk mail, and reduce single-use plastic bags, coffee cups, water bottles, etc.

Many of these strategies will improve the quality of life and develop new industries with significant potential for job creation [36]. An expansion of renewable energy across the city will provide residents with more choices and enhance the resiliency of critical services in neighborhoods that are currently vulnerable to outages and weather impacts. Building retrofits will improve the quality of housing, and improved energy efficiency will help with keeping housing affordable. It is estimated that shifts to cleaner fuel in buildings will improve air quality, preventing over hundreds of premature deaths and hospitalizations every year. Neighborhoods with the highest density of boiler conversions experienced greatest improvement in air quality and health, often in vulnerable and poor areas. Lower energy costs will also help keep residential and commercial spaces affordable. Increased multi-modal cleaner transportation choices will improve air quality and public health outcomes and expand access to communities that lack them.

6.2 Climate Adaptation and Resiliency Planning

After hurricane Sandy devastated the New York metro region, The Sandy Recovery Improvement Act and the Disaster Relief Appropriations Act in 2013 (known as the Sandy Supplemental) authorized $60 Billion in funding to multiple agencies for relief and recovery. Hurricane Sandy Rebuilding Task Force (HSRTF) report recommended a multi-agency collaborative response, working with communities to rebuild better, bringing together stakeholders, and emphasized risk reduction to future threats exacerbated by climate change utilizing best data [39]. The NY Rising Community Reconstruction (NYRCR) Program provided $3-25 million in CDBG to 124 communities, and funded preparation of 66 participatory Community Reconstruction Plans, and over 1000 local resiliency projects [40].

Finn et al. [41] discuss the disaster recovery and resiliency-planning efforts in six post-Sandy recovery planning cases including New York City, Hoboken, Long Beach, and New Jersey. They find that jurisdictions that possessed significant planning expertise before the storm, and had existing plans and ongoing planning were better able to incorporate resiliency into their recovery process. They saw Sandy as an opportunity to improve urban resiliency and risk mitigation. For instance, even though NYC did not have a Comprehensive Land Use Plan prior to Sandy, it had a strong political will as multiple long-term planning initiatives, including the *PlaNYC 2030* sustainability plan [16, 17] as well as establishing the NPCC in 2008.

New York City also has a new web-based Hazard Mitigation Plan that mandated and approved by FEMA [42]. The 2019 plan identifies the specific hazards that has the

potential to affect the communities, evaluate the vulnerability of the community, as well as best practices and city-specific strategies for managing these hazard risks. The hazards identified are coastal erosion, coastal storms, flooding, thunderstorms, winter storms, tornadoes, windstorms, drought, earthquakes, extreme temperatures, wildfire, CBRN (chemical, biological, radiological, and nuclear), cyber threats, infrastructure failures, and interestingly, "respiratory viruses and emerging diseases with pandemic potential." The plan consists of five goals and 28 related objectives for minimizing the effect of natural and non-natural hazards. A majority of the mitigation projects for the protection, coping mechanisms, and disaster risk reduction projects dealing with coastal storms and flooding.

6.2.1 Increasing Resiliency of Critical Infrastructure

New York City's commitment to climate resiliency was evident prior to hurricane Sandy. In 2010, NPCC developed a risk management approach, Flexible Adaptation Pathways, which was influenced by adaptation planning for the Thames Barrier in London. NPCC's approach acknowledged the uncertainties of future climate risks and encouraged a "dynamic sequence of analysis and action followed by evaluation, further analysis and refinement" [28, 30]. NPCC worked in collaboration with various stakeholders in the city to develop this approach, and included both adaptation and mitigation strategies within their short and long-term goals [28, 31, 43].

NPCC [30] applied advanced modeling techniques to identify existing and future climate risks for the coastal areas in NYC. As per NPCC's documentation, coastal hurricanes and nor'easters pose serious storm surge, flooding and wind damage challenges. While hurricanes are less frequent than nor'easters, they cause larger storm surges and damages; nor'easters however cause extended duration of flooding, storm surges and high wind speed. A major portion of NYC's built environment and infrastructure is located less than 10ft above mean sea level, making these extremely vulnerable to inland and coastal flooding during storm surges [28, 30, 31, 43]. While the current sea level rise, ranging between 0.86 and 1.5 inches per decade, may seem manageable for adaptation planning as of now, unpredicted changes in sea level rise due to land-based ice melting in Greenland and the Arctic may pose severe planning challenges in the future.

NPCC's documentation of sea level rise and past coastal storms was used by the Task Force to create inventories of assets and infrastructure, assess their risks to climate change, and develop strategies for adaptation. The Flexible Adaptation Pathways focused on a risk-management approach that is flexible, dynamic and evolves over time. Permanent and inflexible approaches to climate resiliency strategies may lead to more expensive strategies that can become less effective in the long run. The "flexible" approach included an 8-step assessment process (Fig. 11 below) that identifies existing and future hazards, creating inventory of assets, identify risks to infrastructure, develop adaptation strategies, identify coordination opportunities, linking capital and rehabilitation cycles, implement adaptation plans, and finally continue monitoring and reassessment processes [30, 31].

Fig. 11 Flexible Adaptation Pathways: 8-step assessment [30]

Hurricane Sandy became a major tipping point for adaptation planning in New York City. In 2012, Mayor Bloomberg's office formed the second New York City Panel on Climate Change (NPCC2) and formulated a Special Initiative for Rebuilding and Resiliency (SIRR). The NPCC2 further progressed with the early NPCC initiatives and applied advanced modeling techniques to create risk maps for the city. The goal of NPCC2 and SIRR was to protect the critical infrastructure of the city and the vulnerable communities from future storm surges and sea level rise. Their strategies included a wide range of approaches – both short and long term, mostly in the areas of green infrastructure development and implementation of strong building standards, codes and other regulations [43].

The SIRR report [44] established various adaptation strategies and measures to protect the city's vulnerable communities. A combination of building technologically advanced and manmade devices, such as floodwalls, tide gates, reinforced bulkheads, off-shore breakwaters, as well as building natural areas such as expanded green infrastructure, restoring and developing wetland areas, developing sand-filled beaches and dunes, were outlined as critical measures for protection of coastal communities in NYC. In addition, protection of the critical infrastructure was further emphasized from the earlier plans from NPCC.

(i) ***Transportation***: NYC's rail transit system is the largest in the US. Seven local and regional transit systems, NYC transit has more 660 miles of track, Metro-North has 775 miles track, Long Island Railroad 594 miles, PATH has 43 miles, NJ transit has 643 miles. A majority of the tracks which are underground are vulnerable to flooding, particularly public entrances and exits, ventilation facilities, and manholes. Some of the tracks and stations are as low as 180 ft below sea level and some are as high as 91 ft above sea level. Heavy precipitation has led to outage of the subway system in the past. While it is extremely difficult and expensive to relocate or retrofit many of these structures, a number of adaptation strategies included elevating, flood-proofing and adding heat-resistant materials to the existing structures. Since 2010 some existing facilities have been retrofitted even though they were time and resource consuming.

(ii) ***Water & Waste***: New York City's water supply system has historically been one of the most advanced systems in the world since the industrial era. A significant amount of the city's water is acquired from the Delaware and Catskill watersheds and distributed throughout the city through an elaborate network of dams, aqueducts, distribution pipelines, pumping stations and other facilities. It also includes the 14 Water Pollution Control Plants (WPCPs), which were built and upgraded throughout the 20th century involving multi-billion-dollar investments and have the capacity to treat 1,805 million gallons of water daily [45]. Some of these WPCPs are located in high-risk zones prone to flooding. All of the wastewater treatment plants in New York are located along the city's shoreline in the lowest possible elevation above sea level, as they are intended to discharge into the waterbodies. Some of the existing solid waste facilities, including closed landfill sites, are also located in low-lying areas that are prone to flooding, and with rising sea levels inundations in these areas could potentially lead to contamination of water bodies.

NYCDEP's Climate Change Program developed a comprehensive framework for climate change analysis and incorporated a range of tools for adaptation, management, monitoring as well as decision-making processes regarding water infrastructure investments and policy changes. One of the key adaptation strategies of the Climate Change Program includes infrastructure investments in form of storm surge barriers and flood walls that can protect the city's WPCPs and other wastewater treatment plants. The program also proposed relocation of the city's emergency pumping stations and sewer system changes, and increasing pumping capacities as a response to sea level rise and storm surges. Starting in 2010, NYCDEP approximately allotted a decadal budget of $20 billion to maintain its water supply-related infrastructure. In addition, NPCC outlined specific adaptation strategies that included leak repairing in the water supply pipelines to prevent saltwater entry into the system and efficient functioning of the tide gates, were proposed for the WPCPs of the city that discharge into the Estuary. Another key strategy was a greenhouse gas (GHG) management program to assess present emission levels using software to assess emissions from electricity and natural gas consumption. NYC's

WPCPs were identified as the major emitters within NYCDEP system and therefore, GHG Management Plans were formulated for the WPCP facilities.

(iii) ***Energy***: There are about 24 powerplants operating within NYC limits of varying sizes and operational capacities, with multiple owners and operators. Powerplants have traditionally been located close to shorelines or waterfronts as they require easy access to water for cooling purposes, and especially many structures within powerplants (e.g. water intake structures and cooling-water discharges) are located in high-risk zones prone to flooding. Majority of the powerplants in New York are therefore vulnerable to both inland and coastal flooding. In addition, networks of transmission and distribution lines that are distributed throughout the region are also prone to damage during storms and flooding. Adaptation strategies for these energy sources include a combination of storm surge barriers, flood walls and reclaimed natural barriers, such as wetlands, beaches and sand dunes. In case the sea-level rise happens at a rapid pace, many of these hard structures need to be elevated over time. Shoreline armoring strategies such as building of seawalls, groins, jetties, breakwaters, bulkheads, piers and other forms of shore protection that can interrupt the wave energy and reduce their energy are deemed essential adaptation strategies for protection of these structures from flooding and storm surges.

(iv) ***Communications***: The communication infrastructure in New York includes complex networks of voice lines, fiber optic cables, data circuits, switching stations, backbone structures, domain name servers, cell towers, telephone lines (landlines), televisions, and radios. Many private communication companies are service providers in the city. Some of these networks of hard infrastructure are vulnerable to flooding, particularly those located in low-lying areas. Again, combinations of multiple adaptation measures are required to protect these infrastructure network over time.

Various adaptation planning reports from public agencies in New York metro region establish that in the short-term the city may be able to protect itself from storm surges with combination of flood walls, shore armoring, and reclaimed natural barriers measures, as well as effective storm forecasting and information systems that focus on efficient communication among the public and private stakeholders responsible for managing the city's critical infrastructure. However, higher risks during the latter part of the century may necessitate more expensive and technologically advanced systems, such as storm-surge barriers. The New York Harbor Storm Surge Barrier has been proposed for a long time; nevertheless, such systems may not be full proof as they can only protect parts of the New York metro region and may not protect communities again wind and rain. Equal emphasis should be on reclamation of natural barriers, such as wetlands, beaches, sand dunes, oyster reefs, restoration of natural drainage corridors, preservation of ecosystems that are capable of storing and filtering stormwater, as well as preservation of open space and diverse wildlife habitat areas. Examples of innovative programs, such as the *Billion Oyster Project* restoring the oyster reefs in New York harbor area, are garnering attention and public enthusiasm. It is focused on rebuilding the lost oyster reefs in the harbor through

public education, participation from students, volunteers and partnership with other community members [46]. Oyster reefs are crucial natural habitat below sea that are known to reduce the impacts of storm surges, and such cost-efficient natural measures as these are important for promoting overall sustainability and resiliency goals of the city.

6.2.2 Zoning and Building Code Improvements for Increasing Resiliency

New York City's floodplain areas (1% or 0.2% annual chance of flood, also known as 100- or 500-year floodplain) are designated on FEMA's Flood Insurance Rate Maps (FIRMs) and Preliminary Flood Insurance Rate Maps (PFIRMs). In 2015 FEMA prepared updated PFIRMs placing 782,800 buildings in 100- or 500-year floodplain [47, 49]. The updated PFIRMs are currently set to be adopted in 2024. Soon after hurricane Sandy, the NYC Department of Buildings implemented emergency building codes in 2013 to include flood resistant construction, wind and wind-driven rain resistance, making building codes consistent with FEMA's National Flood Insurance Program (NFIP) requirements [48]. These updates incorporate flood resistant construction standards and zoning amendments, and are known as 2013 Flood Text and the 2015 Recovery Text. The 2013 Flood Text suspended height restrictions in FEMA-compliant buildings, establishing new datum line to measure heights based on freeboard requirement, allowed mechanical equipment and flood barriers on roofs, and modified FAR calculations to allow staircases [41, 49]. The *Build It Back* program effectively used the 2013 Flood Text and the 2015 Recovery Text to elevate and rebuilt approximately 8,300 properties of 1-4-unit buildings to flood-resistant construction standards.

There is considerable mismatch between the flood resistant construction standards and the current zoning requirements [49]. The 2013 Flood Text limits investments in resilient building, as it does not provide enough flexibility in the building envelope. For instance, minimum design for 100-year (1% annual chance) floodplain requires the first occupied floor to be above the DFE,[1] but the maximum flood insurance premium reduction is usually achieved when it is 4' above the BFE.[2] 40% of all single- and two-family homes in the city's floodplain are either attached or semi-detached buildings (sharing common walls with neighbors), adding structural and regulatory retrofit challenges. Given the height restrictions, homeowners in areas with BFEs lower than 4' above grade may not be able to raise living spaces above DFE, making retrofits unfeasible since it will require additional floor construction to relocate uses from the lower floor, but that would exceed the permissible height

[1] Design Flood Elevation (DFE) is the minimum elevation to which a structure must be elevated or flood-proofed, determined by adding freeboard (additional height for safety depending on the use occupancy type) to the BFE as determined by flood-resistant construction standards.

[2] Base Flood Elevation (BFE) is the elevation to which floodwater is anticipated to rise during a 1% annual chance storm as shown on FEMA's FIRMs and PFIRMs, as measured from sea level.

[49]. Besides numerous zoning conflicts, retrofitted buildings can create undesirable streetscapes due to inconsistent building forms and heights. They create blank walls at the sidewalk level, which is inconsistent in commercial areas that require transparent storefronts. In industrial areas, zoning does not allow relocation of important equipment or installation of backup systems on rooftops or in new structures. Further, 85% of 1-3 family homes in the NYC floodplain have basements/cellars that increase flood vulnerability, and only 18% were built after 1983 when the City first adopted FIRM and flood-resistant construction standards (Fig. 12).

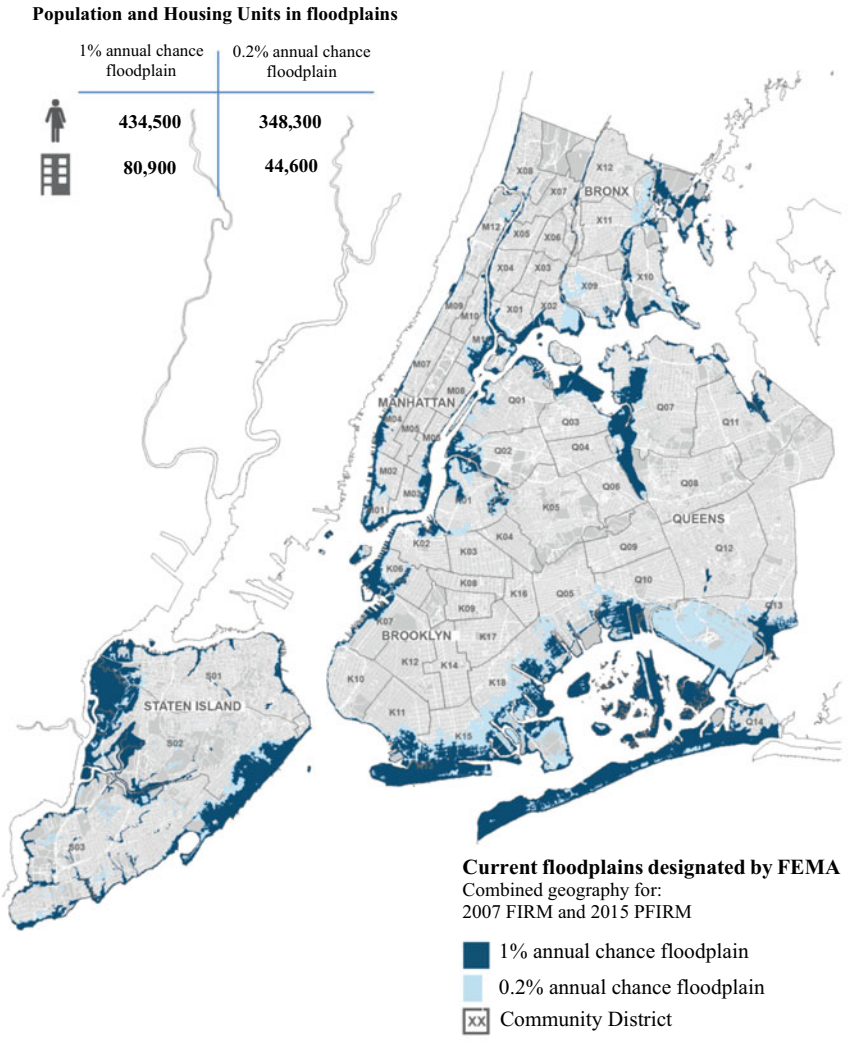

Fig. 12 1% and 0.2% annual chance floodplain [49]

As per 2007 FIRM maps, about 15% of the city area falls under 100-year floodplain, and an additional 4% of the area is under 500-year floodplain. Over 400,000 people live within the 100-year floodplain and over 780,000 people are in the 500-year floodplain. By 2050, the 100-year floodplain is projected to cover a quarter of the city's land area, which resembles current 500-year floodplain area, affecting approximately 794,500 residents and 122,100 buildings [49, 50]. The 2013 Flood Text expired in July 2020, and the 2015 Recovery Text is set to expire 1 year after updated preliminary FIRM maps are adopted (which is set for 2024). Therefore, New York City has recently approved new *Zoning for Coastal Flood Resiliency* to reduce damage from future floods, guide long-term resiliency in the city's current and future floodplains, reduce regulatory obstacles, save on flood insurance costs, and encourage building owners to invest incrementally in adaptation and resiliency improvements [49]. The new rules sapply to both 100- and 500-year floodplains. The city is also contemplating varying population density based on varying risks of flooding in different parts of the city. The zoning may limit density in neighborhoods with higher coastal risk and encourage density and construction of resilient building in areas equipped to manage flooding through coastal protection and infrastructure improvements.

A recent IBHS report assessing the building code system of 18 coastal states found that State of NY lags behind other states [47]. The State of NY ranked 12th, scoring 64/100, while New Jersey scored 90/100, ranking fourth. The main issue is that State of NY lacks state-mandated certification and licensing program for construction trade contractors (general, building, plumbing, electrical, roofing, electrical), leaving it to local jurisdictions. Moreover, while it does have a mandated program for certification of building officials, it does not require continuing education on the residential code [47]. The current New York City building code of 2014 also lags on international standards, based on the outdated 2009 International Building Code (IBC). By contrast, the current 2020 Building Code of New York State is based on the 2018 IBC. One recommendation is to incorporate the most recent disaster-resistant International Building Code (IBC) and the International Residential Code (IRC) as effective methods to ensure new and rebuilt structures be built to higher standards [39]. Another suggestion is to adopt the *Fortified for Safer Living* standard for rebuilding stronger buildings, which is a higher engineering and building standard for both new and existing structures than the minimum building code in order to reduce damage during hurricanes due to high winds.

6.2.3 Equity and Affordability for Increasing Resiliency

Post hurricane Sandy, the Mayor's office also increased their emphasis on equity and affordability goals to achieve resiliency in the city. The SIRR outlined specific strategies in the 2013 report to address affordable insurance [44]. With future projections of flood and sea level rise risks, the need for improved and more affordable insurance programs, specifically for a majority of the low-income population, was realized by the city. Hurricane Sandy triggered a huge debate in the US around

coastal flood insurance coverage provided by the private market and the increased cost that is involved, and more specifically, this issue received wider attention in NYC after Sandy. The SIRR's adaptation measures for high-risk communities also guaranteed significant reduction in flood insurance premiums and reduced uncertainty in insurance coverage for vulnerable communities under high-loss scenarios [43, 44].

While adaptation measures increase resiliency, they might also have some adverse impacts, which compromise the overall equity and affordability goals for the city. Particularly, the housing price impacts of these adaptation measures are notable for the low-income and minority populations. Kim [51] found that hard infrastructure for climate protection, e.g. flood walls, shore armoring, elevation of building structures, as well as green infrastructure and natural barrier development projects, have increased housing prices as they ensure better climate protection. A strong impact of private adaptation measures in individual structures and buildings was also observed. While adaptation planning strategies and implementation may have increased resiliency in New York, these housing price impacts illustrate that the city's response towards equity and affordability have not been addressed adequately. It further stresses the need to integrate regulatory measures to address housing price and rent increases within adaptation and mitigation planning.

7 Conclusion

The New York metro region is one of the oldest megacities in world, maintaining a population of more than 10 million since the 1950s, as well as a stable, growing, and diverse population. The city has also long dominated the world economy and consistently ranked as an alpha+ + city by Globalization and World Cities Research Network (GaWC) [52]. New York has many strengths: it headquarters several internationally reputed specialized service firms, has a high concentration of global elites and wealth, has undertaken iconic redevelopment projects with access to funding, and exemplifies strong diversity and a vibrant street culture. It is home to world-known academic institutions, is considered a global leader in the visual arts, theatre markets and creative activity, and boasts a strong and visionary planning leadership which has committed to the goals of the Paris Agreement.

At the same time, the region faces many weaknesses, such as dilapidated neighborhoods in the inner-city areas, gentrification resulting from urban renewal projects, lack of access to economic opportunities for the poor and racial minorities, and deteriorating public infrastructure. These present opportunities for the region to focus on sustainable urban development projects, embrace emerging innovations in smart and green buildings, urban agriculture, undertake planned infrastructural improvement projects, apply new Climate Resiliency Design Guidelines [20], and implement projects for climate mitigation and adaptation. The region will need to be careful to address threats such as increasing real estate prices and rents that impact housing

affordability, homelessness and poverty, racial and ethnic segregation and inequality, as well as increasing trends of natural disasters such as flooding and hurricanes.

The recent initiatives of adaptation and resiliency planning in the New York metro region, as well as New York City, demonstrates strong political and community will to build a resilient city. This megacity has indeed demonstrated many success stories with its recent plans, policies, and programs to address various challenges. However, maintaining continued economic growth and building an inclusive economy for all (challenges for economic sustainability), gentrification, homelessness, racial and ethnic segregation, inadequate affordable housing (challenges for social sustainability), hurricanes, flooding, and natural disasters (challenges for environmental sustainability) remain significant concerns for the entire region. Gaps and mismatches between existing regulations and proposed strategies continue to persist. To what extent, and how efficiently the city can address these challenges will determine the success and sustainability of the city in the decades to come.

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Hongkong-Shenzhen

Towards a Smart Megacity: Hong Kong and Shenzhen

Sujata S. Govada, Hei Lau, and Suhasini Kotala

Abstract The Pearl River Delta in Guangdong province of China contains some of the fastest growing cities in the world. Enjoying locational advantage as a gateway to China, the cities in the region favor the biggest investments, trade and growth. Having long been a transshipment port in its colonial period, Hong Kong grew rapidly between the 1960s and 1990s with development of industry and manufacturing, and established itself as an international financial hub. Just across the border, Shenzhen experienced exponential growth since its designation as a Special Economic Zone (SEZ) in 1980 as a result of China's economic reform and "open door" policy starting in 1978, attracting Hong Kong and foreign investments that enabled the development of its manufacturing sector and more recently its tech sector. Instead of competing with each other, as neighboring cities Hong Kong and Shenzhen can be viewed together as a megacity within the **Guangdong-Hong Kong-Macao Greater Bay Area** (GBA). With their complementing population, skills and economy, the integration towards a megacity with smart thinking would bring greater synergies and benefits to the two cities. This section assesses the two cities with the Smart and Sustainable City Framework and examines how Hong Kong and Shenzhen viewed together as a smart megacity would benefit both cities and is better for the people as well and could also help drive the smart and sustainable development of the GBA. Following the assessment and analysis, suggestions as to how the two cities can collaborate further on various aspects including physical, socio-economic, environmental, community and administrative integration are also addressed briefly. As the "one country, two systems" of Hong Kong as a Special Administrative Region

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(SAR) of China is set to expire in 2047, the integration will not only result in more collaboration between the two cities, but a much smoother transition after 2047.

Keywords Smart and sustainable city framework · Megacity · Hong kong · Shenzhen · Greater bay area · Guangdong province · Smart living · Smart environment · Smart mobility · Smart infrastructure · Smart governance · Smart economy · Collaboration and integration

1 Introduction

Hong Kong and Shenzhen are two neighboring cities located in Southern China, both having started as small fishing villages. Hong Kong has long been a global world-class city with unique political history whereas Shenzhen has transitioned over the last 40 years since the designation as a Special Economic Zone (SEZ) in 1980 to one of the most economically competitive cities in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA). The GBA was formally formed when the National Development and Reform Commission and the governments of Guangdong, Hong Kong and Macao signed the Framework Agreement on deepening Guangdong-Hong Kong-Macao Cooperation in the Development of the Greater Bay Area on 1 July 2017. It comprises the two Special Administrative Regions of Hong Kong and Macao, and the nine cities of Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen and Zhaoqing in Guangdong Province in Southern China.

Both Hong Kong and Shenzhen started as small fishing villages and their history has been interwoven with each playing different roles since the opening up of China, where Hong Kong was the "shop at the front" and Shenzhen the "factory at the back". However, over the years the roles have evolved as Shenzhen has grown into the "Silicon Valley" of China, while Hong Kong remains an international city and key financial hub in the region. The timeline below highlights some of the key events of Hong Kong and Shenzhen over the course of their development. Having different background and roles, Hong Kong and Shenzhen can collaborate and work together continue to build on their strengths and opportunities, and address their weaknesses and threats complementing each other and double up on their unique locational and context advantages. By working closely together, Hong Kong and Shenzhen can form a smart megacity and address critical urban issues while creating new opportunities for economic development and offer a better quality of life for the people in both cities. The Smart and Sustainable City Framework is used to assess Hong Kong and Shenzhen as a smart and sustainable city and suggest ways to integrate these two cities to form a Smart Megacity (Fig. 1).

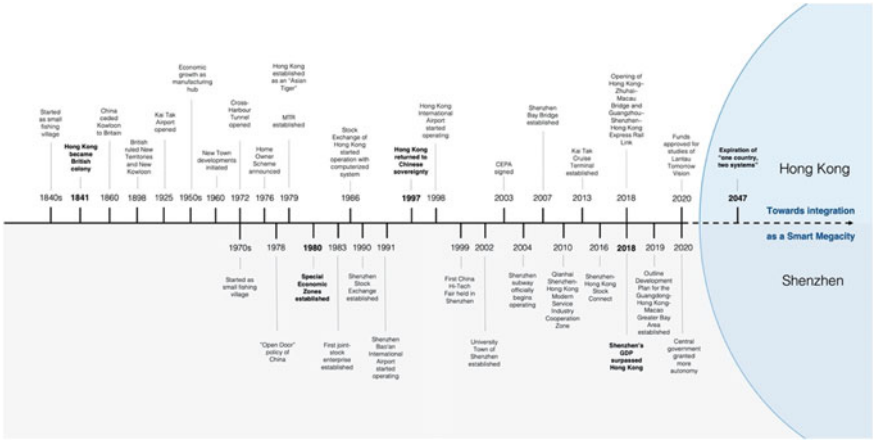

Fig. 1 Development timeline of Hong Kong and Shenzhen. *Source* ISU/UDP International

1.1 Hong Kong

Hong Kong is a Cantonese speaking metropolitan area on the eastern Pearl River Delta of the South China Sea. As part of its colonial heritage, English is also widely used and is an official language alongside Chinese. The name of "Hong Kong", meaning a "fragrant harbor", came from the fragrant wood products and incense that were once traded here. Geographically Hong Kong is divided into three territories: namely, Hong Kong Island, Kowloon and the New Territories. Hong Kong is a coastal city and major port in Southern China, bordering Guangdong province through the city of Shenzhen to the north and the South China Sea to the West, East and South. Hong Kong's climate is subtropical with monsoons, cool dry winters, hot and wet summers.

Hong Kong was a British colony from 1841 to 1997. Following the Sino-British Joint Declaration of 1984 which agreed the "one country, two systems" principle, Hong Kong was handed over to China in 1997. Hong Kong is set up as a Special Administrative Region (SAR) of the People's Republic of China governed under the principles of "one country, two systems", "administration of Hong Kong by the Hong Kong people" and "a high degree of autonomy" since the handover in 1997. Under the "one country, two systems", the mainland Chinese government which practices socialist system promises Hong Kong's capitalist system and way of life to remain unchanged for 50 years till 2047.

The area of Hong Kong is 1,111 km^2, of which only about 25% of land is built up urban area accommodating over 7.5 million population and about 42% of land is country parks or protected areas for statutory protection of flora and fauna. As shown below, grassland, woodland, shrubland and agricultural land make up the remaining land which is almost 75% of the total land (Fig. 2).

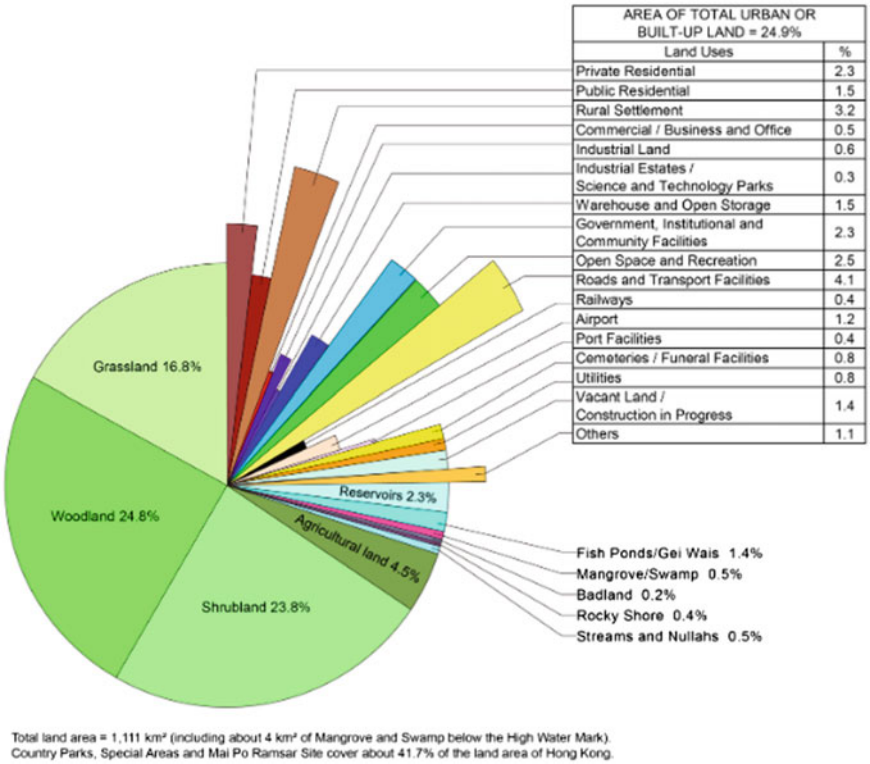

Fig. 2 Hong Kong Land Use, 2019. *Source* Hong Kong planning department

Hong Kong's population is about 7.5 million in mid-2020 with a population density of 6,940 persons per sq. km in 2019 according to Census and Statistics Department of Hong Kong. Hong Kong has a generally well-educated population with majority of the population attaining secondary education or above. A large portion of the younger population aged between 20 to 40 has post-secondary education attainment. Nevertheless, Hong Kong has a problem of an ageing population with a largest population group aged between 50 and 59 and declining fertility trend. According to the Census and Statistics Department of Hong Kong, the median age of the population is 43.4 as at 2016 (Fig. 3).

Hong Kong's tourism plays a key role in the city's economy, with about 50-60 million tourists arriving in Hong Kong each year which is significantly impacted due to the recent protests and the current COVID-19 situation. Victoria Harbor is a key natural asset of Hong Kong with high density compact development on either side with the mountain backdrop. From Victoria Peak local people and tourists get a stunning view of the city and Hong Kong's distinct skyline viewed across the harbor from Kowloon, and the serene Lantau Island for its natural beauty, also known as 'the lungs of Hong Kong'. Shopping is one of the top tourists' attraction, along with

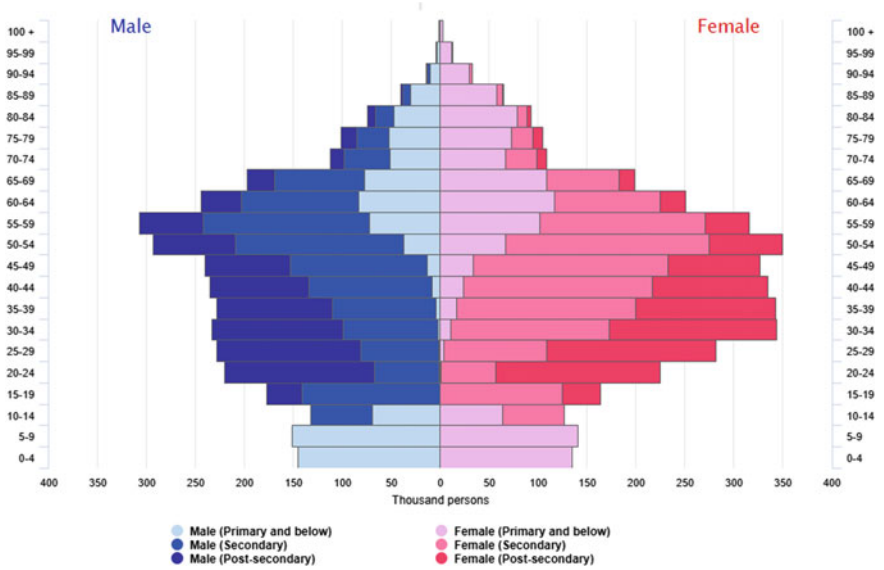

Fig. 3 Hong Kong population pyramid and highest education attainment, 2016. *Source* Hong Kong census and statistics department

Disneyland, a more recent attraction that is a child's dream destination. Ocean Park is another theme park that is home to exotic marine animals and rides in a natural mountain setting. Temples and structures such as Tian Tan Buddha, Po Lin Monastery and Man Mo Temple and the traditional street markets and Dai Pai Dongs represent the spiritual and cultural side of Hong Kong. Repulse Bay among other beaches is famous with beautiful views and a great place to be, with soft-sand beach lined with trendy restaurants and shops. Besides Peak, Repulse Bay is also one of the most expensive housing areas in Hong Kong (Figs. 4, 5 and 6).

Over recent years, there has been an increase of tourists from mainland China than other regional or international cities. In 2019, about 78% of visitor arrivals were from mainland China according to the Hong Kong Tourism Board. Hong Kong hosts a number of events throughout the year that are attracting visitors from around the world. The government claims that Hong Kong is Asia's World City and an Events Capital of Asia. A major port and shopping hub, Hong Kong is one of the best places to buy electronics, fashion, watches, and jewelry. The malls in Central as well as shops in Tsim Sha Tsui and Causeway Bay are major shopping destinations.

Hong Kong's territory is divided into 18 districts, each represented by a District Council. There are 4 districts in Hong Kong Island, 5 districts in Kowloon and 9 districts in the New Territories. The main urban areas are located in districts in Kowloon and Hong Kong Island, with some New Towns located in the New Territories (Fig. 7).

Fig. 4 Skyline of Hong Kong Island viewed from Kowloon. (Photo Credit: Hong Kong Tourism Board)

Fig. 5 Dai Pai Dong in Hong Kong (Photo by Wing/CC BY 3.0)

Fig. 6 Tourist Arrivals in Hong Kong, 2013–2019. *Source* Hong Kong tourism board

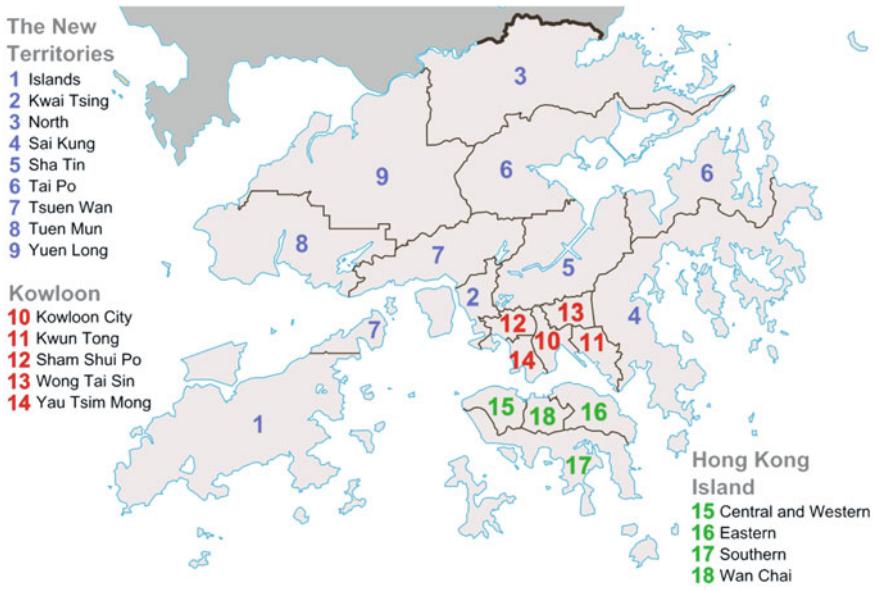

Fig. 7 Administrative divisions of Hong Kong

1.2 Shenzhen

Shenzhen is situated in southeastern part of China. It is a modern metropolis that links Hong Kong, separated by a river and border, to China's mainland. Less than 40 years ago Shenzhen was a small fishing village and swamp, and now it is one of the China's

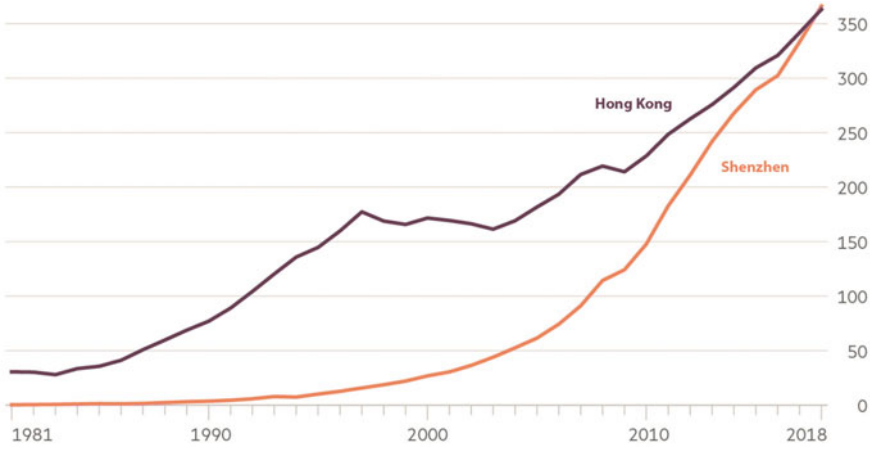

Fig. 8 GDP (in billion USD) of Hong Kong and Shenzhen, 1981–2018. *Source* National Bureau of Statistics of China, Census and Statistics Department of Hong Kong, Financial Times

biggest cities and major gateway city for foreign travelers. In 1980, Shenzhen was established as one of the China's first Special Economic Zones (SEZs) which had since attracted a growing amount of investments from Hong Kong. Shenzhen's rapid development is a result of Hong Kong's investments with its manufacturing industry moving across the border and a vibrant economy through foreign direct investment (FDI) followed by policy of "reform" in 1978. The city has done an economic miracle as seen in its exponential growth of GDP over the 40 years which surpassed Hong Kong in terms of total GDP in 2018 (Fig. 8).

The city is now a leading global technology hub, dubbed as China's Silicon Valley. It is home to some of China's biggest companies, including Huawei, Tencent, BYD, DJI, among others. Shenzhen has transformed into a super modern urban hub with modern public transport network including metro, rail and buses. Shenzhen is one of China's major ports for foreign trade and international exchanges. Many large events including China Hi-tech Expo are held in Shenzhen every year.

Spatially, Shenzhen is a long and narrow city, and is 81.4 km from east to west with the narrowest section from south to north being 10.8 km. The city stands against mountains and faces the sea and has an extensive coastline to the south, east and west of the city. The winding Dapeng Bay has a coastline of more than 70 km, linking Great Meisha, Small Meisha, Xichong, Diefu, Shuishatou and Xiyong snowy beaches together.

The area of Shenzhen is 1,997.47 sq. km after several expansions. In 2020, the "agricultural land" (including farmland and forest) accounts for 45% of total land area in Shenzhen and "construction land" shown as red in the following figure accounts for the other 48%. The remaining 7% of land is reserved for future city growth.

Shenzhen's topography is undulating with the occasional plain with the land elevation declining from the southeast to the northwest. The western part of Shenzhen

comprises coastal plains, and account for 22.1% of the city's total area. Wutong Mountain, with an altitude of 943.7 m, is the city's highest peak. The coastline of the city is 229.96 km long. Deep-water ports have been built at various locations in the city. In the east lie the popular beach resorts of Dameisha, Xiaomeisha and Dapeng Bay. To the west lies Inner Lingding Island, a nature reserve and a water resort.

There are more than 160 rivers and streams in the city, but only five of them have drainage areas larger than 100 km^2. They are Shenzhen River, Maozhou River, Longgang River, Guanlan River and Pingshan River. There are 24 reservoirs in Shenzhen, with a total volume of 525 million cubic meters. The annual average volume of usable underground water is 650 million cubic meters. Shenzhen Reservoir to the east of the urban district has a total volume of more than 40 million cubic meters and is one of the main sources of water for Shenzhen. The city's fresh water resources are 1.93 billion cubic meters, and water consumption is only 500 m^2 a year per capita, accounting for one-third of the nation's average and a quarter of Guangdong Province's average.

Shenzhen is a newly-rising tourist city. Shenzhen's tourist attractions range from the cultural sites, natural landscape to theme parks. Major scenic spots such as Deng Xiaoping Statue and Lotus Hill Park offer panoramic views of the city center. To the west of downtown is Nanshan District, with famous theme parks like Happy Valley, Splendid China Folk Village, Window of the World, Wildlife Park, etc. Natural landscapes such as Wutong Mountain and Dameisha Beach are located in the east side of the city. The new city architecture is also part of its tourist scene of Shenzhen. Among the skyscrapers in Shenzhen, the Ping An Finance Center stands at 600 m with 116 floors and is considered to be one of the tallest office building complexes in Shenzhen, the second tallest building in China and 4th tallest building in the world (Fig. 9, 10, 11 and 12).

There are 6 administrative districts and 4 new districts in Shenzhen. The administrative districts include Futian District, Luohu District, Nanshan District, Yantian District, Baoan District and Longgang District; the new districts include Guangming New District, Longhua New District, Pingshan New District and Dapeng New District (Fig. 13).

Futian District, Luohu District, Nanshan District and Yantian District are the busiest areas in Shenzhen, and they are adjacent to Hong Kong. Travelers can easily get to Hong Kong through the border crossing checkpoints in those districts; main attractions in Shenzhen are sited in those districts as well. Adjacent to Hong Kong, Luohu is the financial and trading center of Shenzhen. Futian, at the heart of the SEZ, is the seat of the Municipal Government. West of Futian, Nanshan is the center for high-tech industries. Formerly outside the SEZ, Bao'an and Longgang are located to the north-west and north-east, respectively, of central Shenzhen. Yantian is the location of Yantian Port, the second busiest container terminal in mainland China and the third busiest in the world.

Shenzhen's rapid development is coupled with its exponential increase in the population. Official data reported more than 41 times increase in total population since 1979, from over 300,000 to about 13 million in 2018. It is also evident that many were attracted by the city's rapid development and opportunities, with 65%

Fig. 9 Splendid China Folk Village (Photo by chensiyuan CC BY-SA 4.0)

Fig. 10 Happy valley (CC BY-SA 3.0)

Fig. 11 Ping An Finance center (CC0)

Fig. 12 Shun Hing square (Photo by Kyman Cheng CC BY-SA 3.0)

Fig. 13 Administrative divisions of Shenzhen

Age Group	Population (approx.)	Share
0-17	1,953,600	15.60%
18-64	10,163,700	81.16%
65 or above	405,900	3.24%

Fig. 14 Shenzhen population by Age Group, 2017. *Source* Statistics Bureau of Shenzhen Municipality

of Shenzhen's permanent population being non-registered (i.e. non-locals without Shenzhen *hukou*) in 2018. As of 2018, Shenzhen has a large employed population of 10.5 million, of which 53.5% were self-employed individuals. The population density of Shenzhen was 6,484 people per sq. km in 2018, with Futian (20,769 person/sq. km), Luohu (13,205 person/sq. km), Longhua (9,527 person/sq. km) and Nanshan (7,965 person/sq. km) being the most crowded districts (Fig. 14).

With Shenzhen's offering from many tech companies and manufacturing industries has attracted a large group of younger jobseekers, the city is dominated by working-age population (81.16% in 2017) with low a ratio of senior citizen (3.24% in 2017). The main labor force aged 15 to 44 accounted for 76% of the total population in 2017 [1]. Currently in 2020, the median age of Shenzhen is only 33 years old, making it one of the "youngest" cities in China.

2 Assessing Hong Kong and Shenzhen

Hong Kong and Shenzhen are neighboring cities in Pearl River Delta with well-connected and convenient transportation network within and across through several border crossing points. When the mainland government designated Shenzhen as the country's first SEZ in 1980, the economies of the two cities have been intertwined with Hong Kong being instrumental in Shenzhen's transformation with the manufacturing industry from Hong Kong moving over to Shenzhen. Shenzhen's rapid economic development has also been spurred by its proximity to Hong Kong's access to foreign

capital, technology and talent. Hong Kong has been the largest source of foreign direct investment (FDI) for Shenzhen, and even mainland China. Official data reveals that Hong Kong accounted for 54% of mainland's total FDI in 2018 and up to 76% of utilized FDI in Shenzhen in 2019. Hong Kong also plays an important technology marketplace for China as it was the 8th largest source of technology imports which accounted for 2.4% of the total contract value in 2017. The close trading relationship between Hong Kong and Shenzhen is also signified by the total value of import and export which amounted to RMB645.89 billion in 2019.

Despite long been the follower of Hong Kong, Shenzhen surpassed Hong Kong in terms of GDP in 2018 for the first time, thanks to its booming tertiary sector in particular the growth of its high-tech industry. Both the cities are considered as major economic power houses within in the GBA where Hong Kong and Shenzhen account for 21.8 and 23.2% of the total GDP of the GBA respectively in 2019.

The two cities are on the same level in various aspects with Shenzhen quickly catching up. Apart from total GDP, Shenzhen has similar port cargo throughput as Hong Kong in 2019. Nevertheless, Hong Kong still holds advantages in terms of GDP per capita, value of merchandise trade as well as air passenger throughput. The industrial structure of Shenzhen also sees it moving away from the "factory" at the back of Hong Kong to a more service-led and innovation-driven city with a larger tertiary sector; whereas Hong Kong has completed its transition to service economy with more than 90% of its GDP generated from the tertiary sector (Fig. 15).

Given its population of over 13 million Shenzhen can be classified as a mega city on its own right. However, aside from the large population formed by mainly immigrants who were attracted by opportunities in Shenzhen, the role of Hong Kong

	Hong Kong	**Shenzhen**
Area	1,107km^2	1,997km^2
Population	7,520,800	13,438,800
GDP	HK$2,865.7 billion	RMB2,692.7 billion
GDP per capita	HK$382,000	RMB204,000
Value of total merchandise trade	HK$8,404.1 billion	RMB2,977.39 billion
Value of export	HK$3,988.7 billion	RMB1,670.9 billion
Value of import	HK$4,415.4 billion	RMB1,306.49 billion
Industrial structure (% of GDP) *2018 data	Primary industry: 0.1%* of GDP	Primary industry: 0.1% of GDP
	Secondary Industry: 6.8%* of GDP	Secondary Industry: 39% of GDP
	Tertiary industry: 93.1%* of GDP	Tertiary industry: 60.9% of GDP
Port Cargo Throughput	260 million tons	260 million tons
Passenger Throughput	Visitor Arrivals to Hong Kong: 55.913 million passenger trips	Overnight visitors received from outside of the mainland: 12.17 million passenger trips
	Hong Kong International Airport: 71.543 million passenger trips	Shenzhen Bao'an International Airport: 52.93 million passenger trips

Fig. 15 Major social and economic indicators of Hong Kong and Shenzhen, 2019. *Source* Hong Kong Constitutional and Mainland Affairs Bureau and relevant government authorities

has been pivotal in Shenzhen's rapid development and could hardly be replaced. Each playing complementary roles within the GBA, with further collaboration Shenzhen and Hong Kong can form a "smart" mega city that is unique in the world.

Hong Kong has moved a step towards "smart city" in 2017 in an attempt to spearhead the development by releasing a Smart City Blueprint. The Blueprint targeted to address challenges of city management and improve livelihood of the people through innovation and technology. Shenzhen reinforced the city's position as the top smart city in China through publishing the "New Smart City Development Strategy" in 2018. Both cities place emphasis on opportunities enabled by technology in governance, but somehow missed or lacked truly smart initiatives on other important aspects under the Smart and Sustainable City Framework.

In the following sections, the cities will be assessed by using the six components of the Smart and Sustainable City Framework, namely Smart Living, Smart Environment, Smart Mobility, Smart Infrastructure, Smart Economy and Smart Governance, followed by a SWOT analysis of both cities and discussion of how they can build on their strengths and opportunities while addressing their weaknesses and threats by working closely together through further collaboration and could benefit each other.

2.1 Smart and Sustainable City Framework

The Smart and Sustainable City Framework, developed by the Institute for Sustainable Urbanisation (ISU) and UDP International is used to assess Hong Kong and Shenzhen not only from a technology perspective, but from a more comprehensive approach focusing on People, Place and Planet. This model highlights the belief that technology is a tool and should not be the primary focus to steer city development. As it is not good enough for a city to be technologically advanced but is a poorly planned and badly designed. It is equally important that the Smart City idea is based on **smart thinking** with good planning and design 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 (Fig. 16).

"Smart Thinking" is the fundamental thought process and mindset to develop a smart city, which should be applied to all sectors and professions [2]. By integrating smart thinking in planning and design, so that new development will be built sensitively with consideration of urban regeneration and conservation of cultural heritage as well as the natural environment. Moreover, there should be good strategic planning with mixed use development, sensitive place making as well as good urban design, architectural and landscape design, so that a smart and sustainable living environment can be achieved.

The three core aspects of Smart and Sustainable City Framework are "Smart People", "Smart Place" and "Smart Planet" [2]. "Smart People" means that people should be smart, educated, open-minded, innovative and creative, with the knowledge of various key issues ranging from mobility, governance, environment, socio-economic aspects and technology. "Smart Place" refers to a city that is designed

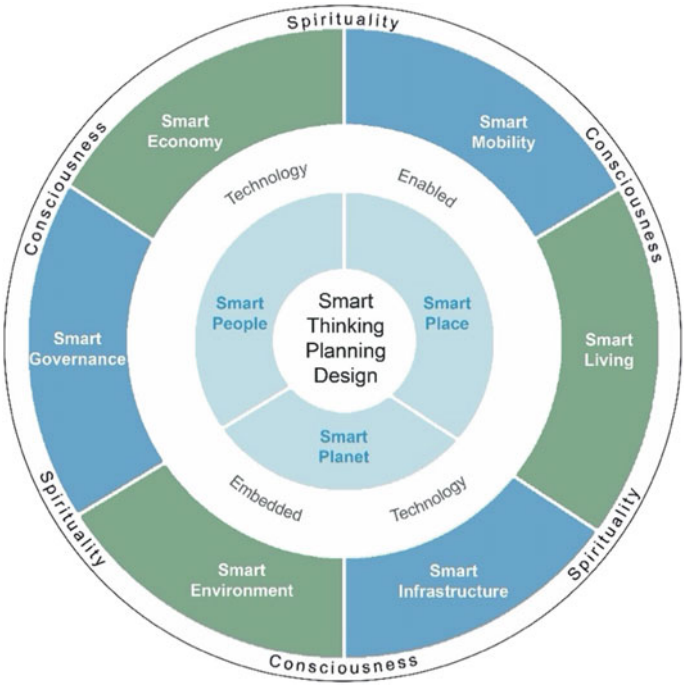

Fig. 16 Smart and sustainable city framework. *Source* ISU/UDP international

and built in consideration of human metrics in terms of block size, density and land use etc. Also, the city should have proper public infrastructure based on people's needs and aspirations. "Smart Planet" refers to the harmonious relationship between nature and the built environment. These three core values can be achieved through the integration of smart thinking in planning and design.

With the above mentioned Smart Thinking and core aspects as the foundation for planning and design of smart city development, technology should act as an enabler and be incorporated into the smart and sustainable city development. With integrated technological infrastructure, network and equipment, city development can be planned, designed and monitored effectively and efficiently.

The six smart city components include Smart Mobility, Smart Living, Smart Infrastructure, Smart Environment, Smart Governance and Smart Economy, and are defined with the above key aspects and characteristics of a smart and sustainable city.

Smart Environment concerns the natural environment including both ecological value and biodiversity, through the provision of open space for varied activities and protection of natural assets. Moreover, the built environment through the promotion of green buildings, sustainable designs and energy saving techniques is better integrated with natural environment [3].

Smart Living refers to all aspects that influence the quality of life. A smart city should provide an equal, inclusive and cohesive society with a safe, secured,

healthy and livable environment [2]. It should provide high quality affordable housing options, employment opportunities as well as accessible and high quality public services including healthcare, education facilities and open space while promoting heritage, art and culture.

Smart Mobility refers to the sustainable transport modes for people movement [2]. Smart Mobility can be achieved through the promotion of public transportation and zero carbon non-motorized transport such as walking and cycling offering last mile connectivity as well as promoting an active and healthy lifestyle.

Smart Infrastructure consists of both physical and non-physical infrastructure [2]. Physical infrastructure includes roads and utilities while non-physical infrastructure contains internet connectivity as well as Information and Communication Technology (ICT). A well interconnected network of physical and non-physical infrastructure enables smart and efficient resource management.

Smart Governance concerns the services and mindset of the government in policy making [2]. A smart city should have a transparent and inclusive public engagement mechanism such that a common city vision is shared among the public sector, private sector, community, NGOs, professional, academia and other key stakeholders. An effective leadership and management system and equitable implementation process are essential elements to shape a smart and sustainable city for all.

A Smart Economy is a transparent and diversified economy with an efficient and effective business environment for various businesses while promoting entrepreneurship and innovation. It should also be competitive locally, regionally and globally, to ensure economic growth and success as well as a stable market for employment [2].

Spirituality and Consciousness should be the basic foundation to be aware that we are all connected with each other and to the environment on this planet to promote a happy, active and healthy lifestyle while being stewards of the environment.

2.2 Smart Living

Since Shenzhen was declared as a SEZ by the Chinese Central Government in 1980, industries and manufacturing moved over across the border from Hong Kong to Shenzhen, with technology and innovation sector booming since 1990. Shenzhen grew with rapid immigration to the city with increased employment and business opportunities over the last 40 years. As compared to Shenzhen's 40 times population growth, Hong Kong's growth is much slower, which only increased from about 5 million in 1980 to 7.5 million in 2019. Despite Shenzhen having a larger land area than Hong Kong, both cities have very high population density and face issues of congested urban areas and soaring property prices, and consequentially affecting the cities' livability (Figs. 17 and 18).

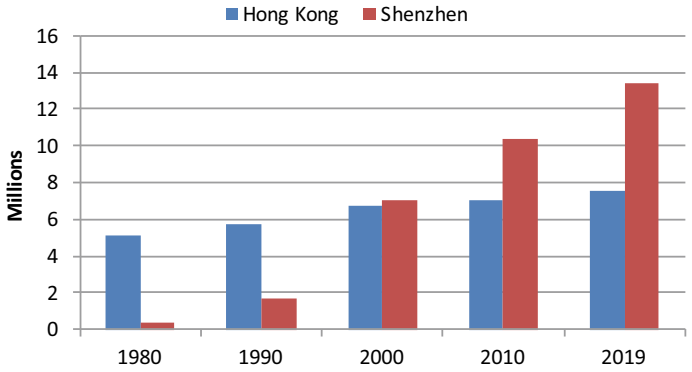

Fig. 17 Population of Hong Kong and Shenzhen, 1980–2019. *Source* Hong Kong Census and Statistics Department, Shenzhen Statistical Yearbook, Statistical Communiqué of Shenzhen

	Hong Kong	**Shenzhen**
Land Area	1,111 km^2	1,997.47 km^2
Population Density	6,940 persons per km^2	6,728 persons per km^2

Fig. 18 Land area and population density of Hong Kong and Shenzhen, 2019. *Source* Hong Kong Census and Statistics Department, Shenzhen Statistical Yearbook

2.2.1 Affordable Housing

Hong Kong and Shenzhen are one of the costliest cities to live, especially in terms of accommodation. The global real estate consultancy CBRE suggests in their Global Living Report 2020 that Hong Kong and Shenzhen are both considered as the top ten most expensive housing markets, with property price averaged at US$ 1.25 million and US$ 0.78 million respectively. The Mercer Cost of Living Survey 2020 and Worldwide Cost of Living Survey from The Economist Intelligence Unit (EIU) also rank Hong Kong as the most expensive city in the world. Shenzhen is not far behind as it is ranked 13th most expensive city in Mercer Cost of Living Survey 2020 (Fig. 19).

Hong Kong is the most expensive city to buy a property in the world, and it is well known for its shortage of residential space with a density of 6,940 people per sq. km. Rents in Hong Kong are also higher than its global counterparts. According to Deutsche Bank Research, Hong Kong tops 56 global cities with an average rent for a two-bedroom apartment costing up to US$3,685 per month. As nearly one in five people of Hong Kong are living in poverty, those who cannot afford a flat have to settle for subdivided flats or even cage homes, which are hardly fit for decent human accommodation. The minimum wage of about US$4.83 an hour offers little help for the 210,000 Hong Kong residents who live the city's thousands of illegally subdivided apartments, with a poor quality of life. Although the Hong Kong government provides

Average property price (USD)		
1	Hong Kong	$1,254,442
2	Munich	$1,000,000
3	Singapore	$915,601
4	Shanghai	$905,834
5	Shenzhen	$783,855
6	Beijing City	$763,498
7	Vancouver	$754,617
8	Los Angeles	$717,583
9	Paris	$650,555
10	New York	$649,026

Fig. 19 The top ten most expensive housing markets. *Source* CBRE global living report 2020

affordable public housing for those in need, the quantity cannot catch up with the demand. There is a 5.4 years average waiting time in 2019 for public rental housing for eligible person, according to Transport and Housing Bureau of Hong Kong. As of 2019, about 45% of Hong Kong people live in public housing, with two third being public rental housing and the rest being subsidized sales flat. These figures show a clear departure from the government's target of increased public housing supply. Nonetheless, the soaring price for private properties which tripled between 2009 and 2019 also means those who are ineligible for public housing and have to spend a huge fraction of their income to buy or rent a flat in the private sector (Figs. 20 and 21).

With very limited land supply in Hong Kong, the housing affordability issue will continue to haunt the city before coming up with any smart and sustainable solutions. One of which could be cooperation between the two cities' authority for affordable housing. As Hong Kong's 2016 Population By-census shows that persons

Population by type of housing

%

	2009	2014	2019
Public permanent housing	47.1	45.7	45.0
Rental housing	29.2	29.2	29.5
Subsidised sale flats	17.9	16.5	15.4
Private permanent housing	52.2	53.7	54.3
Temporary housing	0.7	0.6	0.7

Fig. 20 Population by type of housing in Hong Kong, 2020. *Source* Hong Kong Transport and Housing Bureau

Price of private permanent housing
(average price of flats <70 sq. m of the year)

HK$ / sq. m (SA)

	2009	2014	2019
Hong Kong Island	68,705	129,487	183,368
Kowloon	51,266	107,027	154,275
New Territories	39,279	83,440	128,981

Fig. 21 Price of private permanent housing in Hong Kong, 2020. *Source* Hong Kong Transport and Housing Bureau

from mainland having resided in Hong Kong for less than 7 years (PMRs) has a higher ratio of living in public rental housing than the general Hong Kong population, ranging from 52.4% (113,671 persons) in 2006 to 32.2% (53,504 persons) in 2016. It could be possible that Hong Kong's resources have been used to provide affordable housing to residents of its neighboring cities. The eligibility of PMRs for public rental housing in Hong Kong has also been questioned by the public as PMRs' assets in mainland is less transparent and would be favored under Hong Kong's existing public housing allocation system which has limits for income and asset. Collaboration between the public housing authorities would more efficiently allocate affordable housing to those in real need with shared information of the applicants' background and eligibility.

Apart from efforts of the government, non-governmental organsations (NGOs) in Hong Kong have been active in providing affordable social housing or transitional housing. One of them is Light Be, a social enterprise that aims to provide housing solutions to low income families in Hong Kong. Started in 2010, Light Be has engaged with various landlords and homeowners who are willing to lease their flats to the organization to rent out as social housing, which they have branded as "Light Homes," at cheaper prices below the market rate. On the beliefs that low income families should be offered more than just a place to live, but also with opportunities and guidance to inspire them to continue improving on their livelihood. A Light Home Manager works together with these families on personal development as well. Light Homes are rented to families under a three-year tenancy period. With an aim to provide affordable housing to those who wait for the public rental housing at least 3 years and live in tiny subdivided rental units, the Hong Kong Council of Social Service (HKCSS) carry out "Community Housing Movement" and "Modular Social Housing" since 2017. The HKCSS acts as an intermediary in coordinating and planning transitional social housing, and is responsible in selecting service operators for such housing projects. It also develops transitional social housing on idle land with modular integrated construction method which will be available for short-term usage. Nonetheless, the participation of the public and NGOs to provide social housing to those in need and could not afford their own home somehow highlights the inadequacy of Hong Kong in achieving Smart Living on housing aspect.

With its fast-growing population who seek business opportunities and employment, Shenzhen has faced issues such as acute housing demand and rising property prices. Similar to the situation of Hong Kong, those who cannot afford a decent flat in Shenzhen would normally settle in one of its "urban villages", areas that grew in a haphazard manner due to the influx of migrant workers, crowded with poorly maintained multi-storey buildings and narrow alleys. Shenzhen's average price for new housing in October 2019 is around US$ 8,850 per sq. m, according to Julive, an online and mobile property consultancy service. The cost of a newly built 120 sq. m apartment, comfortable enough for a family of four is priced at slightly more than US$ 1 million.

Currently Shenzhen's residential use accounts for about 22.6% of total developed land, which is well below the national standard of about 25% to 40%, according to Shenzhen Housing and Construction Bureau's report. Hence, Shenzhen is trying to focus more on affordable public housing for its professionals and low-income residents. The city plans to build 1.7 million new homes by 2035, at a rate of more than 80,000 units per year and has made it clear that 40% of its housing supply will be earmarked for subsidized housing. Plans to increase residential land supply include redeveloping 'urban villages', or older parts of Shenzhen currently supplying cheap rental housing. Some 30% of new housing units in redeveloped urban villages will be turned into "affordable" housing under this new plan. According to Shenzhen Planning and Natural Resources Bureau, the yearly supply of residential land in 2019 amounts to 150 hectares, including 73 hectares from urban renewal. However, the supply of both public and private housing only accounts for 14% of total provision of land, less than those reserved for industrial (18% of new supply) and similar to that of commercial (14%) use. The data shows that the Shenzhen authority is struggling to increase the ratio of residential land for housing supply as the city has to strike a balance between housing and space for development. The city must improve further with its housing strategy keeping its people and their living quality in mind.

2.2.2 Heritage, Art and Culture

A community with rich culture significantly enhances its quality of life and contributing to the foundation of Smart Living. It generates a sense of identity, community cohesion, building an inclusive society, promoting social equity and equality, boosting economic growth and employment opportunities as well as facilitating public participation. Therefore, these tangible and intangible cultural assets must be preserved as much as possible for adding value and improving the livelihood of the people in the city.

More recently, Hong Kong acknowledges the importance of protecting its built heritage as it gets more developed starting in the 1970s. The Antiquities and Monuments Ordinance of Hong Kong was enacted in 1976 to preserve the objects of historical, archaeological and paleontological interest and for matters ancillary thereto or connected therewith. The Antiquities and Monuments Office conducted territory-wide survey and identified historic buildings for official recognition as declared

monument and graded buildings. While declared monuments are entitled to be protected by the government, other graded buildings are not entitled to statutory protection. The government takes action through various means and communicates with the owners of graded buildings to protect the heritage value of the buildings if demolition plans are known. However, the statutory mechanism for heritage protection has been criticized by the public as it has not been effective enough to prevent demolition of cultural heritage. The private sector is stepping up their efforts to conserve the built heritage with recent examples such as the Mills, a landmark revitalization project of an old textile industry building by Nan Fung Group where themes of textile and industry are interwoven with innovation, culture and learning for a great experience. With the success of the Mills other private sector examples of revitalization projects are set to emerge in Hong Kong.

Nevertheless, Hong Kong's community has been increasingly aware in preserving the city's heritage through bottom-up initiatives. One of the examples include Smart Cultural Precinct (SCP) @ Central by ISU and UDP International. SCP @ Central is a comprehensive, bottom-up, conservation place-making initiative involving multi-sectoral participation from the community, academia, public and private sectors to create a cultural precinct in the heart of the historic Central District. The core of the SCP is the Cultural Triangle, which comprises of three historical buildings, Police Married Quarters (PMQ), Central Police Station (CPS/Tai Kwun) and Central Market (CM). SCP capitalizes on the adaptive reuse of Government based conservation of PMQ, Tai Kwun and CM to develop a conservation and revitalization plan for the area that promotes the city's cultural heritage and re-brands Hong Kong's city image and identity. SCP aims to conserve the traditional street culture and enhance the neighborhood vibrancy through urban design interventions, place-making and traffic calming initiatives to create a pedestrian friendly and walkable environment with high quality public realm within the cultural precinct. ISU worked together with Young Women's Christian Association (YWCA) and UDP International, with local support from the Central and Western District Council, to host a series of community engagement events to educate and raise awareness of SCP. These events were successfully held and provided a platform for participants to better understand the importance of SCP and area based heritage conservation, share their stories, as well as promote the traditional hidden and vanishing Chinese art and culture bringing the adults and the younger generation together (Fig. 22).

Hong Kong also has a rich cultural scene with a number of performance and exhibition venues for different kinds of arts. Apart from the existing museums for art, science, heritage and more, Hong Kong will be welcoming a new contemporary art museum M + , Lyric Theatre Complex and the Hong Kong Palace Museum in the West Kowloon Cultural District. The City Hall, the Hong Kong Cultural Centre, the Hong Kong Coliseum, the Queen Elizabeth Stadium and the Yau Ma Tei Theatre are also some of the performance venues built or revitalized to serve the city territory-wide. In addition, a newly-built Xiqu Centre in West Kowloon Cultural District serves to promote the intangible cultural heritage of Cantonese Opera and other forms of traditional Chinese theatre. Clockenflap, an annual music and arts festival since 2008, is also one of the city's most famous music event that attracts many of

Fig. 22 Smart Cultural Precinct @ Central with the Cultural Triangle. *Source* ISU/UDP International

its local residents and tourists as well. Hong Kong is home to international sports events such as the Hong Kong Rugby Sevens. The events and cultural scene of Hong Kong surely enrich the cultural identity and positively influence the quality of life of the residents.

Shenzhen has limited effort in preserving its heritage until recent years. In 2008, China published the Regulation on the Protection of Famous Historical and Cultural Cities, Towns and Villages. Subsequently Shenzhen announced in 2018 that 42 buildings are selected as the city's first batch of built heritage. However, the list of 42 buildings was questioned as it includes some modern commercial buildings such as Guomao Building and Shun Hing Square built in 1980s and 1990s, which the authority claims the selections signified China's opening up and "Shenzhen speed". Although Shenzhen may not have the deepest history, taking advantage of its relatively young age as a city, it embraces new architecture and has welcomed many new architectural landmarks to the city's skyline. Ranging from skyscrapers in the downtown, to municipality and institution buildings, Shenzhen has been a popular experimental field for architects to showcase their talents which coincided with the rapid development of the city. Examples include KK100, Ping An Finance Centre, Civic Centre, Tencent Seafront Towers as well as upcoming Shenzhen Natural History Museum. Apart from the architecture, Shenzhen is yet to have many marquee music or cultural events. There is room for improvement for Shenzhen on this aspect to enliven its cultural scene (Fig. 23).

2.2.3 Open Space

Open space forms an integral part of quality of life of city dwellers, as it enables people to reconnect with nature on a daily basis and allows human interaction by facilitating encounters of people and social activities at events, festivals and carnivals.

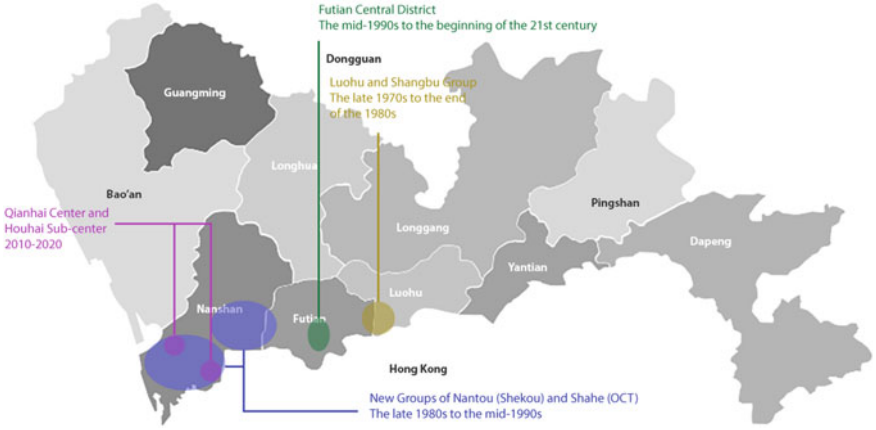

Fig. 23 Key areas for several construction booms in Shenzhen in different periods. *Source* Frontiers of architectural research [28]

Provision of high-quality open space is essential to achieve the vision and goals of Smart Living.

Apart from the abundance of country parks in Hong Kong which will be discussed in the Smart Environment section, Hong Kong's harborfront open spaces in the form of promenades not only capitalizes on the stunning view of Victoria Harbor, it also promotes better quality of life of residents and visitors alike. With the inputs from the Harborfront Commission, an advisory body consisting of public and professional members, the government of Hong Kong has undergone various harborfront planning and design studies with a view to improve Hong Kong's harborfront as well as satisfy the need for public open space particularly in the congested urban core of Hong Kong. A successful example of uplifting Hong Kong's waterfront includes the renovation of Tsim Sha Tsui waterfront promenade undertaken by New World Development, which has become a popular destination for both tourists and locals with well-designed landscaping and public realm amenities. Many other areas along the Victoria Harbor such as Central Harborfront, Wan Chai and North Point Harborfront, West Kowloon Harborfront, Hung Hom Promenade and Kwun Tong Promenade have also been improved or identified for further enhancement to enrich the people's living quality. Despite harnessing the advantages of its "blue assets", Hong Kong's planning standard of open space provision which specifies a minimum 2 m^2 per person in urban areas is less than satisfactory and should be improved to be on par with other leading Asian and international cities.

Hong Kong is also increasingly aware of the quality of open space with concepts such as intergenerational play. Jockey Club Design Institute for Social Innovation (JCDISI) of Hong Kong Polytechnic University together with the Hong Kong Housing Society (HKHS) recently organized an Intergenerational Play Space Design Competition, inviting innovative design proposals for a public space in Prosperous Garden, a local public housing estate of the HKHS. The objectives include increasing

elderly users' confidence and incentives to take more outdoor physical exercise as well as encouraging more interactions between the elderly and youngsters through intergenerational play and activities. Hong Kong aims to provide within public open spaces not only passive recreation, but also to promote a more active and healthy lifestyle while fostering intergenerational interactions and communication. The improvement in provision of quality of open space would make Hong Kong more livable providing a breathing room for the already congested built environment which is vital to the quality of life of the people.

Acknowledging the importance of open space particularly in urban areas, Shenzhen government has endeavored to provide more communal open spaces and parks. Shenzhen has a policy to provide green spaces within 500 m walkable distance of residential developments, as well as city park within 2 km of residential uses. From a city with just two parks in 1980 when Shenzhen SEZ was established, it now has over 1,090 parks which helps enhance the quality of life of its residents. According to the authority, communal open spaces have covered over 90% of the city within a 500 m radius in 2019. It also plans to provide over 1,350 parks, adding 2,000 communal open spaces and building 500 km country park trails by 2035. Shenzhen's achievement in increasing the number of open spaces has been remarkable, but apart from quantity, quality of open space is also important in improving people's urban life. Both Hong Kong and Shenzhen can learn from their respective experience in the provision of adequate open space with good quality landscape and design.

2.2.4 Education and Health Care

Hong Kong's universities far outrank in education as Shenzhen's universities lag behind. Four universities in Hong Kong, namely the University of Hong Kong, Hong Kong University of Science and Technology (HKUST), Chinese University of Hong Kong (CUHK) and City University of Hong Kong, were ranked the world's top 50 in the Quacquarelli Symonds (QS) World University Rankings 2021. On the other hand, Shenzhen University is the only university in Shenzhen that ranked within top 500 universities in the Times Higher Education World University Rankings 2021.

Shenzhen has less number of prestigious academic institutions, when compared to Hong Kong and the city is making efforts in building colleges and universities, as well as strengthening ties with educational institutions overseas. Partnerships include links with the University of Cambridge and the University of California, Berkeley. Several universities in Hong Kong have campuses in China. CUHK has set up its campus in Shenzhen in 2012 as a joint venture between Shenzhen University and CUHK (known as CUHK-Shenzhen). CUHK-Shenzhen recently launched the New School of Data Science (SDS) and the Institute on Global Contemporary China Studies (GCCS). GCCS aims to become a think tank for the country's policy research and offer a platform for global academic exchange. The HKUST opened its HKUST Shenzhen Industry, Education and Research (IER) Building in 2011 to foster academic and research collaborations with mainland universities and institutes in Shenzhen. It is

clear that Shenzhen is committed to improve the educational standard of the city through partnership with institutions in Hong Kong and overseas.

Health care is also an important yardstick for a city's livability. Hong Kong's health care system is considered one of the most efficient medical care systems in the world. The Hong Kong government heavily subsidizes the public health care system which serves as a safety net for Hong Kong residents, by making public health care services available to all at affordable prices, usually a small fraction of the actual cost of service provision. Apart from public health care, private sector also complements the system by offering more flexible services to those who can afford the expense. Hong Kong has 43 public hospitals and 12 private hospitals, providing some 29,417 and 5,056 beds respectively as of end-2019, which translate to about 4.59 beds per 1,000 persons. However, there has been concerns of the shortage of health care professionals in Hong Kong, as the doctor to population ratio was 1:500 by the end of 2019, according to data from Department of Health. Hong Kong can benefit from more open immigration policies to attract talent from overseas beyond mainland China not only in the health care but other industries as well to truly make it a global city.

Shenzhen also suffers from insufficient medical resources. By end-2019, the total number of medical care beds in Shenzhen was 51,470, which roughly translates to 3.83 beds per 1,000 persons in Shenzhen, according to Shenzhen Municipal Health Commission [4]. In view of the limited capacity of health care in Shenzhen, their citizens often buy insurance from Hong Kong from which they can use Hong Kong's private medical system if necessary. This perhaps happen not only because of the lack of capacity of health care facilities, but also the commercialized nature of the health care system where the market-oriented hospitals mainly make profits from the patients while sometimes overlook the interest of patients [5].

2.3 Smart Environment

One of the globally challenging concerns are environmental pollution/degradation of the cities and its surrounding areas as a result of urbanization. Already densely populated, Hong Kong and Shenzhen are both still growing and would thus put further pressure on their environmental resources. Cities, especially those with high density, should endeavor to provide a healthy environment for its citizens through sustainable waste and resources management.

With a recycling rate of 30% in Hong Kong in 2018 [6], similar to that of Shenzhen of about 30% [7], both cities have room for more improvement in waste reduction strategies. Hong Kong mainly disposes its municipal solid waste to landfills. With an increasing daily per capita disposal rate of municipal solid waste from 1.33 kg in 2013 to 1.53 kg in 2018, Hong Kong has been putting pressure on its landfills. To increase the usable life of landfills in Hong Kong, the government is building an incinerator, known as Integrated Waste Management Facilities in Shek Kwu Chau. Though it can raise the city's waste processing capacity, this is hardly a smart solution

for sustainable waste management. Despite the fact that Shenzhen also treats its waste mainly through incineration and disposal at landfill, it is more proactive in minimizing waste from the source. Generating of about 28,500 tons of municipal solid waste per day, Shenzhen in September 2020 has made waste sorting compulsory in a view to improve the city's recycling rate and reduce pressure on waste disposal.

Nevertheless, there are smart initiatives from both cities to improve its air quality. With over 2.3 million motorized vehicles in Shenzhen, the government subsidies RMB 20,000 to electric car owners and offering free 2-h street parking to electric cars in view to promote the shift to electric vehicles. The Shenzhen government also restricts newly registered ride-hailing vehicles to be electric vehicles in a way to promote the use of environmental-friendly vehicles. With supportive policy, Shenzhen also has the largest electric bus fleet in the world. Efforts have also been made to introduce more new-energy vehicles for public services, including 3,200 electric dump trucks. Currently there are over 900,000 registered vehicles in Hong Kong. To reduce emissions, Hong Kong government offers concessions on First Registration Tax for private electric vehicles for up to HK$97,500, or up to HK$250,000 if the private car owner scrap and de-register the old car with combustion engine. It is expected that more environmental policies will be formulated as the Hong Kong Chief Executive Carrie Lam set a target of achieving carbon neutrality by 2050 in her 2020 Policy Address.

Green and open space in cities improve not only the livability of the people, it also works as lungs of the city which reinforce the environmental quality. According to Hong Kong Planning Department, the open and recreational space in Hong Kong totaled to about 28 km^2, which include parks, stadiums, playgrounds and recreational facilities for public enjoyment. Given the extreme density of Hong Kong, there should be much more open space per capita especially within the urban core area of the city. However, the country parks of Hong Kong take up about 38% of the city's territory are easily reachable from the urban areas. Hong Kong has confined its built-up area to less than 25%, leaving abundant area for greenery which reached over 70%. Its large, continuous green area accommodates a wide range of flora and fauna with high biodiversity. Hong Kong is also home to many migrant birds with its internationally important Mai Po Inner Deep Bay Ramsar Site which also borders Shenzhen. The natural conservation of Hong Kong with compact urban development areas can be viewed as a success particularly as compared to urban sprawl. The compact built environment helps preserve the natural environment and protects the naturals assets for citizen's enjoyment while preserving the ecological value.

Now dubbed as the "National Forest City" with about 41.2% coverage of forest, Shenzhen has seen great improvement in making the city greener. By the end of 2019, the number of parks in Shenzhen had reached 1,090 according to the Shenzhen Municipal People's Government. According to Urban Management Bureau of Shenzhen Municipality, the greenery coverage of built-up area is about 43.4% and the length of completed greenways is up to 2,400 km, and the total green area of all parks combined are up to 20,000 ha in 2019 [8]. In Shenzhen, large green areas are mainly located at the south-eastern and northern edge of the city, further away from the downtown districts. There are relatively small areas of green open

space dispersed throughout the central area. Hence, the distribution of green spaces in Shenzhen was not as even as Hong Kong where people can easily enter one of its country parks with public transport within an hour from the urban areas. A study by UN Habitat using satellite images of both cities also shows the green area ratio of Shenzhen is not as high as Hong Kong (Fig. 24).

Rapid urbanization and development would undoubtedly lead to negative impacts on environment if not properly managed. Collaboration between the two cities is key to some of the environmental problems of shared natural resources. The Shenzhen River which flows into Deep Bay/Shenzhen Bay separates Hong Kong and Shenzhen has been very polluted as both cities continued to develop. According to Environmental Protection Department of Hong Kong, in 2000 the two cities formulated the "Deep Bay (Shenzhen Bay) Water Pollution Control Joint Implementation Programme" (JIP) to improve Deep Bay's water quality. The JIP sets out pollution control measures to be undertaken by both governments at various stages, essentially to reduce wastewater discharge into Deep Bay by extension and improvement of sewerage infrastructure. The cross-boundary environmental cooperation saw great success as the river's water quality meets the national standard of agricultural water and general landscape water in 2019's dry season. The water quality of Deep Bay also shows noticeable improvement. This cooperation is a smart move for tackling environmental issues under two different administrations and should be followed as an example in other areas as well.

Both cities have acknowledged the significance of green building design as they both have very compact built environments. Building Environmental Assessment Method (BEAM) was first launched by the Hong Kong Green Building Council (HKGBC) in 1996 tailored for the local built environment in Hong Kong. After several updates to BEAM Plus, the current BEAM Plus offers a comprehensive set of performance criteria for a wide range of sustainability issues relating to the planning, design, construction, commissioning, fitting out, management, operation and maintenance of a building. It assesses a building's overall performance, such as Site Aspects, Energy Use, Water Use, Health and Wellbeing and Community Aspects, throughout its life cycle. It also enables organizations and companies to demonstrate their commitment to sustainable development by obtaining BEAM Plus certification.

Fig. 24 Green Area of Hong Kong and Shenzhen, 2018. *Source* UN Habitat [1]

Today, BEAM Plus is well received in Hong Kong and has been adopted by cities including Macau, Shenzhen, and other large cities in mainland China. HKGBC's recent Beam Plus Neighborhood helps assess sustainability performance at the inception stage of a new or planned development project varying in scale and typology. This can be a stand-alone high-rise tower with several hundred households, a large development with multiple towers or a project with a couple low rise houses. Shenzhen on the other hand has been a pioneer of adopting green building designs in China. In 2010, Shenzhen made a mandatory requirement for government subsidized housing to follow green building standards. The "Plan for Guangming New District (2007-2020)" released in 2012, was the first city plan to have mandatory requirement on green buildings for all of the constructions in an entire district. The district has become a national demonstration zone for green buildings. Though using different strategies, it is evident that both cities are promoting green buildings and sustainable designs for a smarter and sustainable built environment.

2.4 Smart Mobility

A sustainable transport system embodying smart thinking should be well balanced with a focus on promoting public transportation including non-motorized modes and encouraging more efficient, smart and sustainable transportation modes. Depending on its natural terrain and other restrictions, each smart city should develop its own innovative transportation system that brings the most benefit to the society as a whole. Being one of the densest cities in the world, Hong Kong has a world class public transport system and Shenzhen is not too far behind. Both have developed effective public transportation system and are in good position to promote non-motorized transportation modes as well.

2.4.1 Public Transportation

The topography of Hong Kong is characterized by steep slopes and rugged uplands. According to the Civil Engineering and Development Department of Hong Kong, about 60% of land is natural terrain and more than 60% of the hillside slopes are more than 20 degrees steep. As such most developed areas are extended to as far as slopes are too steep to develop. The topography of Hong Kong makes it very difficult to add new roads and as such transportation system and development areas should be carefully planned to minimize burden on road transport. According to Hong Kong Transport Department, the total public road length is 2,127 km (0.283 km per 1,000 people). The result is a huge emphasis by both the government and the people on public transport and a low motor vehicle ownership rate of 105.6 per 1,000 inhabitants in 2019. Hong Kong transportation is fast and efficient by air, sea, or land. The major mode of public transport is the Mass Transit Railway (MTR). The system covers all of the major districts in Hong Kong and is certainly one of the most efficient way to

get around. The railway system links most of the metropolitan areas of Hong Kong, airport, and even goes to the border control points with Shenzhen (Lok Ma Chau and Lo Wu stations). Another backbone of the Hong Kong transportation system is the vast fleet of buses and minibuses. They not only feed passengers to the MTR network, the buses also serve many areas that are out of the railway catchment and link to them to metropolitan areas. Hong Kong's public transport system has an extremely high level of usage and patronage, as 90% of passengers made their trips by public transport system consisting of railways, trams, buses, minibuses, taxis, ferries and other residents' services. In 2019, the public transport system had 12.44 million average passenger journeys per day [9]. Railway is the most used public transport and is about 40.6%. Franchised Buses and public light buses made up another 46% of public transport share. Taxis, residents' services, ferries and trams account for about 10% of public transport patronage. However, for a city on water, Hong Kong water transport is very limited and can be further improved on par with cities like New York and Sydney. A well-developed public transportation system is pivotal in promoting walkable and sustainable neighbourhoods in Hong Kong.

In 2018 two completed infrastructure projects, the high-speed rail and Hong Kong-Zhuhai-Macao Bridge, provide travelers with quicker and more convenient travel options to and within the GBA. Although Shenzhen is easily reached via the MTR in an hour from Kowloon and Hong Kong, the recently opened high speed rail from Hong Kong further shortens the travel time to Shenzhen to just 15 min and makes it even more convenient to travel back and forth between the two cities. Beijing and Wuhan are also within reach in 10 h and 5 h respectively with the high-speed rail (Fig. 25).

Although well served by public transportation, Hong Kong people continue to desire owning vehicles. In 2019, 71.5% of registered vehicles in Hong Kong are private cars, even though there is a first registration tax of 40–115% for private cars depending on the value. The number of registered private cars also increases from 567,886 in 2015 to 643,422 in September 2020. The tax for private cars seems not to be an adequate measure to deter private car ownership in Hong Kong.

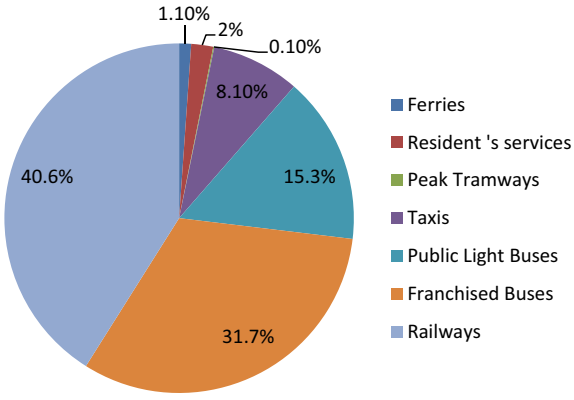

Fig. 25 Public transport modal share of Hong Kong, 2019. *Source* Hong Kong Transport department

There has been a lack of real smart initiatives for promoting public transportation. Although Hong Kong has put forth the Smart City Blueprint in 2017, which will be discussed in more detail under Smart Governance, the current measures in relation to smart mobility under the Blueprint merely include release of real-time information of franchised buses through information display panels at 1,300 covered bus stops, providing more real-time vacancy information of public car parks and on-street parking spaces, and introducing automated parking system to increase spatial efficiency. The Smart City Blueprint could be a good starting point but could not effectively deliver a truly smart and sustainable transportation system without a fundamental change in the current private vehicle-dominant city. All in all, Hong Kong's efficient public transportation systems has made the city's mobility fairly smart, albeit the increasing trend of private cars still needs to be addressed.

Shenzhen has seen a remarkable and fast paced transformation, with developments of ultra-modern high-rise office buildings, huge malls as well as an extensive road and rail network. According to Shenzhen Municipality Transport Bureau, the city's public transport system has a daily ridership of 10.69 million in 2018. Shenzhen has relied on buses as the main mode of public transportation, but in 2018 Shenzhen Metro took over as the most frequently used public transit mode since its operation in 2004. The metro system handles 5.14 million daily passenger trips in 2018. Shenzhen Metro opened its extensions in 2020 which put the network at 411 km of trackage with 11 lines and 283 stations. The Shenzhen Tram with 2 lines and 21 stations also began operation in 2017, which integrates the north side of Longhua District into the city's rail network. By 2030 the network is expected to include 8 express and 24 non-express lines totaling 1,142 km (Fig. 26).

Despite having a declining daily ridership from 6.25 million in 2010 to 4.46 million in 2018, the bus system of Shenzhen still has 981 lines, with 95.8% of the city covered with 500 m diameter of a bus station. The popularity of ridesharing through mobile apps has also contributed to the reduced bus patronage. As of third quarter of 2020, there are 60,751 issued licenses for ride-sharing vehicles and 101,371 licenses for ride-sharing drivers under 12 ride-sharing platforms [10]. In addition, the city is also served by about 22,000 taxis. The ride-sharing economy coupled with various regular public transport services have made Shenzhen one of the most convenient city with public transportation in China.

The Shenzhen government has also put effort in promoting greener public transportation. By 2019 the entire transport bus fleet in Shenzhen, which is about 17,000-strong, have all gone electric, while thousands of taxis have all gone electric, and restricting new ride-sharing vehicles to be electric only, Shenzhen has set an example on how cities could work towards smart sustainable transportation, and is certainly on the right direction to Smart Mobility that thrives with technology.

2.4.2 Walking and Cycling

Smart cities should encourage more sustainable modes of transport including non-motorized transport. More could be done in the two cities, towards walking and

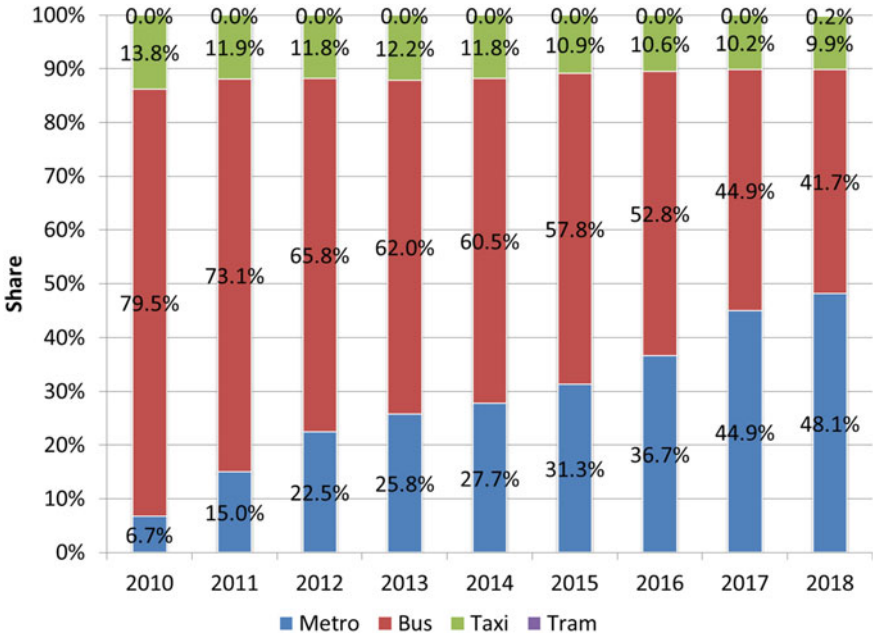

Fig. 26 Composition of public transport modes in Shenzhen. *Source* Transport Bureau of Shenzhen Municipality [29]

cycling. Indeed, Hong Kong and Shenzhen were ranked as the top cities in China in terms of walkability by Natural Resources Defence Council.

The Hong Kong government has been promoting "Walk in HK" with a view to creating a pedestrian-friendly environment, thereby encouraging people to walk more. In some areas such as Kowloon East, pedestrian facilities are improved with greening and beautification of streetscape. Pedestrian linkage systems in urban areas such as Admiralty and Wan Chai have been enhanced through public funding and encouragement of private initiatives to improve pedestrian connections. Efforts to promote Hong Kong's walkability also include construction of waterfront promenades, in particular the northern part of Hong Kong Island along the Victoria Harbor. A planned promenade stretching from Sai Wan to Quarry Bay will be completed by phases. Although the hot and humid climate may not bring the most pleasant walking experiences during the summer, Hong Kong is very walkable as a compact city with well-connected public transportation, not to mention that some of the multi-level pedestrian linkages in commercial areas are air-conditioned.

Despite the fact that the natural terrain of Hong Kong has put some limits on the development and promotion of cycling, the government also works hard to make Hong Kong more bicycle-friendly. The new cycle track linking Yuen Long with Sheung Shui in northern New Territories has been opened in 2020, which completes the 60 km-long bikeway backbone between western and eastern parts of the New Territories of Hong Kong, with bike rentals available along the leisure cycle track.

It is expected that more cycle tracks and bike parking spaces will be provided in the New Territories of Hong Kong. However, in urban areas such as Kowloon and Hong Kong, cycle tracks are non-existent as the built environment in these areas is already compact. Due to the compact city environment which limited the space for bike parking, many bike sharing companies are quitting the Hong Kong market as most of their bikes are removed or confiscated by the government for "unlawful occupation of government land". Official data shows 8,887 bicycles were confiscated in clearance operations in 2016. In view of the above, cycling can yet to be a main transportation mode in Hong Kong.

Shenzhen has also been making efforts to improve the city by setting out a set of guidelines in planning and designing walking and cycling systems in 2013. The guidelines set out the key walking corridors that penetrate through the whole city and connect the urban areas to natural landscapes and leisure areas.

The areas identified as strategic cycling districts include residential, commercial and office land uses, are considered as having huge potential for developing cycling as one of the key transportation modes that form part of the city's cycling network. Shenzhen was also an early adopter of bike sharing in the city. Many different bike companies currently offer bike-sharing service in Shenzhen. Not as compact as Hong Kong in most of the areas, and with cycling networks cutting through the whole city, Shenzhen seems to show better acceptance towards bike sharing and harness the advantages enabled by technology better than Hong Kong. However, Shenzhen also saw serious issue in the uncontrolled increase in number of shared bike, which reached almost 890,000 bikes in 2017 [11]. The Shenzhen government suspended the addition of new shared bike in the city in 2017 in view of this. Similar to Hong Kong, the Shenzhen authority has also tightened controls of parking of shared bicycles where users have to park shared bike in designated parking areas after use. Among the regulations, Shenzhen also requires all bikes to have smart locks installed and be properly maintained by the company. With proper management, bike sharing could definitely bring benefits to the city as a whole and create a smart and sustainable transportation system.

2.5 Smart Infrastructure

2.5.1 Utilities

The Dongjiang River is a major source of water supply for Hong Kong and the government has purchased Dong River water since 1965. Over 70% of domestic water in Hong Kong is imported from the Dongjiang River. With few natural lakes and rivers, high population density, inaccessible groundwater sources, and extremely seasonal rainfall, the territory does not have a reliable source of freshwater within the city. About 738 million cubic meters of Dongjiang River water was imported in 2019/20, which account for about 70–80% of water supply Hong Kong. The Dongshen-Hong Kong water supply system is capable of providing Hong Kong with

a maximum of 1.1 billion cubic meters per annum. However, on some occasions the imported Dongjiang River water may not be fully consumed and exceeds the storage capacity of Hong Kong's reservoirs under the "lump sum package" approach with the mainland water supplier. Although the actual quantity of Dongjiang River water imported can be flexibly adjusted depending on the local yield, there were times that water has to be released to the sea and thus create wastage of fresh water. On the other hand, to reduce the consumption of fresh water, sea water has been utilized for flushing in Hong Kong. An average of about 848,000 cubic meters of sea water was supplied each day in 2019/20.

The total water supply in Shenzhen amounts to 2,062 million cubic meters, of which over 80% of the water supply of Shenzhen comes from the Dongjiang River outside of the city, indicating its high dependence on its water resources from neighboring cities. Where household water consumption per capita has declined dramatically in recent years, Shenzhen still faces severe shortage of domestic water supply, and the magnitude of the dependency on non-domestic support is still increasing due to the growth in population. It is estimated that Shenzhen will face water shortages of 690 and 890 million cubic meters by 2020 and 2030 respectively. While Shenzhen also started to minimize its water footprint by adopting reclaimed water, around 40% of water consumption was reclaimed water and 30% was desalinated seawater. Shenzhen government also set a water-saving goal for the city, which by 2025, water consumption per RMB 10,000 of GDP shall be reduced below 6 m^3, reclaimed water utilization rate of 80% be reached, and the water pipeline leakage rate be dropped below 7% [12]. Sharing the same fresh water source of Dongjiang River, Shenzhen and Hong Kong have significant potential to cooperate in better utilizing the resources.

Hong Kong has relied on coal for half of its electricity generation, with the rest being natural gas and imported nuclear power. Despite Hong Kong government's effort in promoting renewable energy, it seems not to be bearing fruit without fundamental changes. In 2019, coal remains the major fuel used for electricity generation in Hong Kong, accounting for around half of the fuel mix, while natural gas and non-fossil fuels, including imported nuclear power, each account for around 25% [13]. Renewable sources account for a negligible amount of energy generated for the territory. Small-scale wind-power sources have been developed, and a small number of private homes have installed solar panels. As electricity generation accounts for about two-thirds of Hong Kong's carbon emission, changing the fuel mix for local electricity generation is the primary way to reduce carbon emissions.

To promote renewal energy in Hong Kong, the government introduced the Feed-in Tariff Scheme. Under the scheme, people who install solar photovoltaic (PV) or wind systems at their premises can sell the renewable energy they generate to the power companies at a rate about 5 times higher than the normal electricity tariff rate. As a result, the scheme has been attracting owners of available premises to install solar panels as a way to increase the ratio of Hong Kong's renewable energy generation. This scheme can be seen as a success and smart way for resource management.

Electricity and energy have always been in short supply in Shenzhen due to the rapid industrialization and urbanization. By 2000, Shenzhen's self-sufficiency rate

of primary energies was less than 10%; more than 90% of the energies were transported from inland or imported from abroad. In addition to the huge amount of coal, Shenzhen also has to import huge amounts of fuel oil and liquefied petroleum gas. To solve the energy bottleneck problem of Shenzhen, the city convinced the central government to locate the Liquefied Natural Gas pilot project first introduced to China at the Dapeng Peninsula in Shenzhen. In 2017, primary energy consumption structure of Shenzhen by fuel in terms of coal, petroleum, gas and electricity were 7.2%, 27.3%, 12.8% and 52.7% respectively. Compared with 2010, the proportion of coal dropped from 12.5% to 7.2%, the proportion of petroleum dropped from 32.4 to 27.3%, while the proportion of natural gas increased from 10.2 to 12.8% and the proportion of electricity increased from 45.0 to 52.7%.

Shenzhen illustrates a very dynamic growth rate in electricity generation, increasing from 21 billion kWh in 2001 to approximately 85 billion kWh in 2016. Coal was the main source of electricity production, followed by oil. Nevertheless, the Shenzhen government has put some effort to integrate cleaner energy into the overall electricity production. Currently, Shenzhen has seen a decrease in reliance on coal with less than 15% of power generated from it [14]. As claimed by the Shenzhen government, in 2019 85% of electricity is generated from clean sources such as nuclear power, natural gas or from waste, and the ratio is much higher than the country average [15]. Shenzhen showed higher acceptance towards nuclear power which accounts for more than 45% of electricity generated. With Hong Kong exploring promotion of renewable energy sources from private individuals, and the experience of Shenzhen in utilizing nuclear power, the two cities could share their experiences to find a better way forward for each city.

2.5.2 ICT Infrastructure

As an international city, the internet connectivity and ICT infrastructure of Hong Kong is very robust. Broadband internet access is widely available in Hong Kong, with 94.1% of households connected in mid-2019. Connections over fiber-optic infrastructure are increasingly prevalent, contributing to the high average connection speed as one of the fastest in the region, along with the benefits of multiple submarine cable landings. According to the Office of the Communications Authority, Hong Kong has 11 submarine cable systems as at 2019. Submarine fiber-optic cable systems can be regarded as the most important infrastructure in modern-days, as they form the backbone of the vast global telecommunications and carry the world's internet and data between continents. These systems are increasingly critical through linking data centers around the world, which has facilitated the use of cloud computing and Internet of Things. As a major landing point of submarine cables, Hong Kong enjoys internet connections with least latency in the GBA which is pivotal in financial transactions and stock trading (Fig. 27).

Shenzhen is considered as the "most internet" city in China by China Internet Network Information Center, with a high popularity rate of internet usage of about 86.2%. Shenzhen has achieved full 5G coverage in August 2020. The city also does

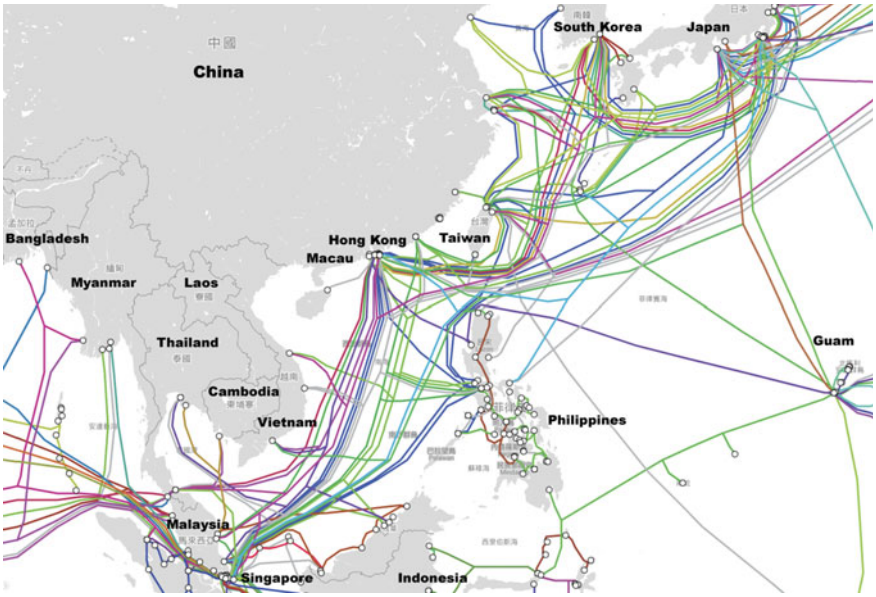

Fig. 27 Submarine cable systems in Asia-Pacific region. *Source* TeleGeography; https://www.submarinecablemap.com

not hide its ambition to be one of the world's leading 5G cities with largest scale and highest innovation level of "new infrastructure" in a recent announcement from the government. Home to some of the tech giants, such as Huawei and ZTE, Shenzhen holds superior advantages for telecommunication developments. Also, being the "Silicon Valley of China", Shenzhen received full support from the central government in development the latest technology.

2.6 Smart Economy

2.6.1 Openness and Connectivity

Hong Kong's economy is well known among the world for free trade, low taxation and minimum government intervention. Hong Kong was ranked by various institutions, including Fraser Institute, Heritage Foundation and World Economic Forum, as the top 3 freest economies in the world. Hong Kong is also the world's 8th largest trading economy in 2019 according to World Trade Organization, with the mainland of China as its most significant trading partner. Hong Kong is also a major service economy, with particularly strong links with mainland China as well as the rest of the region. Hong Kong's free economic system, openness and business-friendly environment have made the city one of the most international city in the Asia-Pacific region.

Hong Kong is also the largest offshore RMB business hub with a huge liquidity pool of over RMB 600 billion, thanks to its system allowing free flow and exchange of currencies. The open and free economy of Hong Kong certainly makes it one of the smart economies in the world.

Following China's "open door" policy, business environment of China has been increasingly more open and hence attracted many foreign investments. Shenzhen as a SEZ has more preferential policies to attract foreign investments. Nevertheless, it is a national policy that a small number of sectors are restricted or prohibited for foreign investment and these are specified in a nationwide Foreign Investment Negative List as issued and amended from time to time. Foreign investors who wish to enter a restricted sector will have to fulfil certain requirements that are not applied to domestic investors. These requirements include caps on foreign shareholding percentages and certain management positions must be Chinese citizens. Although the number of sectors restricted or prohibited are reducing over the years, it still imposes certain hurdles to foreign investors. Aside from restriction on certain sectors, the Chinese government still has capital flow regulations on its currency, amid the trend of gradual internationalization of RMB. Nevertheless, the central government announced in 2020 that it is granting more autonomy to Shenzhen, the city has more room to explore various city-wide policies or initiatives to improve the openness of business environment to attract foreign investments.

In addition to the open business environment, Hong Kong also boasts a high connectivity to the rest of the world. Around half of the world's population is reachable within 5 h' flying time from Hong Kong's airport. In 2020, Hong Kong's airport has around 120 airlines which connects to about 220 destinations worldwide, including about 50 destinations in the mainland, according to the Airport Authority of Hong Kong. The global connectivity of Hong Kong facilitates the flow of people and capital and reinforces its status as one of the freest economies. While Shenzhen airport has fewer non-stop passenger flights, it has better domestic connection than Hong Kong. As Shenzhen continues to grow, it is expected that more direct flights from and to the city will be opened (Fig. 28).

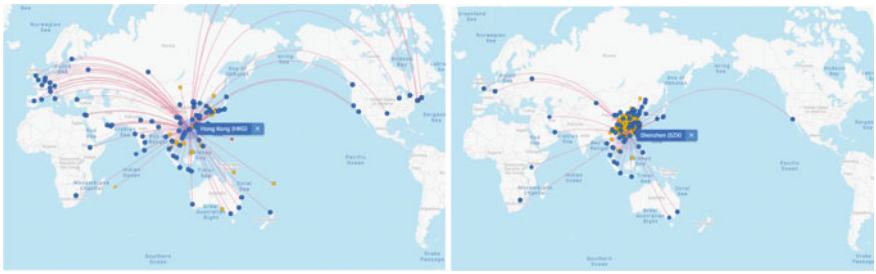

Fig. 28 Direct flights from Hong Kong (left) and Shenzhen (right). *Source* https://www.flightconnections.com/flights-from-hong-kong-hkg; https://www.flightconnections.com/flights-from-shenzhen-szx

Both Hong Kong International Airport and Shenzhen Bao'an International Airport have assisted the growth of the cities and witnessed the tremendous increase in number of air passengers and air cargo. In 1998, the year when the Hong Kong International Airport was opened, it served over 28 million passengers and handled 1.63 million tons of cargo. The numbers continue to grow and reached 50.9 million passengers and 4.12 million tons in 2010, and 71.5 million passengers and 4.8 million tons in 2019 respectively [16]. Since Shenzhen Bao'an International Airport's opening in October 1991, the number of both passenger and cargo traffic has maintained rapid growth. Its annual passenger throughput exceeded 10 million in 2003, 20 million in 2007, 30 million in 2013 and 40 million in 2016 respectively. It has reached 52.93 million passengers in 2019. In terms of cargo, Shenzhen Bao'an International Airport handled more than 1 million tons cargo in 2011 and 1.2 million tons in 2018 [17].

Port cargo throughput is also indicative of a city's openness and connectivity. Being ranked after Singapore as second busiest container port in the world in 2005 with 22,602 thousand Twenty-foot Equivalent Units (TEU) handled, Hong Kong's container throughput reached its peak in 2008 with 24,494 thousand TEU processed. However, Hong Kong slowly loses its edge to other container ports in mainland China, such as Shanghai and Shenzhen, and gradually declined to 18,303 thousand TEU container throughput in 2019 [18]. On the other hand, Shenzhen saw another "miracle" in its container throughput, rising from merely 179 thousand TEU in 1994 to 10,652 thousand TEU in 2003 and 25,769 thousand TEU in 2019 [19]. Shenzhen surpassed Hong Kong as the third busiest container port in the world in 2013. Over the years, Yantian International Container Terminals, the largest container port in Shenzhen, handles over half of the throughputs. It is also noteworthy that the Yantian International Container Terminals, owned by Hong Kong company CK Hutchison Holdings, is an example of Hong Kong's investment in Shenzhen.

Despite the protests in 2019 and the global pandemic in 2020 which led to the decline in visitor arrivals, Hong Kong continues to be one of the most popular destination in the world in terms of both business and leisure travels. Hong Kong's strategic location with its close proximity to China, a vibrant shopping scene, unique natural setting, strong cultural heritage, and infrastructure development have contributed to its tourism economy. With average daily visitors peaking at more than 200,000 in late 2018, Hong Kong enjoyed its greatest moment as an attractive tourism destination, before seeing a rapid downfall in 2019 due to social movements in the city and reaching the lowest point with about 3,000 daily visitor arrivals in February 2020 in the midst of COVID-19 pandemic.

As shown by the statistics from Hong Kong Tourism Board, over 75% of all visitors to Hong Kong in the past from 2013 to 2019 were from mainland China. Due to its close proximity to mainland China and availability of many scenic spots and shopping attraction towards Hong Kong. However, a large share of over half of the visitors did not stay overnight as they were mostly shoppers from the neighboring Shenzhen (Fig. 29).

As compared to Hong Kong, Shenzhen is more famous for its technological development, but it still attracts a fair amount of tourists with its vibrancy and theme parks.

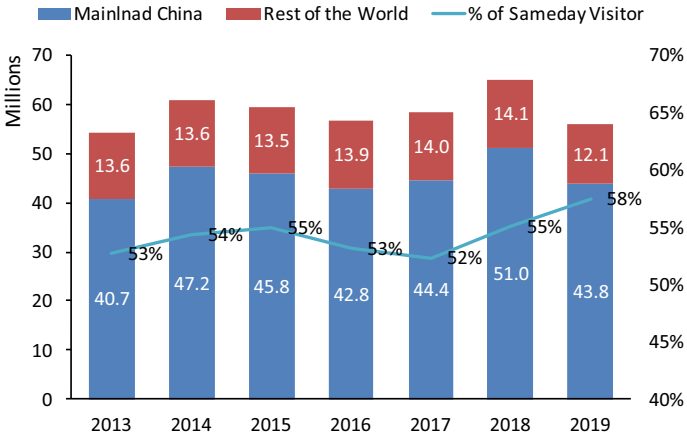

Fig. 29 Total visitors arrivals to Hong Kong by region and the share of Sameday visitor, 2013–2019. *Source* Hong Kong Tourism Board

According to Shenzhen Government, the city received 12.17 million overnight cross-border visitors and there were 252 million people who entered and left through the border checkpoints in 2019 [20]. With the proximity of the both cities reachable within hours, Hong Kong and Shenzhen combined as a megacity would likely attract more tourists.

2.6.2 Diversity, Innovation and Entrepreneurship

The economy of Hong Kong is dominated by certain industries. Traditionally, the "four key industries", including financial services, tourism, trading and logistics, and professional and producer services, have been the largest contributors of Hong Kong's economic growth. Several emerging industries, such as cultural and creative industries, medical services, education services and innovation and technology, have been identified by the government as advantageous industries for further development. Although the finance and trading sectors have contributed a lot to Hong Kong's historical development from a small fishing village to a global financial center, they have been hindering the city's transition to be more innovation and technology driven. As of 2017, only some 0.7% of GDP is contributed by innovation and technology sector in Hong Kong. Located right next to Shenzhen, China's "Silicon Valley", it might be beneficial for the Asian financial hub to explore ways to cooperate with Shenzhen in an attempt to capitalize on the booming tech sector and to further diversify its economy (Fig. 30).

Nevertheless, many entrepreneurs have been trying to break away from Hong Kong's traditional industries. Spanning different business sectors, such as financial technology, e-commerce, supply chain management and logistics technology, as well as information, computer technology, the number of start-ups in Hong Kong was

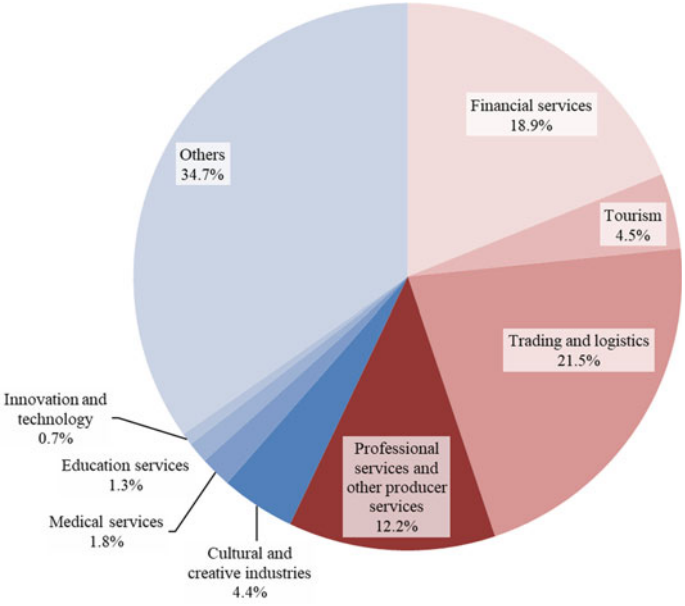

Fig. 30 GDP Contribution by industry in Hong Kong, 2017. *Source* Hong Kong Census and Statistics Department

3,184, growing 42.8% from 2017, according to the 2019 Startup Survey conducted by InvestHK, an official organization for attracting FDI to Hong Kong. These start-ups engaged 12,478 persons, up by 97.4% compared to 2017.

Currently, Shenzhen's economy is undoubtedly led by the high-tech industry, followed by finance, logistics and culture related industries. In 2018, more than a third (34.3%) of the city's GDP is generated from the tech sector. The finance, logistics and culture related industries combined almost took up the other third of the city's GDP. With the city's booming tech sector, it is foreseeable that the economy of Shenzhen will become more tech-driven (Fig. 31).

Shenzhen is also an important playground for entrepreneurs to start a business. According to the Global Entrepreneurship Monitor (GEM), a large working population of Shenzhen is engaged in early start-up stage. About 18.64% of male workforce and 12.98% of female workforce were in early stage of starting up a business in 2016, which was much higher than the national average of 11.8% and 8.6% respectively and was higher than that of Hong Kong. Established as an international finance center decades ago, Hong Kong might have lost its edge in nurturing new businesses. Although, Hong Kong has become more aware of the importance of entrepreneurship in the new technology age and is being more proactive in supporting start-ups, Hong Kong falls behind as a business incubator and could learn more from Shenzhen's experience.

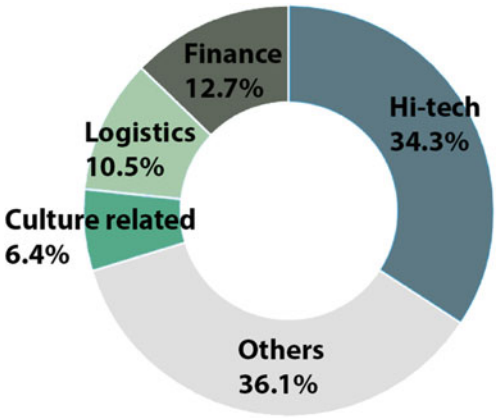

Fig. 31 Key industries of Shenzhen and their share of GDP, 2018. *Source* South China morning post

2.6.3 Labor and Competitiveness

The competitiveness of labor force is one of the cornerstones for smart economy, of which education is one of the important elements, alongside age and initiatives from the government to attract talents.

Hong Kong's working force is generally well-educated. In 2019, over 25% of population aged 15 or above has finished a degree course in university, and over a third of the population at least attained post-secondary education. Despite having an educated workforce, Hong Kong's working population is also facing a problem of ageing. According to the Census and Statistics Department, the median age of Hong Kong grew from 41 in 2008 to 45.3 in 2018 (Fig. 32).

According to 1% National Population Sample Survey of China in 2015, by the end of 2015, college-educated population in Shenzhen was about 2.58 million, less than that of Beijing and Shanghai. The population which received higher education accounted for about 22.7% of the Shenzhen population, far less than Beijing's 35.7% and Shanghai's 28.7%. According to the Shenzhen authority, in 2020 the median age

EDUCATIONAL ATTAINMENT OF POPULATION AGED 15 AND OVER (%)							
		2014	2015	2016	2017	2018	2019
PRIMARY AND BELOW		19.7	18.9	18.7	18.2	17.9	18.0
SECONDARY		50.5	50.2	49.7	49.7	49.0	48.1
POST-SECONDARY							
	Diploma/Certificate course	3.2	2.7	2.6	2.4	2.5	3.2
	Sub-degree course	4.7	4.8	5.0	5.0	5.2	5.4
	Degree course	22.0	23.3	24.0	24.8	25.4	25.3
TOTAL		100.0	100.0	100.0	100.0	100.0	100.0

Fig. 32 Educational attainment of population aged 15 and over in Hong Kong, 2014–2019. *Source* Hong Kong Education Bureau

of the city's population is 33 years old. The number of Shenzhen's working-age population accounts for more than 90% of the total population [21].

The influx of young population of Shenzhen can be attributed to the numerous employment and business opportunities, as well as the government's initiative to attract talents which include tax benefits and accommodation. In Shenzhen, employed talents can enjoy a reduced tax rate of 15%, much lower than the highest tax rate of 45% for monthly earnings over RMB 80,000. They are also eligible for "talent housing", a kind of guaranteed low-cost housing for rent or purchase for high-end talents or talents that are in short supply, which account for about 20% of the city's new flat units. However, Hong Kong has no specific talents attraction policy apart from various "talent admission schemes", a fast-track arrangement to admit overseas and mainland technology talent.

2.7 Smart Governance

2.7.1 Transparency

Since 1997, Hong Kong became an autonomous Special Administrative Region (SAR) of China with the guarantee of practicing "one country, two systems" for at least 50 years till 2047. Its political system is considered a limited democracy. The territory's Chief Executive is the head of the Hong Kong SAR and the head of the government. He/she is elected by an election committee comprising 1,200 members and is appointed by the Chinese central government. Power of the Chief Executive is counterbalanced by the Legislative Council, of which half is elected by universal suffrage and half is functional constituencies elected by the members of the sector they represent. Apart from law making, the Legislative Council can examine and approve budgets, taxation and expenditure introduced by the government and raise questions on the work of the government. Such political system requires the government to disclose information to and engage the Legislative Council and the general public in making important policy decisions, making Hong Kong's governance adequately transparent. The government offers a wide range of easily accessible information of public services, policies, census data and even data measuring the efficiency of the government in both Chinese and English. Statistics of market conditions are also regularly updated, which are essential for companies to gather market intelligence. It fosters the market transparency as well as competition.

The Hong Kong government released the Smart City Blueprint for Hong Kong in December 2017, which set out measures to promote the development of Hong Kong into a smart city with recommendations in six major areas, namely smart mobility, smart living, smart environment, smart people, smart government and smart economy. The Smart City Blueprint has proposed to develop the Common Spatial Data Infrastructure, which includes 3D digital maps, to facilitate the sharing of geo-spatial data across government departments and government-to-business applications. The provision of more geo-spatial data open to the public is a major step

towards better governance as it facilitates public participation in important aspects in land development and resource management. The government updates the Smart City Blueprint to "2.0" in 2020 with more smart city initiatives. These include the developing a Traffic Data Analytics System to enhance traffic management and efficiency under Smart Mobility; developing the Electronic Submission Hub for processing building plans and implementing the Be the Smart Regulator Programme to facilitate online application for all licenses under Smart Government; developing an online platform to provide efficient and cost-effective online dispute resolution and deal-making services under Smart Economy. However, the "smart" elements of the six areas under this Blueprint proposed by the Hong Kong government are almost the same as those included under the Smart and Sustainable City Framework, except for Smart People in place of Smart Infrastructure. The "smart" elements in the Smart City Blueprint relates mainly to the application of technology, though it improves efficiency and transparency of the government, it lacks true smart thinking with emphasis on important aspects such as smart planning and design with a focus on people, place and planet which should be a priority.

The other side of the Shenzhen River lies a very different governance system. The politics of Shenzhen is structured in a parallel party-government system, in which the Party Committee Secretary, officially termed the Communist Party of China Shenzhen Municipal Committee Secretary (currently Wang Weizhong), outranks the Mayor (currently Chen Rugui). Shenzhen is far less transparent in its governance with limited release of information with most information only available in Chinese. A report published by UN Habitat, *the Story of Shenzhen*, which examined the economic, social and environmental transformations of Shenzhen, finds there are some issues with the budgeting process and the budget itself, as many of infrastructure investments are financed off budget, without adequate transparency and tracking [1]. Although the city is gradually improving in terms of transparency with more information being available to the public in English as it is getting more international, the government has to improve information openness and operation transparency with a smart thinking that puts the people, place and planet as priorities.

Indeed, as an early adopter in many of new technologies, the Shenzhen government published the "New Smart City Development Strategy" in 2018 to reinforce its position as the leading smart city in China. The Strategy covers six major aspects, including display of the city's spatial information, developing e-public services with assistance of biometric information, developing smart decision-making system based on big data and artificial intelligence, holistic and digitalized management of city services, open data and trading big data through platforms, and developing an integrated platform for citizens to access daily services. In recent announcement, Shenzhen as one of the most important SEZ of China will enjoy more freedom in making city-wide decisions with central government bestowing higher degree of autonomy.

2.7.2 Public Engagement in Governance

Since 1997 Hong Kong government has recognized the importance of opinions of stakeholders, and it is evident that public participation elements, such as public consultation exercises and consultation sessions for relevant statutory consultations bodies, are present in most policy initiatives or feasibility studies. The District Councils, one in each of the 18 districts of Hong Kong, are responsible to advise the Government on matters affecting the well-being of the people in the District; on the provision and use of public facilities and services within the District; on the adequacy and priorities of Government programs for the District; and on the use of public funds allocated to the District for local public works and community activities. District Council members are mostly elected by popular vote with some appointed members by the Chief Executive of Hong Kong and *ex officio* members who are Rural Committees Chairmen in the New Territories. To a certain extent, the political system allows representation of the public opinion in government's policy making. Apart from political representation, Hong Kong citizens can also directly participate in public engagement activities in many policy initiatives and studies. For example, a study on "Enhancing Walkability in Hong Kong" by the Transport Department of Hong Kong conducted design and community workshops for the public, along with meetings with concern groups, business sectors, motorist representatives, community organizations and academia. Perhaps the most well-known example of the community and civil society's effort to influence government's plan for development was the enactment of the Protection of the Harbor Ordinance (PHO). In response to the government's further reclamation plan for the Victoria Harbor, the Society for Protection of the Harbor was formed. The society conducted "Save Our Harbor" Campaign in 1996 and was well supported by the Hong Kong public. With over 95% of Hong Kong people opposed to further reclamation according to a public opinion survey, the society secured the enactment of the PHO in 1997. The PHO recognizes the Victoria Harbor as "a special public asset and a natural heritage of Hong Kong people, and for that purpose there shall be a presumption against reclamation in the harbor". Under the PHO, any future reclamation in Victoria Harbor will be difficult and will need to demonstrate an "overriding public need" and go through extensive community engagement.

Shenzhen has limited channels for engaging the public. Shenzhen was trying to engage the public in urban planning [22] or invite the public to provide opinion in make major policy decisions. In the formulation of Shenzhen City Master Plan 2010–2020, the government pioneered the introduction of public engagement activities through various channels, including advertising on media, conducting symposiums and creation of an online platform for collection of public opinions. Indeed, Shenzhen's governance could improve as the central government has recently given more autonomy to the city government. Working towards a more transparent government that engages the community is the only way for Shenzhen to reach Smart Governance.

2.8 SWOT Analysis

Having assessed the two cities under the six aspects, namely Smart Living, Smart Environment, Smart Mobility, Smart Infrastructure, Smart Economy and Smart Governance of the Smart and Sustainable City Framework, the following SWOT analysis identifies the strengths, weaknesses, opportunities and threats of both cities, and discusses the possibility and merits of further collaboration between Hong Kong and Shenzhen. As elaborated below, the complementary characteristics of both cities on certain aspects could harness the strengths of both the cities while overcoming some of the weaknesses. Still, there are some weaknesses to be improved with smart thinking with more attention to the People, Place and Planet. Amid some potential threats from ongoing geopolitical tensions and social incidents, the opportunities arising from the integration could balance out or even outweigh the threats.

Strengths

Hong Kong is a world city that leverages on the mainland and engages the world. Well connected to Asia's key markets as a major aviation hub in the region, Hong Kong is a perfect location for businesses to capitalize on the opportunities in mainland China and Asia-Pacific region. Being the most international city in the GBA, Hong Kong is very business-friendly with a free economic system, well-established financial and legal system with good information technology infrastructure. Hong Kong is also an important offshore RMB business hub and a key source of FDI into China. Hong Kong is also well-equipped towards the internet age with good ICT infrastructure and numerous submarine cable landings that enhance connection speed to other continents.

Hong Kong's soft infrastructure has been well developed with good health care system and education system, among other welfares. The health care and education systems even serve the population on a regional scale. The governance of Hong Kong is considered transparent and allows community input in its policy making. The public transportation system has been regarded as a role model for other cities in the world with high patronage and efficiency. The wealth of highly-educated and multicultural talent offering professional services with extensive knowledge on global markets, forms the backbone of Hong Kong. The multifaceted city also has rich cultural offerings with awareness in heritage protection evolving and maturing. Coupled with the futuristic cityscape, well preserved country parks and extensive coastline, Hong Kong has long been the most sought-after tourist destination in the region.

Shenzhen is currently one of the world's most economically vibrant cities and an important economic engine for the GBA. With a large population of over 13 million, which easily qualify as a megacity on its own right, but together with Hong Kong both cities will benefit even more. Having been a paradise for start-ups and entrepreneurs all over the world, Shenzhen has attracted many likeminded and innovative talents and provided a good incubating environment with supportive policies. It is clear that the talent attraction policy of Shenzhen which provides tax benefits and housing for

talents is a right direction towards the goal of having Smart People. Undoubtedly it is now the most important base for high-tech research, development and manufacturing in the southern part of China. The continuing influx of young working-age population will allow Shenzhen to enjoy a longer term of demographic dividend. Perhaps having an advantage of being a SEZ, or the leader of the country's reform as a result of opening-up with favorable policies by the central government, the young and tech savvy city also does not hesitate to pioneer and adopt smart initiatives and ideas. Under the leadership of the municipal government, Shenzhen has promoted the wide-scale use of electric car on the city's roads, as well as using nuclear power as one of the main energy sources to reduce pollution. With some involvement from Hong Kong's MTR the developing public transportation system in Shenzhen with more railway lines to open in a few years will surely make it on par with that of Hong Kong.

Weaknesses

Being one of the densest cities in the world, Hong Kong and Shenzhen clearly lack enough land for expansion and development, in particular Hong Kong has to face constraints such as the mountainous terrain and the large area of preserved country park and natural reserve. Both cities struggle to build enough homes to meet with the ever-growing housing demand, not to mention affordable housing. As both cities continue to grow, environmental sustainability should also be put higher up on the cities' agenda with proper waste and resource management. Currently, without an embedded smart thinking for the planet, there is not enough efforts to make Hong Kong and Shenzhen more environmentally friendly and to be self-sustaining.

As the tourism industry in Hong Kong has been hardly hit by recent protests and the COVID-19 pandemic, the city has learnt a lesson that over-reliance on a certain industry would make the economy vulnerable to economic cycles and unexpected events. In comparison Shenzhen does not suffer much from the pandemic, with the help of electronic and technology industry which has boomed during the pandemic as people adapted well in changing to remote working and online shopping. But Shenzhen should also take Hong Kong's experience into account in developing a more diverse economy without over-relying on the technology sector.

There is a large number of migrant workers in search for employment in the China's "Silicon Valley". The floating population which often live in remote provinces not only puts pressure of the transportation system during festive days when they need to go back home, it also changes the local culture and the way of living of the locals. Although Shenzhen has been very inclusive to immigrants, the city would need time to nurture its own cultural scene and identity. In addition, even Shenzhen enjoys its status as a SEZ, the governance of the city has to allow more transparency and public participation so as to develop the citizen's sense of belonging and be more international in its outlook.

Opportunities

Although working together since the 1980s, the two cities could be further linked to become a smart megacity with more cooperation opportunities, such as social, education, economic development and cultural tourism.

The economies can be more diversified if the two cities join as a megacity. Each having different functions in the GBA, the cooperation between Hong Kong and Shenzhen can be a win-win situation for both cities. Shenzhen can lead Hong Kong in the innovative economy and technology sector, while capitalizing on Hong Kong's ability to introduce foreign capital and investment. Together both cities are booming simultaneously with local and international firms investing in various sectors. Both cities have the potential to expand on their financial and technology markets by working together and complementing each other rather than competing with each other. In addition, while Hong Kong has a problem of ageing population, Shenzhen can complement well with its young labor force, together they will have a more balanced demographic profile with experience and innovative ideas. Hong Kong and Shenzhen both are very unique and important cities to drive the economy of the GBA as well as to lead in the global markets in terms of their potentiality as a smart megacity.

Sharing boundary and some of the natural resources, sustainable measures that help to mitigate pollution of air, water and ecologically sensitive areas can be more efficient if the two cities collaborate seamlessly. Successful examples of improving the water quality of Shenzhen River Resources such as energy and water can also be more efficiently used by putting the two cities together as a smart megacity. In addition, sharing of information in certain parts of the administrations, such as provision of subsidized housing, will allow better utilization of social resources and avoid loopholes between the two systems.

As an integrated megacity, there are more opportunities for different people to communicate and provide a good platform to push the cities to embrace different considerations and thinking. There will be public participation and community engagement to let the people from Hong Kong and Shenzhen to listen to and understand each other and suggest changes to initiatives. This can possibly be a catalyst of change to the transparency of Shenzhen's governance, with more participation from the Hong Kong side.

What is more important that is the central government sets out the Outline Development Plan for GBA with a mission to bring Hong Kong and Shenzhen closer, which include supporting the development of the Hong Kong-Shenzhen Innovation and Technology Park in the Lok Ma Chau Loop and enhancing the functions of the Shenzhen-Hong Kong Modern Service Industry Cooperation Zone in Qianhai of Shenzhen. As Hong Kong's status as the SAR with "one country, two systems" will expire in 2047, the close cooperation between Hong Kong and Shenzhen will pave way for smoother transition leading up to 2047.

Threats

In recent years Hong Kong's political and social situation has been unstable with an increasing discontent towards the government of the SAR and even with the Chinese central government, especially with the new National Security Law. Although there is continuing integration between the two cities, specific mention may have negative connotation and intensify the discontent among Hong Kong people, and may not be well received by many in Hong Kong. The cultural differences and possible conflicts between the two cities should be looked into. Ways for conflict resolution and building trust must be carefully considered by the relevant authorities concerned otherwise it would work against the collaboration let alone integration between the two cities with missed opportunities for both cities in the longer term.

As Shenzhen is being more developed it attracts more population seeking opportunities. The continuous population growth in Shenzhen with influx of migrant workers would probably be detrimental to the city which will result in increased density and drain on the already limited resources. The city would be under threat if there is no smart and sustainable growth strategy coping with the current trends.

The intensifying US-China competition which set restrictions to US exports to China, especially the high-tech components and services, would certainly overshadow the development of Shenzhen's tech sector. Huawei is one of the big names that is badly hit by the US sanctions. Hong Kong's status as international finance center is also under challenge, as US threatens to end Hong Kong's special trading status and impose sanctions on key officials as part of the US-China political conflict.

3 Hong Kong and Shenzhen as One Smart Megacity

Through the comparative analysis of 6 elements of Smart and Sustainable City Framework and the SWOT analysis of the two cities helps to identify the various opportunities and constraints for Hong Kong and Shenzhen. These key issues can be further addressed when both cities are viewed as a smart mega city or even meta-city, if the total population exceeds 20 million. The strengths of Hong Kong and Shenzhen should be utilized to formulate greater opportunities while at the same time address some of the weaknesses and constraints in each city respectively. Given Hong Kong's status as an international financial hub and Shenzhen as a technology hub, the two cities can complement each other in many ways to create a smart and sustainable environment working together as a megacity that could provide greater success for the GBA and beyond. For Hong Kong and Shenzhen to function well together as a whole, strategies need to be implemented to ensure they are integrated properly with an inclusive and balanced relationship such that Hong Kong and Shenzhen are operating in parallel as a smart megacity while maintaining the unique identity of both cities. Integration between Hong Kong and Shenzhen shall be studied in the following five aspects: physical, socio-economic, environmental, community, and administrative.

3.1 Physical Integration

Hong Kong's role as a gateway to mainland China is getting faded, and the GBA is becoming more prominent. Under the "one country, two system" principle, borders continued to exist between Hong Kong and Shenzhen after the handover in 1997 to regulate the people traveling between Hong Kong and mainland as well as defining the jurisdiction of the city. Currently there are a total of six different Boundary Control Points (BCPs) for the passage of people and cargo linking Hong Kong and Shenzhen together, with the seventh (Liantang/Heung Yuen Wai BCP) opened in 2020 as seen in the figure below. In addition, A high-speed rail line that opened in 2018 reduced the travel time between the Central Business Districts of Hong Kong and Shenzhen to just 15 min, which has considerably reduced the relative distance and commute time between the two cities. However, many people continue to commute through the BCPs, which makes them crucial in implementing the physical integration between the two cities. The BCPs themselves have the opportunity to activate and transform into nodes as they are in the center of both cities. The border crossings should function not only as a gateway between the two cities but also a place to get business done as well as a place to meet people and linger. Mixed use development with offices, markets and shops can be located within the BCPs to create vibrancy in the surrounding area. It would also reduce the commuting time and distance to avoid adding unnecessary trips and congestion to the city. Lo Wu has demonstrated how successful BCP can be as a destination with retails and restaurants, which attracted many visitors from Hong Kong over for shopping and eating. Other BCPs can be developed similarly and not only function as a passage point before going further into Hong Kong or Shenzhen (Fig. 33).

Fig. 33 Hong Kong Shenzhen boundary control points. *Source* Hong Kong Planning Department

The frequent contacts and communications between the two cities present a true need for physical integration. According to Cross-boundary Travel Survey 2017 by Planning Department of Hong Kong, the average daily passenger trips between Hong Kong and Shenzhen made by people living in Hong Kong was 218,000 (68.4% of northbound trips to mainland) [23]. Although Hong Kong residents can freely enter the mainland with a valid mainland Travel Permit after clearance, Shenzhen citizens require a permit or a visa to travel to Hong Kong. The visa arrangement has been changing as there was an increasing number of mainland residents visiting Hong Kong in recent years and this created problems in Hong Kong in terms of capacity and parallel trading activities. The Hong Kong government suggested the Chinese central government to replace the "multiple-entry" Individual Visit Endorsements policy with the "one trip per week" Individual Visit Endorsements to limit the number of travellers and parallel trading activities. As such, the magnitude and the method of the physical integration should be carefully considered.

The current measures for both governments of Hong Kong and Shenzhen are limited to clearance facilitation, where electronic devices equipped with face recognition technology for identity verification are installed for self-served clearances for greater travel convenience. Although the governments have been promoting the "one-hour living circle" where one could live in Shenzhen and work/study in Hong Kong or vice versa, it is not gaining much popularity as border crossing is still time-consuming and fast transportation to most of the areas are still lacking. Smart initiatives would be required to improve the current situation to ease travel between the two cities including the need to streamline the numerous daily cargo trips as well.

Perhaps both governments are exploring the method of physical integration at Lok Ma Chau Loop, a small piece of land transferred from the mainland to Hong Kong after straightening of natural border of Shenzhen River. Jointly planned and developed by Hong Kong and Shenzhen governments the proposed Shenzhen/Hong Kong Innovation and Technology Co-operation Zone, which comprises the Shenzhen Innovation and Technology Zone in Futian, Shenzhen and the Hong Kong-Shenzhen Innovation and Technology Park at Lok Ma Chau Loop, is a trial by both governments to establish "one zone, two parks" at "one river, two banks" under "one country, two systems". The governments will formulate supporting policies to facilitate the flow of talent, capital, goods, information, etc. at the cooperation zone. The cooperation zone is also an ideal venue to explore smart measures to eliminate BCPs electronically or to create a "bonded zone for talents" for free movement of personnel. "Bonded zone for talents" means a visa-free zone or a closed area for talents to work or stay, while people getting out the "bonded zone" would still need to go through an electronic BCP. A valid permit or visa would still be required if the talent wants to visit the other city. The Lok Ma Chau Loop could be set as an area for testing out how BCPs could be partly eliminated electronically in a closed area. This is similar to the preferential policy for talents in Qianhai area of Shenzhen of exempting employment permit requirements for Taiwan, Hong Kong and Macao residents. The implementation of the cooperation zone will be worthy of study in promoting physical integration of the two cities.

Besides, there has been talks of implementing the co-location of border control facilities at the new Huanggang Port in Shenzhen, so as to release over 20 hectares of land in Hong Kong's Lok Ma Chau Control Point, which is now part of the frontier closed area, for other uses. It presents a good chance for the Hong Kong government to explore suitable proposals to activate the BCPs and closed areas with mixed uses apart from border facilities which currently over-prioritize the smooth flow of cargo truck traffic. Similar to Lo Wu, Lok Ma Chau is served by MTR and has a steady flow of passenger traffic, it has a great potential to be developed into a vibrant BCP with the adequate provision of spaces for smart and sustainable mixed-use development.

3.2 Socio-Economic Integration

Hong Kong is globally recognized as a financial hub and service center, which attracts investors from locals and overseas to explore business opportunities. The success of Hong Kong has also led to an influx of investors to Shenzhen, which has allowed the city to become one of the biggest markets in China. Together both cities are booming simultaneously with local and international firms investing in various sectors. Investment on real estates is also noteworthy as property value in Hong Kong and Shenzhen have been on a growing trend, which is raising concerns of affordability for citizens of both cities. The provision of affordable housing could be one of the key issues to be dealt with in the integration.

Favorable policies and foreign investments have allowed Shenzhen to become a home to many international high-tech companies, including Huawei, Tencent, ZTE, OnePlus, and many others. Apart from its leading financial sector, Hong Kong's technology sector has begun to grow in recent years with more and more start-ups forming. Together the Shenzhen-Hong Kong technology cluster is ranked second in the world based on the Global Innovation Index 2018. Both cities have the potential to expand on their financial and technology market by working together and complementing each other rather than competing against each other. Hong Kong's small and medium sized enterprises (SMEs) can leverage the increased opportunities to work with big technology firms and Shenzhen can attract more investors working with Hong Kong. Initiatives are already in place with collaborations from both cities to move towards this direction, such as the Hong Kong-Shenzhen Innovation and Technology Park in the Lok Ma Chau Loop to offer more R&D companies access to Hong Kong and mainland markets [24]. These include agreement on jointly funded projects between Ministry of Science and Technology and the Innovation and Technology Bureau, as well as establishing "Affiliated Institution by Chinese Academy of Science" in Hong Kong. In addition to government initiatives, the private sector, professionals and academia could also play a stronger role in socio-economic integration of the two cities building on what has been done to date.

Regional cooperation which allows the cities to diversify their industries and complement each other's strengths and weaknesses has been increasingly important, particularly in the COVID-19 pandemic and the changing US-China relations.

Despite efforts from the Hong Kong government to stimulate the development of technology sector by establishing the Hong Kong Science Park and Cyberport in around the 2000s, the sector is still in its infant stage with limited contribution to Hong Kong's economy. Hong Kong has been relying on the traditional industries including financial services, tourism, trading and logistics, which are severely hit by the recent global pandemic. Shenzhen on the other hand did not suffer much from the pandemic, thanks to its booming innovation and technology industry which is not affected or even benefited from the pandemic. However, Shenzhen faces tough challenges in the increasingly complex international geopolitics amid the intense US-China competition, the key industries of Shenzhen such as the technology and telecommunication were affected by restrictions on exports to the US. The further collaboration between Hong Kong and Shenzhen would create a more diversified and balanced economy when facing uncertainties, where Hong Kong's traditional industries can form a solid foundation for Shenzhen's technology sector to develop and expand into Hong Kong.

Aside from synergy in the financial and technology industries, Hong Kong's education has also attracted many students from Shenzhen and other parts of China to attend Hong Kong's universities. Many students are willing to commute daily across the border to go to school. Some of the universities in Hong Kong have already collaborated with universities in mainland to open campuses, such as PKU-HKUST Shenzhen-Hong Kong Institution and Chinese University of Hong Kong, Shenzhen (CUHK-SZ). Institutes can further explore the opportunity to open up campuses in Shenzhen to improve their education while relieve the needs of the long commutes for students. These can grow into a larger education hubs serving the GBA and beyond.

Hong Kong has played an important role in nurturing talents for mainland China. In 2016/17 academic year, about 15% of enrolments for University Grants Committee-funded programs in University of Hong Kong, Chinese University of Hong Kong and Hong Kong University of Science and Technology (HKUST) are mainland students [25]. It is also noteworthy that one of the most well-known mainland tech entrepreneur, Frank Wang, the Founder and Chief Executive Officer of DJI, is an alumnus of HKUST. While Shenzhen lacks a world-class university to foster innovation and cultivate talents, collaboration with Hong Kong as one smart megacity on education aspect can capitalize on the strengths of the two cities.

As the majority of the working class of both cities live in difficult conditions and may not be able to afford a house due to exorbitant housing prices, the integration of Hong Kong and Shenzhen can more efficiently utilize their scarce land resources for housing. Though both cities currently have their own affordable housing policies which are implemented in their own capacity without cooperation, some may take advantage of the loophole and it is possible for one to get affordable housing, even he or she owns a property in the other city. Every small step in improving the affordable housing situation will count towards optimizing land resources and fairness in governance. As both cities face shortage in land supply, the governments can explore collaboration opportunities to collocate or share facilities, such as BCPs, utility infrastructures or even port facilities, to free up land for affordable housing development.

Also, integrating tourism for both the cities will help boost the regional economy. Hong Kong's place as one of the top destinations in the world can benefit Shenzhen through its close proximity to Hong Kong. Shenzhen is striving hard to make its mark in tourism by creating theme parks and shopping malls and high-rise towers etc. With the opening of high speed rail connecting Hong Kong and Shenzhen and other infrastructure that greatly shorten travel time from Hong Kong to Shenzhen, tourists will be more willing to visit the technology boomtown. Aside from the improvement in cross-boundary transportations, payment systems lie at the heart of shopping experience of tourists. Mobile payment systems have been an integral part of people's lives in China, and is slowly gaining popularity in Hong Kong, particularly in shops of major tourist destinations. The adoption of mainland mobile payment technologies in Hong Kong reduces hassles in transations for mainland shoppers and demonstrates how socio-economic integration can be done. By integration the two cities they can complement each other and benefit in other socio-economic aspects as well.

3.3 Environmental Integration

Despite the high-density urban environment in Hong Kong, there are many country parks and land reserves in the city. In fact, Hong Kong's country parks, reserves and agricultural land accounts for close to 75% of the entire city's area. This has allowed residents and visitors to enjoy two vastly different spectrums of Hong Kong, from a highly dense built environment to outdoor nature in relative close proximity. However, the open space within the built environment is lacking and with many pocket open spaces being underutilized. Shenzhen, on the other hand, has less percentage of green spaces but there are a number of public city parks and community parks within the urban environment. While these public city parks and community parks have a reasonable high rate of users, the distribution of the parks are not spread equally between districts, which resulted in some areas in Shenzhen able to access to more open spaces than others [26]. Hong Kong's country parks can be better utilized to provide the open space needed for both citizens of Hong Kong and Shenzhen as well. The country parks should be further promoted with limited sensitively designed weekend accommodation as destinations to increase the attractiveness of Hong Kong not only as a business center but also a place offering unique outdoor experience (Figs. 34 and 35).

Apart from better utilization of green spaces in Hong Kong, the integration of the two cities enhances efforts in environmental protection. Shared by both cities, the wetland in Deep Bay (Shenzhen Bay) area is a highly ecologically sensitive area internationally renowned for migrant birds. However, while Mai Po wetland in Hong Kong is adequately protected, the parts close to Shenzhen is susceptible to rapid development of skyscrapers in Futian and Nanshan districts. Number of birds arriving in the wetland has been dwindling in recent years, coinciding with the construction boom in districts of Shenzhen near to Deep Bay [27]. With a potential

Fig. 34 Shek O Country Park. (Photo Credit: Joe Chen)

Fig. 35 Tai Tam Country Park. (Photo Credit: HK Discovery)

integration of the two cities would not have allowed the two contrasting policies near the conservation area i.e. high-density development on one side and total conservation on the other side. As smart cities should be conscious of the environment and nature, the two cities should find a smart development strategy to reconcile the need for development and conservation with attention to the planet.

While Shenzhen plans to develop the city with the concept of eco city which aims to enhance the well-being of the inhabitants and society through harnessing the benefits of the ecosystem and protecting the natural assets, integration with Hong Kong would allow more holistic planning and management that does what is best for the environment. Apart from adopting BEAM Plus green building design standards, the integrated smart megacity should consider to development a set of standards for

"eco development" that also put the fauna and flora in mind, and foster co-existence of humans as well as other forms of life. The ecologically sensitive areas near Futian District of Shenzhen and Lok Ma Chau of Hong Kong would be a good testing ground for "eco development".

By integrating both the cities, it would be beneficial for both the city governments to work together and mitigate the pollution of air, water and address climate change issues as well. As Shenzhen leads the world for encouraging the use of electric vehicles and is the headquarter of BYD, a leading manufacturer of electric vehicles and batteries, it can guide Hong Kong into a more wide-spread adoption of electric vehicles, with assistance from aspects ranging from supply of vehicles to policy initiatives. Apart from shifting towards adopting more renewable energy sources, the integration of the two cites paves the way for more efficient use of resources such as electricity and water. By connecting the power grid and water supply systems, the excess production or under-utilization of power or water could be sold and transferred to the system of the other city. It could be lucrative if a city succeeds in reducing water and power usage while still have excess resources, the resources could be sold to the other city or cities in GBA at a lower price. It rewards good implementation of environmental policies while still optimizing the production power of plants and remaining resources.

As Shenzhen and Hong Kong are becoming more interdependent, it is recommended that the two cities should also work together and plan to build a better future together as a smart megacity rather than doing different individual plans and environmental policies that might undermine the other city.

3.4 Community Integration

Public participation and community engagement is especially important to ensure the opinions and voices of all key stakeholders are heard. While working closely together, the government of Hong Kong and Shenzhen should be proactively reaching out to the community, the private sector, academia and other key stakeholders to educate and raise awareness for any future initiatives. At the same time, this also allows government to receive feedback to come up with a workable solution together through an inclusive and transparent process. There should also be crossed border joint community engagement so that stakeholders from Hong Kong and Shenzhen can listen and understand each other.

Aside from public participation and community engagement, there are also other aspects of community integration. As communication and cultural exchanges between the two cites grow over the years, communities integrate naturally as seen in the increasing number of cross-boundary marriages. Government statistics show that, out of the 50,008 registered marriages in Hong Kong in 2016, mainland-Hong Kong cross-boundary marriages account for 34.7% of the total number. Marriages between mainland and Hong Kong people have brought the two sides closer. Apart from

family relationships, interaction of other social groups is also vital to the integration of communities.

As part of the vision to bring Hong Kong more closely tied with the GBA, the Department of Housing and Urban-Rural Development of Guangdong Province announces new measures to facilitate the construction and engineering related enterprises and professionals in Hong Kong to start business and practice in the nine mainland cities in the GBA, which allows relevant construction and engineering professionals to work in GBA, including Shenzhen, with their recognized professional memberships in Hong Kong starting from 2021. The integration of professional community to not only share practical experiences and mentor the younger generation, but also helps foster interpersonal relations between the people and mutual understanding. Through the ongoing interaction and community integration, people of the two cities could become Smart People, who are open-minded, knowledgeable, innovative and creative.

3.5 Administrative Integration

As Hong Kong's status as the SAR of China will be coming to an end in 2047, the city should be prepared for changes in the system but at the same time retain its position as one of the world class cities. Shenzhen on the other hand is a growing city that is gaining global recognition and the recent policy to make it autonomous will only further help in its transformation. For two major influential cities to be linked closely together, it should be favorable for both administrations to collaborate and find synergy to make both cities better and help drive the smart and sustainable development of the GBA.

For Hong Kong and Shenzhen to grow together as a smart megacity, it is crucial that both city governments are working together in the same direction. Hong Kong and Shenzhen should also work to come up with a strategic plan through holistic approach guiding the future direction. Both sides should be communicating and reviewing regularly to carry out and support the various strategies in both cities. Hong Kong has been working closely with mainland in deepening their relationship. A Closer Economic Partnership Arrangement (CEPA) was signed in 2003 to facilitate the growing investments and trading in the GBA. Hong Kong and Shenzhen have also signed a "Shenzhen-Hong Kong Innovation Circle" cooperation agreement in 2007 to promote technology collaboration between the two cities. As more partnerships and collaborations are formed, Hong Kong and Shenzhen will benefit in creating a sustainable and competitive market for years to come.

More recent and possibly more well-known administrative integration initiative is the promulgation of the Outline Development Plan for Guangdong-Hong Kong-Macao Greater Bay Area by the mainland Chinese government. The Outline Development Plan covers the period up to 2022 in the immediate term, extending to 2035 in the long term. It sets out seven areas for development:

- developing an international innovation and technology hub;
- expediting infrastructural connectivity;
- building a globally competitive modern industrial system;
- taking forward ecological conservation;
- developing a quality living circle for living, working and travelling;
- strengthen cooperation and jointly participating in the Belt and Road Initiative; and
- jointly developing Guangdong-Hong Kong-Macao cooperation platforms.

Hong Kong and Shenzhen are well placed in the Plan as core cities earmarked for deeper cooperation and to leverage the comparative advantages to strengthen the radiating effect and lead the development of nearby regions. Combinations of Hong Kong-Shenzhen, Guangzhou-Foshan and Macao-Zhuhai are viewed as three "poles" to drive the growth and international participation of the whole GBA. It is clear that the central government of China is aware of the advantages of deepened cooperation of the two cities and is paving way for their integration that lead up to a smooth transition by 2047 for Hong Kong. GBA offers a bigger vision with the whole area being integrated. Embedded with Smart Thinking, the integration of GBA cities has the potential to become a Smart and Sustainable City-Region, unparalleled by other city clusters in the world (Fig. 36).

Fig. 36 Cities of Guangdong-Hong Kong-Macao Greater Bay area

Compared with other city clusters in the world, the GBA currently has the largest population and land area. Data shows that the GBA's GDP is higher than that of San Francisco Bay Area but falls behind the New York Metropolitan Area and Tokyo Bay Area. The GBA is also the most visited metropolitan area by air with the highest air passenger throughput and the busiest air and sea ports with a lot more cargos handled compared with the counterparts. According to HSBC Research's prediction, by 2030, with the advantage of a larger population and increased connectivity from transportation projects, the GBA will exceed the other city clusters in terms of GDP, providing a lot more opportunities compared with its counterparts (Fig. 37).

Large city-regions in the world have been pivotal in a country's development and innovation as evident in the examples of New York Metropolitan Area, Tokyo Bay Area and San Francisco Bay Area. Administrative integration which ensures consistency and holistic planning is crucial to the city-regions' development. Different from other city-regions, Hong Kong and Shenzhen worked under different systems due to Hong Kong's unique history and status. The high-tech hub Shenzhen is likely to play a larger role in driving the area's future growth, but mainland Chinese capital controls will keep it from becoming a portal for global investment. While Hong Kong may have passed its peak period for growth, its freely convertible currency and business friendly environment, thanks to the "one country, two systems", ensures its unique position as China's window to the world. With smart thinking and a focus on People, Place and Planet, the partnership and further collaboration of administrations

	Guangdong-Hong Kong-Macao Greater Bay Area	San Francisco Bay Area	New York Metropolitan Area	Tokyo Bay Area
Land area (sq. km)	56,094	17,887	21,479	36,899
Population	72.65	7.75	19.3	44.28
GDP[1] (US$ bn[2])	1,679.3	946.6[3]	1,772.3[3]	1,976.8[4]
Real GDP growth	4.4	6.8[3]	1.6[3]	2.7[4]
Per-capita GDP (US$)	23,116	122,093[3]	91,812[3]	44,855[4]
Air passenger throughput (mn passenger times)	223.2	86.0	140.0	127.8
Air cargo and airmail throughput (mn tonnes)	8.11	1.22	2.33	3.28
Port container throughput (mn TEUs)	67.89	2.55	7.47	7.49[3]
GDP share of tertiary industry (%)	66.2	71.6*[3]	82.9*[3]	74.5[4]

Note:
[1] At current market prices
[2] Converted with the yearly average exchange rates
[3] 2018 figure
[4] 2017 figure
*Estimated figure

The San Francisco Bay Area covers nine countries bordering the San Francisco Bay. The New York Metropolitan Area covers the three cities of New York, Newark and Jersey and 25 surrounding counties. The Tokyo Bay Area covers Tokyo and its seven surrounding prefectures.

Fig. 37 Comparison of the World's Major Bay areas. *Source* Hong Kong trade development council

that harness the strengths of Hong Kong and Shenzhen will naturally form a smart megacity critical to the development of the GBA and beyond.

4 Conclusion

The historic importance of being a gateway between China and China's opening up to the rest of the world, Hong Kong and Shenzhen flourish as the most competitive cities in the world in the old and new economy. Despite their differences in culture, regulations and administrative system, with both cities' relative advantages, they are better off working in partnership and could come together as a smart global megacity that will be incomparable to others. It is suggested that closer collaboration between Hong Kong and Shenzhen could maximize the strengths and minimize the weaknesses of Hong Kong and Shenzhen while complementing and benefiting each other.

Each having unique trajectory of development Hong Kong developing from a small fishing village to a world-class city in Asia, and Shenzhen transforming itself in a short period of time from a small fishing village to a high-tech hub, the "Silicon Valley of China", thanks to favorable policies of China attracting Hong Kong's manufacturing industry to move across the border along with substantial investment as well. Both cities are potentially the most important cities and the key economic drivers of the GBA within South China. According to data compiled by the Hong Kong Trade Development Council, Hong Kong and Shenzhen each account for 21.8 and 23.2% of the GDP in GBA in 2019. Having worked closely together since Shenzhen's designation as SEZ, the Hong Kong-Shenzhen partnership continues with each specializing on different functions as both cities continue to grow. Despite being outgrown by Shenzhen recently, Hong Kong, plays an important role in bringing foreign investments to Shenzhen. Adopting the Smart and Sustainable City Framework developed by UDP International and Institute for Sustainable Urbanisation (ISU), this chapter builds on the analysis previously done in the book series and evaluates Hong Kong and Shenzhen based on the six Smart City Elements, namely Smart Living, Smart Environment, Smart Mobility, Smart Infrastructure, Smart Governance and Smart Economy.

Both cities have done poorly in providing affordable housing, one of the important criteria of Smart Living, with both being ranked as one of the most unaffordable cities in the world in owning a housing property. Despite efforts from the governments in providing affordable housing, more needs to be done to alleviate the current housing affordability issues. Shenzhen has been struggling to increase the ratio of development land for residential uses, while Hong Kong also faces difficulty in finding available land for public housing as well as private developments. From a cultural heritage perspective of smart living, Hong Kong has its edge in comparison to its neighboring Shenzhen. Hong Kong has more to offer in terms of cultural heritage, with a more vibrant creative, art and culture scene and attractiveness for global artists to participate in cultural events. With some existing colonial-style buildings and heritage,

Hong Kong will be welcoming new contemporary art museum M + , and the Hong Kong Palace Museum in West Kowloon Cultural District. With better awareness of the Hong Kong government in preserving cultural heritage, or the private sector efforts in conservation such as The Mills by Nan Fung Group, as well as bottom-up initiatives such as Smart Cultural Precinct @ Central by ISU, Hong Kong has a richer cultural foundation than Shenzhen, which has come onto the world stage in less than 40 years. Hong Kong's distinctive skyline across Victoria Harbor and its unique Peak View are world famous. Nevertheless, Shenzhen has been an inviting playground for architects as the city is hungry for architectural masterpieces to decorate its skyline. Hong Kong also has better health care, with affordable public health care system as a safety net with additional choices in private hospitals and clinics. Hong Kong also performs better in education than Shenzhen with more world-class universities and academic exchanges with other higher education institutions in the world.

Cities should be conscious in managing the resources and the natural environment in their endeavor towards Smart Environment. With a recycling rate of 30% in Hong Kong in 2018, similar to that of Shenzhen of about 30%, both cities have a need to use their resources better and also improve their waste recycling and reduction strategies. Nevertheless, there are smart initiatives for the environment to improve air pollution problem in Shenzhen including subsidizing electric car owners and using electric vehicles in public services, such as bus fleet. On the other hand, the Hong Kong Chief Executive Carrie Lam has set a target of achieving carbon neutrality in 2050 in her 2020 Policy Address with more in-depth environmental policies to follow, which include the promotion of electric cars. On provision of green spaces, Shenzhen has put a lot of efforts in making the city greener (41.2% coverage of forest) and it is now dubbed the "National Forest City" in China. By the end of 2019, the number of parks in Shenzhen had reached 1,090 according to the Shenzhen Municipal People's Government. However, the distribution of green spaces in Shenzhen was not as even as Hong Kong where people can easily enter one of its country parks by public transport within an hour from the urban areas.

On Smart Mobility front, both cities are very well served by public transport with modes ranging from metro, buses, with real-time schedules available with the aid of an app, and on-demand services like taxis and more recently ride-sharing, which is more common in Shenzhen as ride-sharing in Hong Kong is officially illegal. Underpinned by the cities' compactness and the availability to commute without a vehicle, Hong Kong and Shenzhen are regarded as very walkable, despite Hong Kong is not as pleasant and cycle-friendly as its neighbor with hilly terrain and compact built environment especially in the city center.

Openness and connectivity of a city is one of the indicators for Smart Economy as it facilitates the free flow of information and exchange of ideas. Having long been a global financial hub, Hong Kong has established good connectivity with the rest of the world, while Shenzhen has plenty of direct domestic flights, the cooperation of the two airports could bring synergy to the whole region. Probably a victim of its own success, Hong Kong has been struggling to diversify its industry from predominantly financial services and trading to be more innovation-driven. Shenzhen has successfully transformed itself as the "Silicon Valley of China" and moved to the

upper echelon of the global value chain. It is also evident that the entrepreneurship and start-up culture with competitive, well-educated young population have paved the way for Shenzhen's "smarter" economy.

It is widely agreed that transparency is an important element of Smart Governance as the government has to be made accountable for its decisions and it lays the foundation of public participation. Hong Kong is relatively transparent with a wide range of easily accessible information of public services, policies, and even data measuring the efficiency of the government in both Chinese and English. Statistics of market conditions are also regularly updated for easy compilation of market intelligence. Public participation is evolving in Hong Kong as most policy initiatives include public consultation exercises and relevant statutory bodies such as District Council would be normally consulted. Shenzhen is far less transparent in its governance with limited release of information with most information only available in Chinese, not to mention the limited channels for engaging the public. Going forward, Shenzhen's governance could improve further as the central government has recently given the city more autonomy on aspects including intellectual property protection, economic legislation and talent attraction.

Both cities are working towards "Smarter" Infrastructure. Hong Kong has relied on coal for half of its electricity generation, with the rest being natural gas and imported nuclear power each accounting for 25%. Despite Hong Kong government's effort in promoting renewable energy, it seems not to be bearing fruit without fundamental shift and mind set changes among the local people. Shenzhen has seen a decrease in reliance on coal with less than 15% of power generated from it. Shenzhen showed higher acceptance towards nuclear power which accounts for more than 45% of electricity generated. Aside from utilities, Hong Kong has strong basis in its ICT infrastructure and digital connectivity. With 11 submarine optic-fiber cables interconnected with other continents, Hong Kong is in a pole position for developing data centers and hub for cloud computing. Achieving full 5G coverage across the city in August 2020, Shenzhen has also announced its ambitious plan to be one of the world's leading 5G cities with largest scale and highest innovation level of "new infrastructure". With each city exceling in different aspects, by bringing the two cities closer together, the formation of a potential megacity could unleash the largest potential for Hong Kong and Shenzhen which could be more beneficial than for each city to be working on its own.

The formation of Hong Kong and Shenzhen as a Smart Mega City would require further collaboration and integration at various levels including physical, socio-economic, environmental, community and administrative aspects. Physically, being the connecting points of Hong Kong and Shenzhen and well connected with transit, the Border Control Points (BCPs) should be activated as nodes and act as the starting points of physical integration. Visa and immigration process for trips between the two cities should be friendlier and easier with initiatives or policies allowing smoother flow of personnel with lower time and cost. By integrating physically and having a collaborated planning approach for development and growth and managing infrastructure needs, the cities could better utilize man-made and natural resources and

have potential to move towards becoming "smarter" and sustainable cities. On socio-economic aspect, both cities can take their strengths to improve the weaknesses of each other, such as providing better education and health care, increasing synergy between technological innovation, financing and other professional services, and attracting foreign investors to fund smart initiatives and technological developments with better connection with the global financial market. Environmentally, Hong Kong would be able to provide a unique outdoor experience for people of Shenzhen, especially for parts of the city that are nature-deprived, as the green spaces in Shenzhen are not evenly distributed. While Shenzhen has less to offer in arts, culture and heritage, Hong Kong can comfortably serve as the tourism outlet with richer cultural offerings in the unified smart megacity. Aside from different elements and characteristics of both cities, bringing the people together is also important. Therefore, more interactions and exposure especially for the younger generation, more community engagement should be proactively done to educate, raise awareness, and obtain feedback from the various key stakeholders on both sides. Lastly, administrative integration should be achieved through collaborations of both city governments working together to formulate a strategic plan through a holistic approach. By combining the resources, working closely in partnership with both sides of the government, and engaging the public sector, private sector, community, academia and other relevant key stakeholders of both cities, a smart global megacity can be formed with Hong Kong and Shenzhen viewed together with a focus on People, Place, and Planet. This would also help to ensure a much smoother transition for Hong Kong leading up to 2047. Also, other cities in GBA can follow suit and pair up for more synergies and develop together in a smart and sustainable manner.

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Kolkata

Smart Global Megacities Spatial Strategies for Kolkata Metropolitan Region

Prabh Bedi and Mahavir

Abstract Metropolitan cities are the drivers of the economy. Some of these metropolitan cities have merged into mega cities. As these are centers of attraction it is pertinent to govern these centers so as to harness their full potential. There is no clear guideline or precedence of governing the mega cities in the country. Through this research attempt has been made to understand the structure, governance systems and the issues of the mega cities. The largest city centers that have been existing and experimented in governance are the metropolitan cities and regions. Metropolitan governance in India is polycentric and fragmented system with limited coordination. This research discusses the governance systems of the metropolitan cities and their issues as well to create a comparison with those of the mega city. It has been put forth that the existing governance system is suboptimal and requires a research and discussions as a way forward for the newly emerging mega cities. Some suggestions have been made to improve the governance of these mega cities.

Keywords Mega city · Metropolitan region · Metro city · Kolkata · Spatial planning

1 Introduction

The metropolitan scale creates challenges in planning, management and governance. A metropolis is an area of continuous spread of cities and intervening rural areas. These are merging of urban space which become areas of accumulation of resources. Metropolitan regions witness increasing linkages with the global economy as well as competition among themselves for attracting investments. For this study the terms metropolitan area and metropolitan region in this chapter have been interchangeably used. Some of the metropolitan cities and regions have grown in mega cities on account of the population exceeding ten million people.

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Through this paper an attempt is being made to understand the urban structures in India, specially in light of the 74th Constitutional Amendment Act, 1994. Further the functioning of metropolitan governance of Kolkata is analyzed in light of the structure at the national level. With the emergence of the mega cities in the country, an understanding has been developed about the structure, governance and issues of the mega cities. As a case study, Kolkata has been studied.

Metropolitan governance in India is attributed with multiple organisations and overlapping jurisdictions. However, these are also characterized with an absence of cooperation, coordination and competition. These are essentially polycentric in nature. Through this research, the polycentric nature of Kolkata has been demonstrated. An attempt has been made to find the solution to the metropolitan governance issue in consolidation and strengthening or in coordination and cooperation of the existing fragmented setups.

Despite metropolitan regions being economic entities and there being several lacunae in the governance of the mega cities and their metropolitan regions, there is dearth of literature or discussion on these issues. The research attempts to bridge this gap. It assesses the existing governance systems in Indian metropolitan and mega cities and provides a way forward.

2 Urban Area Definitions

Census of India in 2011 [1] defined an urban area as one that fulfils the criteria as:

1. having a statutory status of a municipality, council, corporation, cantonment board or a notified town area committee,
2. and having criteria as:

    a. minimum of 5,000 people,
    b. 75% of male main working population engaged in non-agricultural activities
    c. population density of at least 400 persons per square kilometer

The urban areas are further classified into categories from one to six (Refer Table 1) based on the population, class-I urban areas (UA/city/town) being the ones with population above 0.1 million. The urban areas having population above 0.1 million are further categorized into medium town, large city, metropolitan city and megapolis (Table 1).

In the 1971 Census, large urban areas were recoganised for the first time under the name of urban agglomerations. Planners have considered metropolitan regions inclusive of the urbanizable area, the area lying outside the existing urban settlement. As stated by Sivaramakrishnan [3] the metropolitan identity of these Indian cities came about for the first time in 1970s with the constitution of development authorities. This was the decade which experienced formation of multiple organization and parastatal agencies to handle multiple tasks in the metropolitan regions.

Table 1 Classification of urban settlements

S. No.	Classification	Sub-category	Population range
1	Medium Town	I	50,000 to 100,000
2		II	100,000 to 500,000
3	Large City	–	500,000 to 1,000,000
4	Metropolitan City	I	1,000,000 to 5,000,000
5		II	5,000,000 to 10,000,000
6	Megapolis	–	Above 10,000,000

Source URDPFI Guidelines, 2014 [2]

The Urban Agglomeration (UA) is delineated as per the criteria of Census, while the metropolitan area is defined by identified authority as per the constituted act under the aegis of the state governments.

Merriam Webster dictionary [4] defines a megapolis as a thickly populated region centering in a metropolis or embracing several metropolises. Kulshrestha [5] defines megapolis as an agglomeration of cities merged with a metropolis forming a thickly populated area having a population of above 10 million people. These areas are defined by its population size. The most accepted definition of a megacity is a very large city consisting of at least 10 million inhabitants. The United Nations uses the figure of 10 million, upgraded from the initial threshold of 8 million, to designate this new class of very large cities [6]. There has been a rapid increase in mega cities since 1950, when New York and Tokyo were the only mega cities. At the turn of the century these types of cities were 16 [7] and as of 2018 were 33 [8]. Majority of these cities are found in less developed regions.

Amongst these, there are five in India, namely, Delhi, Mumbai, Kolkata, Bengaluru and Chennai. These cities account for 3.39% of India's total population and 10.89% of its urban population [9]. Amongst these Kolkata, a trading hub, is the only city that has experienced a negative growth in its population.

These cities have grown into megacities over time by attracting people from surrounding rural and urban areas. Better employment services and facilities leading to lower mortality rates, better access to food, and improved sanitation, which helps in improving the death rates have been one of the key attractions for the migrants. This leads to the birth rate exceeding the death rates and other than the increase due to the influx of populations leading to both induced and higher natural growth rate. In addition, these cities have functioned as centers of economic activities as centers of production at the national and global scales creating wealth for governments and becoming pivotal locations for import and export. Becoming places of agglomeration due to location of industries and its ancillary units makes it economical for goods to

Table 2 GaWC ranking of indian megacities

City	GaWC ranking							
	2000	2004	2008	2010	2012	2016	2018	2020
Delhi	Beta	Beta −	Beta +	Alpha −	Alpha −	Alpha −	Alpha −	Alpha −
Mumbai	Alpha −	Alpha −	Alpha	Alpha	Alpha	Alpha	Alpha	Alpha
Kolkata	Gamma	High Sufficiency	Gamma	Beta −	Beta −	–	Gamma	Gamma +
Bengaluru	Gamma +	Gamma +	Beta	Beta +	Beta +	Beta +	Beta +	Alpha −
Chennai	Gamma	Gamma	Gamma +	Beta	Beta	Beta −	Beta	Beta

Source GaWC—The World According to GaWC (lboro.ac.uk) [11]

be produced at these locations, further attracting population to these cities. Lastly, technology has in recent times played a key role in causing the accumulation of resources and activities, which has led to some of the cities in the world to grow into megacities.

Megacities are a recent phenomenon across the world and are essentially global in nature. The worldwide growth of the cities on this massive scale has been due to economic linkages, which has led to traditional planning strategies and policies being rendered problematic [10]. Not all large cities in India are global. Those may be considered as global which have been listed in the various world city rankings from time to time, as the ranking by Globalization and World Cities Research Network (GaWC) [11]. The megacities in India as listed by UN in 2018 [8] have been in the global cities list since 2000 (Refer Table 2).

The role of the city in the global trade is a determinant of its being a global city as well. With that perspective, Indian cities like Mumbai, Chennai and Pune hold a dominant position, Kolkata having lots its standing post-independence. The current claim of Kolkata in the global city arena can be attributed only to its population.

3 Spatial Strategies in Planning

3.1 International

Metropolitan area as defined by OECD [12] is a functional urban area of at least 500,000 inhabitants. This functional area is an urban agglomeration with a continuously built-up urban core and surrounding areas. The limits of the area are delineated based on the commute of the inhabitants from surrounding areas into the urban core.

Urbanisation differs from country to country but is shaped by similar trends all over the world. The urban regions as megacities are defined as those with a total population

in excess of 10 million, a metropolitan area has at least 500,000 inhabitants and the small and medium-size urban agglomerations are those that have 50,000 to 500,000 inhabitants.

OECD [12] suggests four typologies of metropolitan governance based on institutional setup:

- informal/soft co-ordination: these are mostly of polycentric urban development, having informal institutionalized platforms for information sharing. These governance systems generally lack enforcement tools and their relationship with citizens and other levels of government tends to remain minimal;
- inter-municipal authorities: Such systems are established for a single purpose, with an aim of sharing costs and responsibilities across the various municipalities within the metropolitan area. There is some level of participation of other levels of government and sectoral organisations like parastatal agencies. Various sectors like land use, transport, infrastructure is managed by multi-purpose authorities;
- supra-municipal authorities: An additional layer above municipalities can be introduced either by creating a directly elected metropolitan government or with the upper governments setting down a non-elected metropolitan structure. The extent of municipal involvement and financial capacity often determine the effectiveness of a supra-municipal authority; and
- special status of metropolitan cities is extended to cities that exceed a legally defined population threshold, which puts them on the same footing as the next upper level of government and gives them broader competencies.

Sorensen and Okata [13] have observed that the definition of megacity varies based on the population from as low as four million [14] to eight million [15] or those urban agglomerations that have population in excess of ten million [16].

3.2 India

Immediately after Independence, the focus on urban India had been on the ideologies of region and decentralization with emphasis on setting up industries away from then existing large cities. This manifestation was more so as it was perceived by the planners that population growth in metropolitan cities like Kolkata and Mumbai would lead to issues of law and order. The country experienced policies of containment of large and metropolitan area with restrictive investment initiatives. Trade and tariff policies were designed to remove locational advantages of metropolitan cities and regions [17]. From the Fourth to the Ninth Five Year Plan, the emphasis had been on small and medium towns. The emphasis shifted to large cities in the Tenth Plan, with a possibility of secondary and high-value tertiary activity giving people residing in large cities an opportunity of earning higher income [3]. This approach continued in the Eleventh Plan, stating the Megacities to become the centers of trade and commerce, with a need to be planned beyond the municipal limits with integration

of transportation and communication [18]. The emphasis on the large, metropolitan and megacities has continued since, with the more recent initiatives of Smart Cities.

The metropolitan cities in the country have grown despite unfavorable government policies. The growth has not only been in population but in terms of area as well. The four main metro cities of the country, namely, Delhi, Mumbai, Kolkata and Chennai have grown manyfold. Delhi having boundary limitations has grown into a large National Capital Region leading to mushrooming of growth centers and satellite towns in adjoining states. Mumbai, Kolkata and Chennai being port cities and having global connections have played significant role in manufacturing and trade.

3.3 Smart Cities Era

With the turn of the century and the increasing innovation in technology, the field of urban planning and management too has experienced it benefits. The most visible role played by technology has been the emergence of concepts like intelligent city, digital city and later smart cities. The smart cities initially had been considered to be those that are based on technology. Smart is generally defined as that which is clean, attractive and happens quickly. Technology has enabled the quickness of delivery of the various aspects of an urban area, be it planning or management. The definition of smart city has evolved over time. It can now be considered to be one that is inclusive, sustainable in social, environment and economic terms and is essentially built on a robust and scalable technological platform.

Government of India embarked on its journey of building smart cities in 2015. The government intends to focus on sustainable and inclusive development the with idea to look at compact areas, create a replicable model which can act as light house to other aspiring cities [19]. The government states that the smart cities shall be solution based with the purpose of primarily improving the infrastructure of the cities. The Mission has had two-pronged approach, pan city and area-based development. Area based development has been mainly focused on developing and improving the condition of the core city, while the pan city focus has been on improving the infrastructure through smart solutions.

Smart City, a multi-disciplinary concept, rooted largely in the spatial planning and information systems domains. The statement and guidelines from the Ministry of Urban Development are silent on the legal framework to regulate and manage these. Would tweaking and strengthening the current municipal, development and state laws be more beneficial, rather than any over-arching legislative framework to govern these Smart Cities.

Urban development is a state subject as per the Constitution of India [21]; hence the state authority makes its acts, regulations and policies taking guidance from the regional or/and central level acts and policies. There exist some missions and schemes that are launched by the central government and are implemented across the country, like the Smart City Mission.

4 Metropolitan Governance in India

Governance refers to structures and processes designed to ensure accountability, transparency, responsiveness, rule of law, stability, equity and inclusiveness, empowerment, and broad-based participation. It goes on to represent the norms, values and rules of the state through which affairs of the governed area are managed in a transparent, participatory, inclusive and responsive manner. Governance is the cultural and institutional environment in which citizens, government and stakeholders interact and participate in public affairs. The governed area in this context are the metropolitan regions in India.

The Constitution of India as per Article 243P defines the metropolitan areas as those having a population of one million or more, comprised in one or more districts and consisting of two or more municipalities or *panchayats*[1] or other contiguous areas, specified by the head of the state by public notification. Governance of these areas has been through specially constituted authorities.

Metropolitan governance in the India has been through multiple organization with overlapping jurisdictions. Multi-level, multi-type and multi-sectoral and multi-functional nature renders the governance of metropolitan areas to be polycentric in nature [20]. However, the governance systems experience lack of cooperation and coordination amongst its various organisations. In essence the true spirit of polycentric system should be that of cooperation between organisations.

The complexities arising out of a multilevel system in India with functional fragmentation and overlapping jurisdictions have been detrimental to the effective discharge of functions that are best undertaken at the metropolitan level, such as transport planning and coordination, urban planning, and financing large-scale infrastructure projects that have interjurisdictional spillovers.

Some large cities, due to certain favorable economic, cultural and institutional drives have grown to become megacities, accommodating exceptionally large population in a large expanse of area. As of date, there are no separate governance setups for these megacities. The pre-existing metropolitan governments are continuing to evolve and manage these city centers.

Area delineation of the metropolis is a crucial stage in the spatial planning of the metropolitan city. The delineation activity should be with the objective of containment of growth and future expansion of the core city from sustainability perspective and to ensure the coordination of land use development plans of the various parts of the metropolis. This has been achieved in some cases in the country by way of demarcating a green belt in the periphery. However, it must be noted that over a period of time, the green belt has been built up. There is a general sense among the stakeholder including the administrators, planners, politicians, developers and citizens that the green belt is an urbanisable area and in all likelihood would be converted into built-up use during the subsequent development plans.

Public satisfaction has emerged as a key component in the urban governance, irrespective of the size of the urban area. It is argued that planning and management

[1] Panchayat is a village council in India.

of the urban areas is a technical aspect, which in some aspects holds true and forms the basis of governance of the metropolises. However, citizen satisfaction has emerged as one of the key factors in the success of the metropolis.

Management of the urban areas has been largely in the control of the political institutions, as a mayor who is the elected representative, responsible for the functioning of the municipal body. In actual, the person who is appointed by the state government as the commissioner or chief executive is fully responsible for the running the organisation. This situation is existing in almost all major cities in the country with palpable tension between the two formed power centers.

Inter-municipal cooperation becomes a prerequisite in the smooth governance of the metropolitan city owning to the multi-jurisdiction nature of these large cities. Interesting, none of the metropolitan regions of the country welcomed the setting up of the metropolitan level development bodies. Even in the case of the Kolkata, despite the initial support that was rendered in the initial stages of setting up of the metropolitan level body, there was much resistance subsequently, not only in the bureaucratic but political spectrum as well [3].

5 74th Constitutional Amendment Act (CAA)

It is provided in the Act [21] that in every Metropolitan area (with a population of 1 million or more), a Metropolitan Planning Committee (MPC) shall be constituted with the prime purpose of preparing a draft development plan for the metropolitan area as one entity. The Metropolitan Planning Committee shall take into account the following for preparation of the Draft Development Plan:

- plan prepared by the Municipalities and the Panchayats in the metropolitan area;
- matter of common interest between the Municipalities and Panchayats including coordinated spatial plans of the area;
- sharing of water and other physical and natural resources;
- integrated development of infrastructure and environmental conservation;
- overall objectives and priorities set by the Government of India and the State Government;
- extent and nature of investments likely to be made in the metropolitan area by agencies of the Government; and
- other available resources, financial and otherwise.

Sustainable and equitable development of the metropolitan region was one of the key purposes of constituting the Metropolitan Planning Committee under the 74th CAA. The 74th CAA envisaged an independent metropolitan governance through identified representatives from the local governments. Rapid urbanisation and increase in the number of metropolitan areas substantiates the need for this institutionalization. This system of governance and institutionalization is to ensure people's indirect participation in the metropolitan development. The 74th CAA legitimized to establish one Metropolitan Planning Committee in each metropolitan region and

suggested its structure, wherein two-thirds of the committee members are to be chosen from the elected representatives within the region by the ratio of people living in the participating urban local bodies. The remaining committee members are to be chosen by the elected representatives and some of the remaining one-third committee members are independent technical experts and technical assistants. The organization structure of Metropolitan Planning Committee includes the Members of Parliament and the Members of the (state) Legislative Assembly.

The members of Parliament coordinate the local development agenda with the national policy and funding opportunities and provide relevant exposures without any veto or decision-making rights. The members of (state) Legislative Assembly oversee development strategies of a metropolitan region and nurture its' growth as an important entity of the concerned state. However, none of the Indian states was proactive in setting up Metropolitan Planning Committees. Kolkata established the first Metropolitan Planning Committee after a decade of the enactment the 74th CAA [22, 23]. Most metropolitan regions have instituted Metropolitan Planning Committees though these efforts have remained more as a formality. In India, all metropolitan regions' jurisdiction lies within one state except for that of National Capital Region (NCR) Delhi.

The MPC depend on the metropolitan development authority for technical advice and for preparing the plan for the metropolitan region. The participating urban local bodies carry out their responsibilities as outlined in the 12th schedule of the 74th CAA as per the powers devolved. These tend to depend on the metropolitan development authority for knowledge and necessary technical support.

74th CAA has not brought any significant changes to the existing arrangements in metropolitan governance. It has been observed that [3] the governance system in the metropolitan areas is no different from what existed in the pre-amendment era. There is still the predominance of fractured systems, which are a collection of parastatals and agencies having overlapping sectoral and spatial jurisdictions.

6 Metropolitan Governance Philosophy

The urban areas undergo a metamorphosis as they transform from a small town to a metropolitan region in terms of physical, economic, administrative, social and environmental complexities [24]. At the time of independence, the vision of the political leaders was to develop the country through self-sustaining, self-governing villages. The concept of urban and governance of urban areas was introduced by British through the enactment of various acts and institutionalization of municipal corporations for governing the large urban centers. This created a dichotomy is the structure of governance in the country. In time, Improvement Trusts were created by the British to plan the towns, which is seen as the first step in negating the role of the municipal authorities in managing, governing and planning the urban areas. Over time the municipal authorities lost their efficacy [25]. The local bodies in the rural areas were unable to deliver urban like services and the municipal authorities

were strained to provide services outside their jurisdiction [26]. In the absence of regulation and control, haphazard development was experienced in urban periphery, especially around large urban areas, which was furthered by multiplicity of authority and overlapping of jurisdiction between the local authorities and parastatal agencies. Planning organisations as development authorities and metropolitan development authorities came to be established, furthering the concept of Improvement Trusts to have an overarching control and comprehensive growth of the larger geographical area.

These institutions are responsible for planning, development, and policy recommendations, whereas the urban local bodies provide utilities and civic services to citizens. The state governments administer the functions of the metropolitan authorities under the patronage of the political representatives.

7 Issues in Metropolitan Regions

Metropolitan regions typically contain at least one primate city, a few smaller towns or cities, and many villages. As stated above the 74th Constitutional Amendment Act, metropolitan regions are areas having a population of a million or more, comprised in one or more districts and consisting of two or more municipalities and/or panchayats forming a contiguous area which is specified by the state authority by public notification. The metropolitan regions do not have a legitimacy as a political entity.

The governance system for these regions have evolved to meet specific needs for delivering infrastructure and services at that scale. These laws and policies vary due to land being the state subject in the Indian constitution. These complexities exist in the megacities too as there is not underlying rule to form the basis. In most instances, these complexities are multifold owning to the involvement of larger population and a greater number of authorities involved in the governance. It is to be noted that there is no specific authority to look into the smooth functioning of the mega city region. Till date this task has naturally fallen on the existing metropolitan development authorities of the defined metropolitan regions.

Metropolitan areas are characterized by complexities of governance especially in terms of institutional structures and the inter relationships and interactions created by the overlaps, contradictions, and definitional ambiguities. Partly arising from definitional ambiguities, a significant challenge within metropolitan areas relates to different boundary/area arrangements that exist within or around these areas, and the various institutional arrangements that could potentially exist within the same metropolitan area, with different jurisdictional claims.

Planning for the mega city involves articulating a vision not just for the city's core but for the region controlled by the governing organisations with participation of the involved central, state and local authorities not only in the plan making but across all the stages of its deliverance including its management. There is a need

for functional coordination at sectoral level as well like between the organization dealing with environment, infrastructure and other parastatals.

Most large cities in India have been growing indiscriminately outside their municipal boundaries, which entails conversion of peripheral land from agricultural to non-agricultural use and construction of real estate for residential and commercial purposes. These areas are either governed by rural panchayats or smaller municipal councils that lack the capacity to cater to the infrastructure and service needs of the growing population. These areas have lacked in basic infrastructure and suffered due to the politician-builder nexus, lack of monitoring, unauthorized development and faulty and/or lack of planning vision of the authorities.

In many instances, the planning authorities have embarked on the process of delineating a planning area, called as the controlled area boundary, which is the urbanisable area until a certain time period, which is typically the target year of the development plan. Plans are prepared for these areas for the so-called planned growth of the area outside the municipal limits. Sheer lack of capacity of the concerned authorities clubbed with improper planning and implementation has furthered the issues.

The mega cities of India suffer due to the problem of too many plans and too little coordination. The development authorities prepare regional plans in accordance with the acts that govern them and in accordance with various states' town and country planning acts, while the Urban local bodies (ULBs) prepare local plans for land use along with development control regulations. Besides these, separate plans are also prepared for certain specific demarcated areas by the relevant planning authorities with a clear lack of connection between the plans of areas with overlapping jurisdictions. Further, there is no uniformity in the planning policies, laws, governance systems and the institutional setups across the mega cities. These do not exist at the metropolitan scale either.

It must be noted that a mega city is a complex entity. Another issue with planning at the megacity and metropolitan scale is the involvement of the state government. Regional plans are prepared by respective development authorities or town and country planning departments, which are under the state governments. The plans are notified at the state level, which causes a conundrum whether the plan is owned by the state or the local authority. Further in most of the cases in India, the planning, implementation and the managing authority is different, leading to loss of accountability. Owing to the size and complexities involved, the involvement of the state government in the planning, governance and management of mega cities is inevitable. This has been so in the metropolitan regions as well, which calls for well researched and innovative solutions for based on use of technology, inclusivity and institutional capacity enhancement.

8 Is Megacity Different from a Metropolitan?

A metropolitan area comprises of multiple jurisdictions of municipalities, panchayats and development authorities along with interventions by central and state level governments for their various projects and schemes. With the change in social, economic and political institutions of the emerging urban areas the metropolitan areas have become key economic and political regions. The mega cities are defined by population residing in the areas.

The prime definitions of both the metropolitan and the mega cities is based on the population. However, the metropolitan cities and regions have a spatial connotation on account of boundary delineations. These regional boundaries have a statutory backing and a designated authority responsible for their smooth functioning. The cities continue to be named as 'mega' based on the population. These mega cities are typically within the same spatial boundary as the metropolitan city. Like the metropolitan city is one that comprises of one leading city, other subsidiary cities and towns and the peripheral rural area in the contiguous region of the metropolis with a population of million plus. A mega city is an outgrown metropolitan city that is a contiguous spatial spread of the leading and subsidiary city along with the peripheral rural area with a population above 10 million.

The issues that have been persistent in the metropolitan cities in the country are continued to be experienced in these mega cities [27]. The approach towards their governance and management needs to be reinvented for the smooth and efficient functioning of the region. As stated by Kübler and Lefèvre [28] megacity governance is the ability to make collective decisions and devise public policies that effectively tackle these problems in the context of the megacity. In case of the mega city the linkages that it has with not just its hinterland or at the national level but with the international marketplace is crucial for its definition and success. Continued and long-term success of the mega city is heavily dependent of the livability and its environment, in social, physical and economic terms. To achieve this, it has been observed and emphasised by experts [29] that it is important to adjust the spatial scale for policies and government. As iterated by Ken Newton [30], large cities need large governance.

The prime question in the governance of mega city is if it is any different from the governance of large and metropolitan. The issue of coordination between the participating organisations which becomes a deterrent in increasing the livability index of the metropolitan city. Does it lead to the option of having an overarching statutory body that would be responsible for the mega city, which means the devolution of the smaller local bodies and authorities in one large authority responsible for the complete city. This aspect needs further research and exploration if the larger body would be capable enough to solve the societal problems.

As the cities have grown from large to metropolitan to mega cities, the spatial expansion has been produced through urban sprawl. The betterment of the standard of living coupled with the tremendous growth of car ownership has considerably increased transport problems. Traffic congestion is nowadays the rule in large

metropolises and the difficulties of movement of people and goods require massive investment in infrastructure and multi-sector policies in order to cope with mobility problems which largely overpass technical and economic dimensions and encompass issues of equity and ecology as well [28].

Large cities across the globe have seen an increase in social segregation [31]. Government programmes devised to counteract this trend have largely proven ineffective. The lack of affordable housing is today one of the most important issues faced by large metropolitan areas and it is of general acceptance that area-wide policies must be implemented in order to cope with this problem [28].

The degradation of the environment and more recently the question of climate change are also increasingly pressing policy problems that face large cities around the globe. It can be concluded that issues and problems of the mega cities are no different from those of large and metropolitan cities.

As observed, [28] megacities, like smaller cities, need to address the five core challenges of urban politics and policy pointed as: steer spatial development, provide technical infrastructure, offer public amenities and services, set up redistribution mechanisms and limit environmental degradation. The enormity of the issues would be higher in the mega cities, but similar problems would still exist.

It has been observed by the authors that as the size of the settlements have increased in population and space, there has been fragmentation in the governing bodies as well. There are larger number of local jurisdictions in addition to authorities that have been assigned sectoral tasks to cater to the infrastructure needs of the growing cities. Multiplicity of authority creates an impediment in the smooth governance of the metropolitan and mega cities. Delhi, the second largest megacity today, is also characterized by high governmental fragmentation due to a multiplicity of often overlapping public agencies and jurisdictions which is particularly acute [32]. Delhi has three Municipal Corporations with their respective spatial jurisdictions, and a Municipal Council for the New Delhi area.

Mega cities are economic drivers of not only the region but of the nation. These increasingly draw population, resources and investments not only from within the country but globally. The governance of megacities thereby becomes a matter of national importance. In a democratic country like India, states will be responsive to the policy problems and public needs owing to the stakes involved. Kübler and Lefèvre [28] have not been wrong to assume that the involvement of national agencies and authorities in urban policymaking is stronger in megacities than what is the case in cities of lesser size. Is the involvement of the state in policy making of the cities, even if these are mega cities holding few million people justified, when compared to a major fraction of population which is living outside the mega city? The answer to this may not be forthright yes unless it is seen only from the economic perspective. It should not be negated that in India, in most metropolitan cities the agencies managing such cities are controlled by central or state authorities.

There is going to be no reversal to the urbanisation trend in India and neither so in the world. As stated by Kübler and Lefèvre [28] the twenty-first century will be an urban century and more and more the century of megacities and these cities will be

crucial for the national economic well-being and will feature as the most important nodes of international economic, cultural and political exchange.

9 Case of Kolkata

Within the state of West Bengal, at the district level, top five districts in terms of percentage of urban population to the total urban population of West Bengal are Kolkata, North 24 Parganas, Howrah, Bardhhaman and Hugli which all are situated near Kolkata (Refer Map 1—Level of Urbanisation: West Bengal—2011).

The industrialization of Kolkata has been accompanied by rapid urbanisation. The economic opportunities that followed Kolkata's industrialization led to massive influx of population from the neighboring states of Bihar, Orissa, and the northeastern parts of the country.

Kolkata Metropolitan Area (KMA) is not only one of the largest metropolises but also the oldest metropolis in India, the genesis dating back to the 19th Century after the British colonial rulers set their foot in Kolkata. Spread over an area of 1,851.441 sq. km., Kolkata Metropolitan Region (KMR), the third most populous metropolitan area in India, is the urban agglomeration of the city of Kolkata. The area comprises of-

- the conurbation area, stretching in a linear manner along the east-west bank of Hooghly river and
- the rural areas lying as a ring around the conurbation area.

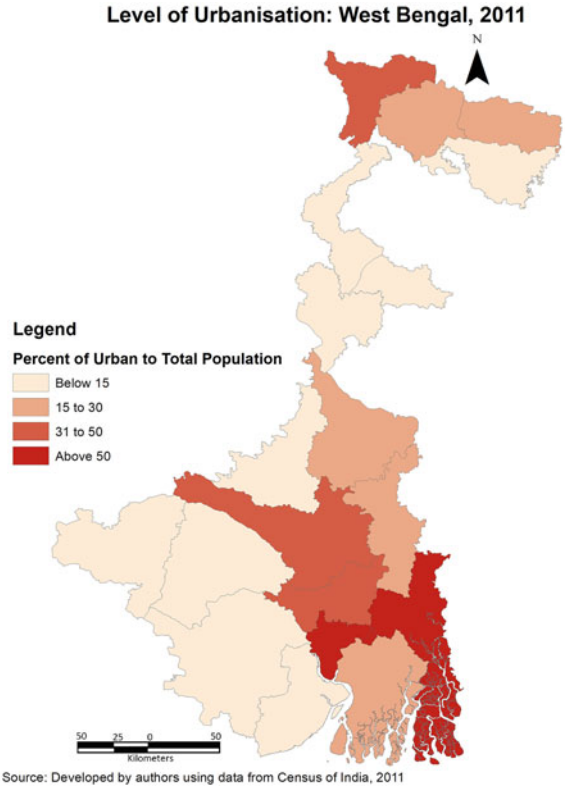
KMA, as delineated under West Bengal Town and Country (Planning & Development) Act, 1979, comprises of 3 Municipal Corporations, 38 Municipalities and 24 *Panchayat Samitis*. Three municipal corporations include Kolkata, Howrah and Chandannagore Municipal Corporations. The Urban Extent of Kolkata in 2014 was 96,868 hectares, increasing at an average annual rate of 4.7% since 2003. The urban extent in 2003 was 59,600 hectares, increasing at an average annual rate of 4.9% since 1990, when its urban extent was 31,319 hectares (Map 1).

The suburban areas of KMA includes parts of districts of North 24 Parganas, South 24 Parganas, Howrah, Hooghly and Nadia [33]. Spatially, the urban agglomeration expanded from 144 sq. km. in 1970 to 633.2 sq. km. in 2010. Indeed, the spatial growth pattern of the city show that major expansion occurred towards the east and south, by mostly converting large tracts of marshy areas, wetlands and agricultural land

It is the largest urban agglomeration in eastern India, and third largest in India with a population more than 50% of the total population of West Bengal state.

KMA has the highest density among the metropolises in India at around 8000 persons per sq. km. The metropolitan area of Kolkata is above 90% urbanized indicating a fast-approaching point of saturation in the region.

India's first metropolitan entity, Kolkata is the administrative capital of the eastern Indian state of West Bengal. It is the 20th largest city in the world [34]. The city



Map 1 Level of Urbanisation: West Bengal, 2011

stretches in north south direction along the eastern bank of River Hooghly in the deltaic basin (Refer Fig. 1). Most of the city area was originally a wetland and has been reclaimed over time to accommodate a burgeoning population [35].

Kolkata has grown from a colonial port city established by the British to a megacity with a population of over 14 million [9]. Rail, road and air transport connect the city to different parts of India as well as South-East Asian countries. Job Charnock, a Britisher, is considered to have founded the city in 1690, with three villages: Sutanati, Kolkata and Gobindapur [36]. Calcutta (now Kolkata) was established as the East India Company's trading center and served as the capital of the British India until 1911.

The city is considered the most popular livelihood destination for thousands of migrant laborers not only from the neighboring states of Uttar Pradesh, Bihar and Odisha and from the hinterland of West Bengal including the North Eastern states in India. Being the only mega agglomeration hub of economic, political and business activities as well as the educational and cultural pivot of eastern India, Kolkata has held enormous geopolitical importance since the colonial era [37]. Over the decades uncontrolled influx of population, haphazard and unplanned urban

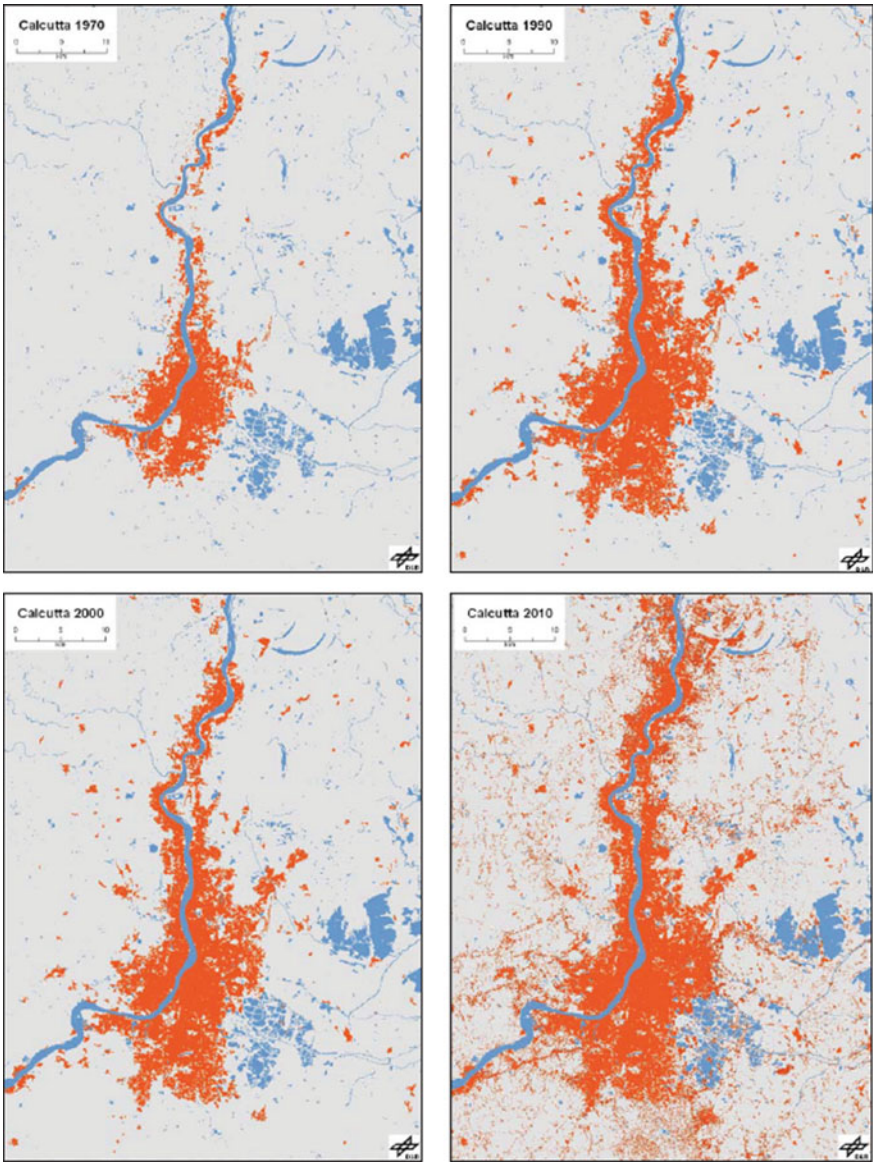


Fig. 1 Urban Sprawl of Kolkata (then Calcutta) 1970 to 2010 Source: K. Rajashekariah, WWF-India [41]

growth have caused strain on Kolkata's urban structure and socioeconomic resources, transforming the city into a premature metropolis [38].

The jurisdiction of Kolkata Urban Agglomeration (KUA) and Kolkata Municipal Corporation (KMC) extends to an area of 1,886.67 sq. km. and 205 sq. km., respectively. These population accommodated in these areas is 14 million and 4.5 million [9]. Kolkata Metropolitan Area is the urban agglomeration of KMC, other smaller municipalities and the rural area. The core of this metropolitan region consists of Kolkata and Howrah municipal corporations, which have been experiencing the lowest growth rate in the region.

Kolkata has experienced irregular demographic growth since Independence, which can be attributed to conspicuous socioeconomic and political trajectories, which has led to horizontal and vertical expansion of the city. The state of West Bengal had been the leading industrial state in the country until the mid-1950s with established economic infrastructure and manufacturing industry [39]. Over the next decades the hinterland of Kolkata continued to remain highly dependent on the city, leading to accumulation of businesses in Kolkata. With political emphasis shifting to Delhi and post-Independence with Mumbai emerging as the economic hub of the country clubbed with degradation of infrastructure, excessive housing construction, increasing corruption and inefficiency in the local government in Kolkata contributed to the decline in growth rate of the city.

As is evident from Tables 3 and 4, Kolkata recorded a higher population growth rate before independence. Since then there has been a steady decline. The population in the Kolkata Urban Area, particularly in its peripheral area has grown at a higher rate compared to the core, that is the KMC (Refer Table 5). In the last decade, both the core and periphery have experienced negative growth, KMA's being much lower than the periphery.

Kolkata city or the KMA and many other neighboring municipalities are experiencing negative growth rate. Kolkata's land use is characterized by an extremely dense built-up core and large-scale linear residential development in the peripheral areas. So as to sustain the growing population and the economic and commercial needs of the city region, large-scale development of infrastructure has been taken up.

Table 3 Decadal population growth in Kolkata municipal area

Year	Population (in millions)	Growth rate
1941	2.35	82.4
1951	2.95	25.7
1961	3.35	13.4
1971	3.72	11.2
1981	4.12	10.7
1991	4.39	6.6
2001	4.57	3.9
2011	4.49	−1.7

Source Census of India, 2011 [9]

Table 4 Decadal population and density in Kolkata UA

Year	Population (in millions)	Growth rate	Area (Sq. km.)	Density (per Sq. km.)
1951	4.67	–	–	–
1961	5.98	2.5	–	–
1971	7.42	2.2	–	–
1981	9.19	2.1	857	10,732
1991	11.02	1.8	901	12,255
2001	13.21	1.8	1,034	12,776
2011	14.11	0.7		13,653

Source Census of India, 2011 [9]

Table 5 Growth Rate in Kolkata UA—Core and Periphery

Area definition	1981–1991	1991–2001	2001–2011
Core	0.94	10.03	−9.64
Periphery	2.69	2.74	−0.65

Source Census of India, 2011 [9]

As urban areas expand from core to periphery, smaller urban centers grow with the fastest pace. However, the 2011 census shows that most of the small towns that were in the periphery have experienced either negative or very slow growth rate in the metropolitan area of Kolkata. Saturation of the core or KMA to absorb more population due to paucity of the built-up area, stagnant economic conditions, poor infrastructure and shortage of services and increased cost of living have contributed this negative growth.

The density in the core has been increasing over the decades (Refer Table 6) and is amongst the highest of the metropolitan cities in the country. Ease of travel to and from the periphery has been preferred by the population to move to the periphery where land and housing costs are lower and better services are available. Failure of both local and state governments to manage these issues through effective urban policies further exacerbated the conditions.

Research and theories indicate that in the life cycle of the city and its region, as the size of the city increases, its functional linkages to the adjoining towns and cities also get strengthened and urbanization spreads over space causing a spillover effect in the

Table 6 Density (persons per sq. km.) in Kolkata UA—Core and Periphery

Area definition	1981		1991		2001		2011	
	Area	Density	Area	Density	Area	Density	Area	Density
Core	202.87	20,506	205.34	21,914	219	25,540	219	25,441
Periphery	498	8,684	517	10,947	593	12,539	593	11,758

Source Census of India, 2011 [9]

metropolitan region of the city. In the case of Kolkata, the decline of the population in the core as well as the periphery negates this theory. This can be attributed to the deindustrialization of Kolkata over time which is weakening the functional linkages to the periphery and its region. This is indicative of the need for innovative solutions to develop and retain Kolkata's standing among the Global cities.

Kolkata became a corporation body in 1726, with the mayor as the head of the city. Numerous laws have been enacted and amended to improve municipal governance. The Calcutta[2] Improvement Trust was set up in 1911 through the Calcutta Improvement Act, 1911 with the purpose of expansion and improvement of Kolkata and its urban surroundings. With the enactment of the Calcutta Municipal Act, 1951, the KMC was envisioned as a policymaking, directive and rulemaking civic institution. However, despite several amendments over the next two decades, the 1951 Calcutta Municipal Act failed to provide appropriate guidelines for the better governance in the problem-ridden metropolis. The Kolkata Metropolitan Development Authority (KMDA)—formed in 1970 under a Presidential Ordinance and later sanctioned under the KMDA Act, 1972—functioned essentially as a statuary development authority under the administrative control of the Ministry of Urban Development, Government of West Bengal, with the goal of administering major developmental activities (planning and infrastructure) in the Kolkata Metropolitan Area (KMA). The KMDA derives its power and functions from the West Bengal Town and Country Planning Act, 1979.

The KMA and the KUA, the third largest urban agglomeration of India, consist of four municipal corporations, namely, Kolkata, Howrah, Chandannagar and Bidhannagar. It has 36 municipalities and 24 Panchayat Samities. Constituent to the 74th CAA, the West Bengal Metropolitan Planning Committee (WBMPC) Act, 1994, the process of decentralized planning and development gained momentum in the KMA. In the 2000s, following the provisions of the WBMPC Act, the Kolkata Metropolitan Planning Committee (KMPC) in 1994 which mandates the KMPC to prepare the draft development plan for the KMA.

10 Planning of Kolkata

KMDA has now become the technical arm of the KMPC. The KMDA's functions in three domains:

- planning for development,
- project implementation and
- regulatory functions.

In addition to this, the KMDA acts as a nodal agency, providing consultancy services and implementing projects on behalf of various government departments and institutions. In accordance with the guidelines of the West Bengal Town and Country

[2]Now known as Kolkata.

(Planning and Development) Act, 1979, the KMDA is mandated to prepare existing Land Use Maps and Registers (LUMRs) for various ULBs within the KMA to help them prepare Land Use and Development Control Plans (LUDCPs) for those sub-areas. Development Control Regulations (DCRs) are usually drafted and enforced to control unregulated and haphazard land use and development. The KMDA also executes various planning exercises, ranging from perspective plans to the formulation of investment programmes; it must continually upgrade perspective plans and sectoral development plans to keep up with changing socioeconomic, physical and other contexts.

Incidentally, in 2015, the union government launched its new urban agenda, aiming to develop 100 smart cities across the country. According to Smart City Mission's guidelines, these cities would have adequate civic amenities and services; affordable housing; smart transport solutions; efficient governance and participation of citizens; safe, secure and sustainable city environment for all, with particular emphasis on the elderly, children and women; and accessible healthcare and education. While the SCM's agenda and methods of implementation have triggered a debate in the academic and political spheres, it is crucial to examine critically the extent to which smart cities can help achieve a sustainable and inclusive city.

The metropolitan planning area was first delineated under the Kolkata Metropolitan Planning Area use and Development of Land) Control Act of 1965, which was adopted in the Kolkata Metropolitan Development Authority Act 1972. The same area was adopted as the metropolitan area by the West Bengal Town and Country Planning Development Act of 1979. This Act empowered the state government under section 16 to enlarge, curtail or modify the metropolitan area as deemed fit. In 2003 Dankuni township project was included in the metropolitan area of Kolkata under the provisions of this act.

The Basic Development Plan for Calcutta Metropolitan District was prepared in 1966. The Plan proposed the setting up of metropolitan functional authorities for various sectors like water, sanitation, traffic and transportation, parks and recreation, housing, education and improvement of bustees. As part of the reorganisation, 38 municipalities were to be consolidated into 10 municipal corporations. KMDA was to be responsible for the planning and coordination, budgeting, review and enforcement. The municipalities strongly resisted the setting up of agencies like Calcutta Metropolitan Water and Sanitation Authority. Likewise, the bill for consolidation of the municipalities too did not mature. The proposal that was farsighted in the vision of creating the metropolitan city could not be realized due to the vested interests of the few which has been gargantuan loss to the citizens.

Implementation of the schemes in Kolkata rested with the municipalities which was in time taken over by KMDA expanding its role from being a fund-raising, allocating and coordinating agency. The concentration of roles with KMDA were devolved with the constitution of the 74th CAA. With the implementation of the central government schemes, the responsibility again shifted on KMDA. Any of the municipal authorities were never chosen for the tasks. This is indicative of the resource capacity for handling the mega projects at metropolitan scale that rested with KMDA.

11 Issues in Kolkata Metropolitan City and its Region

The current status of Kolkata is just an amorphous collection of municipalities. In India, traditionally, large cities have been considered as centers of exploitation that have extracted resources from the rural hinterland. Kolkata has been able to attain and maintain the primate city status not only in its state but this the larger region of eastern India.

Municipal authorities have been always considered less capable of governance, which has been well evident from the fact that new authorities and parastatals have been created to oversee the urban functions, thereby deeming the municipal organisations not capable of managing the growth and expansion of ever-growing urban centers. KMA has numerous municipalities that hold the prime role of provisioning the services to the citizens. Despite the 74th CAA mandating the devolution of the powers and roles to the municipalities, there have been mushrooming of parastatals to look into the tasks of planning and implementation and in some instances have taken over the tasks of the municipalities as well.

KMA is not bereft of the socio-economic and environmental problems that have come to plague not only the large cities but all settlements of the country. The enormity of these problems only increases with the increase in the spatial spread and large size of population. KMA has a large number of slum settlements, particularly in the cities of Kolkata and Howrah. Around one-third of KMA's population lives in slums. On the other hand, from an economic perspective, KMA's contribution to the state domestic product is estimated to be around 30%, although KMA accounts for only 18% of the State's population.

The region suffers from inadequate housing specially to the lower sections of the society. The region has at the same time experienced a boom in the real estate sector specially for the MIG and HIG sections of the society. The gap in the supply and demand for housing is evident not only in quantity but also in quality. This skewed growth has resulted in associated problems in the areas of environment as well as socio-economic conditions. The massive influx of population into Kolkata has led to an insatiable demand for urban space. This resulted in large scale reclamation of all forms of nature, including the East Kolkata Wetlands. Rapid and rampant urbanisation has altered the natural drainage system of the city, causing frequent floods. [40] Sinha (1988) states that although the original growth of Kolkata followed the flood-safe levels along the banks of the Hooghly river, urban growth in the 21st century has ignored the natural gradient leading to an increase in the frequency of flooding.

Another key observation in the mega city of Kolkata is the state of environment and governance, which stand amongst the most pertinent concerns. This is evidenced from the consistent encroachment of the East Kolkata Wetlands by the urbanising giants. With so local authorities aiming to obtain more and more investment for bettering the infrastructure, funding emerges as a big issue for many stakeholders. However, what is more important is the improvements to governance. There is a need to balance the environment, competitiveness and quality of life of the citizens (Refer

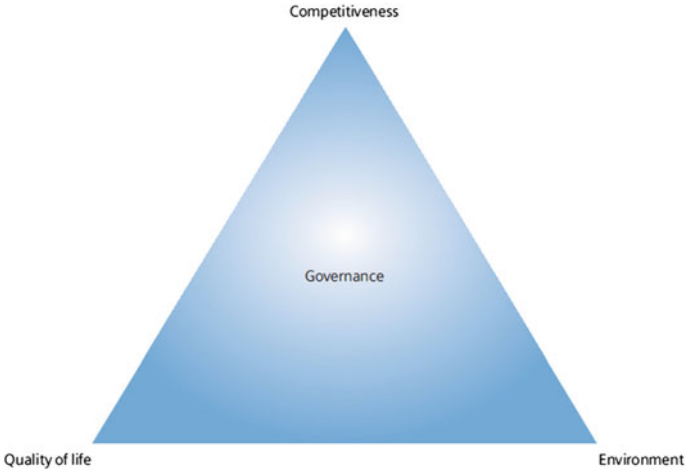


Fig. 2 Model for megacity development

Fig. 2), which can be achieved through better governance based on extensive use of technology.

12 Conclusions

There is a need to have a clear understanding and definition of not just metropolitan regions and cities but also the newly emerging terms and concepts like mega cities in the context of India. The present definition in terms of a population criterion by Census of India, URDPFI Guidelines and the 74th Constitutional Amendment Act do not capture the various factors that characterize the various scales of urban centers including the metropolitan regions/cities and mega cities. There is a need to have clear conceptualization of the basic typology of the nature of how metropolitan regions and mega cities arise in actual situations. As of date the understanding and conceptualization is purely in terms of population size and resultant sprawls leading to high densities due to concentration is limited spaces.

Some of the solutions can be found in adapting technology in the planning, management and governance of the metropolitan and mega cities. Setting up of mega city observatories that can be repositories of spatial and non-spatial data of the physical, social, environmental, economic segments of the mega city is a pre-requisite. These observatories have the capability of being the building blocks of the city, contributing towards its sustainable development. The issues that are faced due to lack of coordination too can be overcome with the use of technology, thereby bringing in transparency in the systems.

In order to be able to coordinate complex and global activities, the city candidates to globalization must have technical resources and infrastructures, high skills and

above all formal and informal institutions well adapted to this objective. As a consequence, the nature of institutions is crucial for the understanding of the mega-global divergence.

The continuing sprawl of Indian cities has been causing the creation of the complex metropolitan systems where in recent decades with contrasting characteristics have emerged in the core and peripheral areas, as has been specifically the case of Kolkata. The core area has diminished in their ability to attract economic activities owning to deteriorating infrastructure and housing stock. There is a need for reinventing the approach to the management and governance of these areas so as to attract the population to maintain and continue being the livable and sustainable cities. This can be further addressed through an urban policy that simultaneously takes into consideration the challenges of these two contrasting types of areas within the city is clearly needed.

In India, urban development and management is under the purview of the state governments as per the Constitution of the country, which has led to different policies for metropolitan planning, governance and management in various states. This is so despite the fact that there has been intervention at by the central government through its national level schemes and policies for the metropolitan areas as well as smaller urban settlements. These interventions have been possible owing to the central level ministry of urban development, now existing as Ministry of Housing and Urban Affairs (MoHUA). This ministry has been in existence despite the urban segment being a state subject. The planning, management and governance of the metropolitan and mega cities have led these settlements to be in the plight that they exist today. In this light, the option of centralization of coordination for the better management of the mega cities needs to be explored.

The centralization of the coordination is likely to lead to removal of multiplicity of authority both in spatial and sectoral terms. A possible way to achieve this is by bringing together the existing authorities under one umbrella authority under one name, which means merging of the existing urban local bodies, development authorities and other parastatals into one authority with specialised departments. This in all likelihood will be opposed by the agencies involved owing to various reasons including the autonomy enjoyed by each. However, for the benefit of the citizens and sustainable future, it is a pertinent solution. This centralization of coordination will likely lead to the timely completion of infrastructure projects like that of road, rail and sewerage projects in both old and new city areas which is important as is the need to create housing for all income groups. A possibility of diverting some of the capital functions to some other cities of the state, could also be explored on the lines of what is being done in the case of Andhra Pradesh [42].

It is a required conclusion of this research that the mega cities need to have a spatial connotation as well. As of date the mega city is defined on the basis of the population and exists within the defined metropolitan region. In other words, it is just a very large urban settlement. It has been observed the problems of the mega city are similar to those of the metropolitan cities. However, the solution to these mega problems of the mega cities does not lie in those adopted by the smaller settlements. Most of the problems are due to the lack of coordination between the participating

agencies, which can be overcome by either adopting such governance systems that are built on accountability, transparency and coordination or by creating one mega city government that looks into all the aspects including planning, implementation, management and governance.

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Conclusion

International Collaborative Research: "Smart Global Mega Cities" and Conclusions of Cities Case Studies Tokyo, New York, Mumbai, Hong Kong-Shenzhen, and Kolkata

T. M. Vinod Kumar

Abstract This chapter has two parts. In the first part, objectives, and the organizational details of the international collaborative research project "Smart Global Megacities" are discussed. In the second part are presented in consultation with the team leaders of the city study, their general conclusions of the study Smart Global Megacities.

Keywords Study organization study · Results

1 Smart Cities Global Megacities

This Book on Configuring "Smart Global Megacities", is an outcome of international collaborative research using city case studies. The aim of the book is how these megacities can be configured to smart and global cities. At present this capability and potential are largely not realised. IoT and ICT applications in all walks of work and living in a megacity makes it easy for converting any megacity to smart and global based on local endowments. There are smart communities and higher educational, professional and research institutions in these cities to accelerate the deployment and use of ICT and IoT in all sectors of the urban economy and reap the dividend both locally and globally. Megacities with more than 10 million population in a contiguous urban agglomeration account for a huge magnitude of income and expenditure cash flow in a limited geographic space with a relatively high density of population. This opens huge possibilities for global enterprises which is largely untapped. In recent time the number of billionaire taxpayers produced in a megacity like Tokyo, New York, Delhi and Mumbai and many cities in China such as new towns like Shenzhen megacity surprised income tax authorities and Government who never "planned" for such growth of taxpaying billionaires. India does not have a planning commission today to preside over its socialist command economy by bureaucracy and instead we have Neeti Ayog which is largely a body for research

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to guide developmental policies. The planning commission in Russia and China and also India of the past never talked about citizen billionaire production as it was taking place but always tries to implement by financial allocative planning give the Peter the poor what Paul the rich had policies for income distribution without more creation of wealth to automatically distribute. The muscles of the administrative arms of the planning commission with taxpayers money allocation are replaced hopefully by the capabilities of smart communities who think for themselves for work and living allowed in the constitution to make their global presence felt. These smart communities seek their oxygen from research in universities and the strategy of the chamber of commerce and industries than administrators and their government subsidies the instrument of legislations. This megacity accounts for the best high ranking universities and research establishments of the nation or the universe, but no connection with the institution and the local community outside their gate by extending the result of research to apply in the local communities for their prosperity and good living; barring a few cases like silicon valley and Boston Corridor. These megacities are endowed with a higher quality of urban infrastructure as well as gifted individuals from their universities and research establishment. It is in the megacities we see the migrant spirit of the search for higher income and a good standard of living. You see, innovations and daring ventures in all economic spheres. The place to practice it all is in the next door outside the gate of the institution. The Smart Global Megacities calls for an active role of Local Community that gets transformed into a smart global community, fully using all capabilities of IoT and ICT for daily work and living. Local higher educational Institutions, Chamber of commerce and industries, and Government are jointly involved in megacity economy and hence its management is a joint and synchronous effort of E-Democracy, E-Governance, ICT and IoT system in a 24 h 7-day framework in all aspect of life in any smart cities. The ecological system under transformation and cultural background of inhabitants with a long past have a greater bearing on the smart global megacities which has been detailed out in Chap. 1.

The smart global megacity use information and communication technologies, Internet of Things, Internet of Governance (E-Governance) and the Internet of People (E-Democracy) along with conventional management tools to realise smart global megacity for all. It is a coordinated, effective and efficient information-based management system for the smart community for daily living, human development, and conservation that improves ecological systems, strengthen the cultural system, equitably improve social welfare without compromising the sustainability of development ecosystems and stakeholders' cultural values. This book will present 11 city case studies from 4 countries in two volumes centred on city-specific aspects of the study city under configuration. The Smart global megacity energises, reorganises, and transform the living style existing to an appropriate smart global megacity style embracing highly responsive ICT and IoT, creating a sustainable and harmonious work environment and living, responsibly sharing this effort, by smart communities.

These 11 city studies conducted in this book start with a background Chap. 1, the state of the art of smart global megacity studies. These megacities face gigantic problems like sea-level rise that may act a disappearing act of some part of the megacity,

air and water pollution, the chaos of traffic and even terrorism and insecurity. These problems require unique and innovative solutions. This concept "smart global megacity" has a history of many academic achievements with a great many approaches and never-ending progress and refinement of ideas to create a view which often faces alarming human issues but generates timely intervention often automatically and timely action towards solving these issues.

A smart global megacity can be conceived and developed emphasizing the sum of integration of internet of enabling ICT and IoT technologies for the smart global megacity, embracing a carbon-neutral living style monitored in real-time with a transportation system that performs intelligent and smart mobility based on real-time information drawn from big data using renewable electric energy for movement replacing fossil fuel with its pollution and disease. The authors of this book have adopted only one simple and dependable way of looking at Smart global megacity and smart global megacity 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 store, 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 therefore the price of marketed goods become cheaper than in brick and mortar malls and stores. In the same way, they can also be a part of the largest taxi services like Uber with only one taxi at his disposal while Uber does not own even one taxi. They can be part of Air B and B without owning a hotel defeating the central concept of Capitalism namely ownership which is replaced by sharing. Since Uber just provides location-based computer and smartphone platform for the taxi service it does not have a huge and expensive bureaucracy that dictates movements, unlike Socialism and Communism. Similarly, we must find ways and means for smart global megacity by smart community suited for local needs. Since real-time information and big data guide all these economic activities, socialism and its consequent ills of proliferating and expensive and mostly corrupt bureaucracy which can be oppressive and disgusting for taxpayers with no value added to the urban economy are no use for the Smart city economic development and smart global megacity. In simple term, data-based, or well-informed work and living in a smart global megacity can be what smart global megacity aims at largely operated by smart people.

During the colonial period, everything about life was centred around the bureaucrats of the colonialist with a Stockholm syndrome. Even when many countries became free from colonialism this dependency on bureaucracy was evident as if bureaucrat regulator can give leadership to create a good living with a great increase in household wealth which by the very job of the bureaucrat cannot. This is a false image a part of Stockholm syndrome. At best, he can implement policies of the elected government enshrined in legislation in close cooperation with people with a history of more failures than success which is due to lack of innovations. This does not mean any regulation or no law and order in Smart global megacity. Like tax compliance by the electronic filing of Goods and Service Tax, income and wealth tax, Smart E-Governance is there to replace age-old and dysfunctional bureaucracy enshrined in a brick and mortar building in a prominent place in the city, a legacy

of the sixteenth century in many colonial countries. We consider Smart People and smart community and their E-democracy as all-powerful and capable building blocks of Smart Cities for Smart global megacity replacing capitalism and socialism as well as the largely inefficient, dysfunctional, and increasingly corrupt bureaucracy of socialism at one go replacing with smart and sharing working and living for Smart People using electronic self-governance. There should be opportunities in Smart Cities for continuing education and skilling for Smart People to make them smarter today compared to yesterday in a rapidly changing world with new skills requirements. This calls for the closer relationship of the community with academia which does not exist today. Potential 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 to create the smart global megacity designed by themselves. 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 global megacity system in Smart Cities. Smart People are the creators, governors, regulators, managers, and maintainers of Smart City Living and work. This replaces the expensive bureaucrats. The required Smart Cities technologies which are ICT-enabled can easily be designed by Smart People's creativity in collaboration with academia and business community, and prototypes are made in Fabrication Laboratory (Fab Lab) located in Smart Cities for adoption and mass production and use. Being the creators of the emerging technologies, Smart People can maintain, repair, innovate and evolve the existing technologies to more cost-effective and functionally superior, next-generation technologies which can be shared profitably with other smart cities for creating a smart global megacity the international goal. No one is running away from Smart People's creation and redevelopment of next-generation Smart city technologies like some international firms.

2 The International Collaborative Research Projects on Smart Cities

This book is ninth and tenth in two volumes, in a series, Professor T.M. Vinod Kumar conceived, coordinated, implemented, and edited about articulating the various aspects of smart cities and roles of Smart People in Smart Cities.

The first book entitled "Geographic Information System for Smart Cities" [1] was aimed at creating a comprehensive and spatial 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 augment 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 thereby progress towards their self-directed goals, such as they demand Smart global megacity, and Smart Economic Development. They aspire to the highest level of quality of life in Smart megacity city living which they can very well afford and can expand many folds the economic development opportunities to satisfy higher income and employment needs to sustain Smart People. No smart person in a city is an island or isolated 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 is 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 as against Government who comes to know about the issue when a case is filed in the court which takes many decades to get a final judgement. The existing governance systems are obsolete being a product of sixteenth-century or earlier designed for colonial rulers, built on the model of East India Company's administration in India or elsewhere which cannot be used or Smart city economic development and for the smart global megacity creation and functioning. 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]. This book is all about E-Governance in Smart Cities in action. It is divided into three parts, State of the Art Surveys, Domain Studies and Tools and Issue of E-Governance in Smart Cities

The third book in this series is, "Smart Economy in Smart Cities" [3]. This book explores possibilities for rapid change in 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 a desired higher level consistently for the next many decades. Then, the current trend of urban local economic development is required to be converted to Smart city Economic Development. A, 10% NDP growth rate envisaged for the next three decades in India and many other countries can only be realized through Smart city Economic Development. The projection that Indian GDP in PPP will be the second largest in the world after China in 2050 can only be realised through smart metropolitan or megacity economy. Smart Cities and the related conceptualization boast of the Smart Economy but not much has been systematically researched or documented about it so far. This calls for a study of many 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 cases in different countries emphasize different approaches, establishing that there are no cookbook solutions. The cities being studied in this book are spread across 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; Dakar in Senegal; Lagos in Nigeria; Nairobi in Kenya; Cape Town

in South Africa; New Delhi, Varanasi, Vijayawada, and Kozhikode in India; Hong Kong in China, Cape Town, Dakar, Nairobi and Lagos in Africa.

The fourth book in this series is "E-Democracy for Smart Cities" [4]. The world over, participatory democracy is worshipped and preached but what is practised is representative democracy at the city level and beyond. It is believed that in meta cities, megacities and metropolitan cities, only representative democracy with elected representatives will work. However, democracy practised in small cities like Athens in Greece, and the Licchavi Republic 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/country during war or peacetime. Citizens not only participated in decision making but acted together as one government and even as an administrator for a task and as a regulator. There were no permanent administrators then. With the advent of ICTs in Smart Cities of the twenty-first century, it is possible to go back to the face-to-face democracy in meta city with 20 million-plus population, a megacity with 10 million-plus population and metropolises with one million-plus population that, by any measure, is much superior to representative democracy. We do not want to middlemen the representative of the citizen to make legislations but all citizen using electronic medium demonstrate the creation of regulations based on their own ability to think and act under the constitution. The fourth book is all about E-Democracy in Smart Cities in action. It is divided into three parts, State of the Art Surveys, Domain Studies and Tools and Issue of E-Democracy in Smart Cities.

The fifth book in the series is"Smart Metropolitan Regional Development: Economic and Spatial Design Strategies" [5]. Here these cities however large these cities may be, need to be converted to smart metropolis using the specific design of economic and spatial strategies and not by purchasing smart technologies alone. The city studies for the "Smart Metropolitan Regional Development" result in many insights on many smart spatial and economic strategies using the Internet of Things, Internet of Democracy and Internet of Governance oriented to the specific issue of a town and its potential; taking into consideration that the Smart metropolitan city is an integrated six systems in which Smart Economy is a dominant component. The smart economy can relate to Smart Mobility or Smart Environment. Based on the elaboration of Smart metropolitan city System, if one must develop any metropolitan-, region, then a country-and city-specific economic and spatial design strategies for a Smart metropolitan city, must be designed based on a local ecological and cultural system of the city and not a type universal design. Location-specific and culturally acceptable economic and spatial strategies can be locally evolved, governed, and managed. This is the only way local culture will find expression in the Smart metropolitan city using specific economic and spatial strategies by utilizing local, creative talents of smart people in many institutions in Smart Cities. 16 cities were studied in this project namely Pittsburgh in the USA, Stuttgart in Germany and Naples in Italy, Dakar in Senegal, Conakry in Guinea, Abuja in Nigeria, Johannesburg in South Africa and Nairobi in Kenya, Ahmedabad-Gandhi Nagar, Bangalore, Chandigarh, Jaipur, Kozhikode, New Delhi, Surat in India and Hong Kong and greater Pearl River Delta Region from China.

The sixth book that was published in mid-2019 by Springer-Nature is entitled "Smart Environment for Smart Cities" [6] as a product of international collaborative research. This book is aimed at developing the Design and Protocol and Practice of Smart Environmental Resources Management for Smart Cities. Environmental Resources are common proprieties where an active role of Government and People are required and hence its management is a joint and synchronous effort of E-Democracy, E-Governance and IoT system in a 24 h 7-day framework on any resource in any smart cities.

The smart environmental resources management is a practice that uses information and communication technologies, Internet of Things, Internet of Governance (E-Governance) and Internet of People (E-Democracy) along with conventional resource management tools to realise the coordinated, effective and efficient management, development, and conservation that equitably improves ecological and economic welfare without compromising the sustainability of development ecosystems and stakeholders. This book presents many city case studies (Hong Kong in China, Ahmedabad, Gandhi Nagar, Chandigarh, Kozhikode, New Delhi, Patna, Surat, Yokohama in Japan, Nairobi in Kenya, and Dubai in UAE), that is centred on one or all environmental resource each in a city.

The Seventh and Eighth Book in two volumes published by Springer Nature in 2020 are on smart living for smart cities [7, 8]. The first volume focus cities case studies and the second volume on community studies and ways and means. This book, based on international collaborative research; is aimed at developing state of the art design of "Smart Living" for metropolises, megacities and meta cities as well as a community and neighbourhood level. Smart living is one of six components for Smart Cities: the others being smart people, smart economy, smart environment, smart mobility, and Smart Governance. The smart living in any smart city can only be designed and executed by active roles of Smart People and Smart City Government and is a joint and synchronous effort of E-Democracy, E-Governance and ICT-IoT system in a 24 h 7-day framework on all activities. In addition to uses of information and communication technologies, Internet of Things, Internet of Governance (E-Governance) and Internet of People (E-Democracy) the design of smart living utilizes domain-specific tools of many aspects of living by age cohorts to realise the coordinated, effective and efficient management, development, and conservation that improves ecological, social, biophysical, psychological and economic wellbeing equitably without compromising the sustainability of development ecosystems and stakeholders. This book presents many case studies covering many cities centred on domain-specific smart living components.

3 The Ninth and Tenth Book Is on Smart Global Megacities

The editor and coordinator of the book series T.M. Vinod Kumar and many authors who participated in the earlier eight books felt that there is a gap in knowledge about Smart global megacity. Funding for such collaborative research project like all earlier

book was another issue. Universities and research centres dominated in collaborating these-smart megacity city research projects. 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 (Fig. 1).

This book presents many city case studies as shown in the map above.

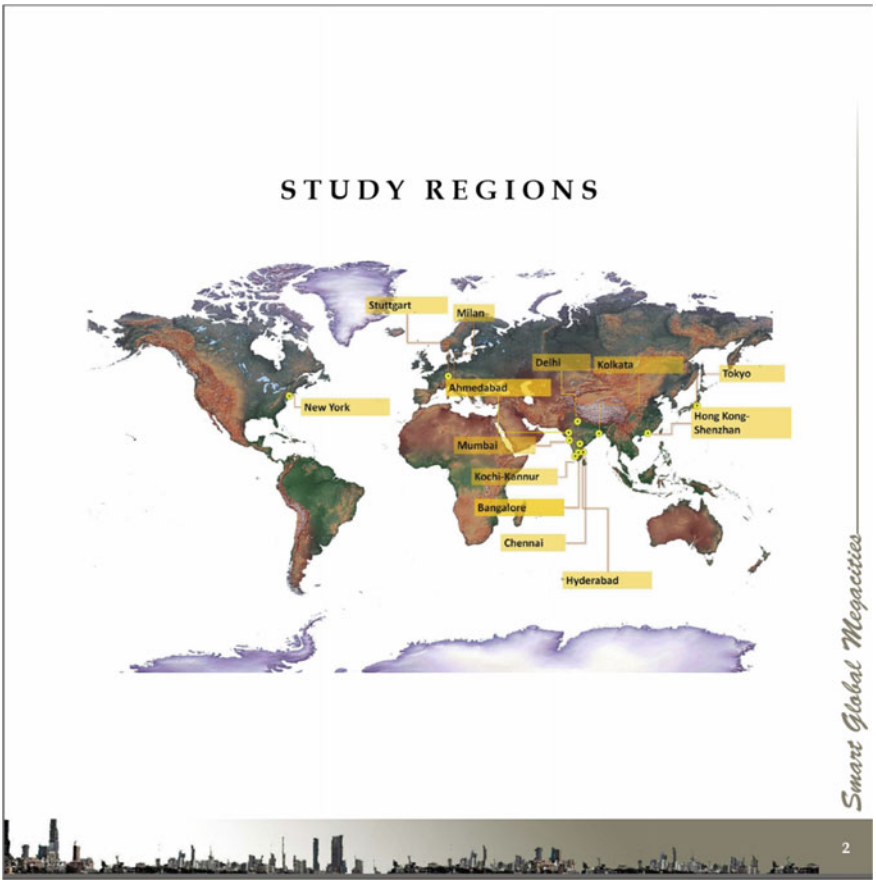


Fig. 1 The location map of the studies conducted in this book

4 Design of the Collaborative Research Programme

Research Collaborations worked out is purely voluntary and without any financial support that binds a project together. Since collaborators are universities, Government, research institutions, professional networks and not-for-profit associations from several countries, complete independence for pursuing the research was there, free of the baggage of ideologies of granting organisation. They need not accept existing smart cities policies of study cities in their research. Coordinator Editor of the project has no financial or administrative control over an institution participating in the project since he was not in receipt of any grants and did not distribute it. Typologies of the institutions involved in this international project are given in Fig. 2. All these autonomous institutions are guided by the highest standard of scholarship and timely completion of research and publication.

Fig. 2 Typologies of Research Institutions Participating in this book

5 Research Questions on Smart Global Megacity Research

The kind of collaboration in this international research project requires that all participating institutions shall formulate their research questions and research the methodology which is of use to the country or federal state where these study cities are located. Depending upon the type of city some of which are leading Smart Global megacities, and some are not, the approaches must differ? However, the paucity of empirical evidence on the Smart global megacity opens a new area of research: What strategy intervention brings about Smart global megacity? This is the central focus of the book.

Do megacities awaken social, cultural development and ecological (environmental) management through smart city development? This question lies at the heart of the proposed international collaborative research programme, and unpacking it gives us four interrelated research questions, as follows:

I. What constitutes a Smart global megacity beyond its official definition by UNHABITAT? This will need identification of the key ingredients and their role in making Smart global megacity and Spatial changes in megacities.
II. What changes the Smart global megacity brings to social development, cultural preservation, heritage conservation and ecological management? This calls for understanding the inter-linkages between Smart global megacity on one hand, with social development, cultural preservation, heritage conservation and ecological management on the other.
III. How and what processes facilitate the changes to the smart global megacity? Do cities bring 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.

IV. 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 iii.

A deeper understanding of changes in the social, cultural, and ecological system of the Smart city with the advent of Smart global megacity and Smart People for smart city development 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.

6 Scope of Research

The following outlines the areas that may be covered when researching the "Smart global megacity" programme. This is an indication only, and it is left to the team to decide what is appropriate.

I. A time-series study of changes in the urban parameters and identifying distinctive features of evolving to the Smart global megacity.
II. Study of theories of the megacity and global city interventions at the smart city level and modelling for study city.
III. The concept of accessibility in the Master Plan and its changes to the increasing use of ICT in Smart mega global Cities for the smart global megacity development.
IV. Changing the role of the hierarchy of service areas or watersheds in a Smart global megacity as influenced by the increasing use of ICT to make city smart.
V. Evolving structure of megacity urban agglomeration and changes required in a Smart city when transformed.
VI. Evolving structure of cities in urban agglomeration and changes required because of the increase in the use of ICT.
VII. Change of spatial standards in a Smart metropolitan city.
VIII. Changes required in zonal policies and plans.
IX. Study of Town and Country Planning legislation and suggest changes as per the special requirement of Smart global megacity
X. Change of role of community-based organizations (for example, Residential Associations in India) in a Smart global megacity with an increase in the use of ICT.
XI. Change of role of Ward Committee in a Smart global megacity with an increase in the use of ICT.
XII. Change of role of the Municipal Council in a Smart global megacity with an increase in the use of ICT.
XIII. Change of role of the Planning system in a Smart global megacity 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 the university participating in this research programme shall incorporate relevant Smart global megacity Development features appropriate to the goals of each department. 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.

7 Study Cities

The study city will be selected as a 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, their doctorate and post-doctorate students, while others used students at masters and first professional degree level. A post-doctoral student in 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 Smart global megacity, and Research institutions can charter their strategic areas of research.

8 Project Details

One City will be selected as a 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.

The project details of the study city are given in Table 1.

9 Way of Working the Programme

9.1 Integrating Smart Global Megacity Research with Academic Programmes

This international collaborative research programme, with the participation of 4 countries and 11 study cities as tabulated above was conducted by many diverse university departments, research institutions and others as shown in the table above.

9.2 Role of Students

This international collaborative research programme is essentially meant for students since they are the future and being part of an internal academic programme of the university. We consider they are the main actor and shall be given an important role in this programme. Perhaps many that age group will live in the Smart Cities than their older faculty. Under the direction of faculty new concepts were introduced in the studio and empirical studies were conducted around these concepts.

Table 1 Project details

Chapter	Country	Megacity	Tentative chapter title	Authors
1			Smart Global Megacities	**T. M. Vinod Kumar**, School of Planning and Architecture, Delhi
2			Industry 1 to 4 and megacity	**Michael Hertwig**, Fraunhofer-institute for Industrial Engineering IAO, **Joachim Lentes**, Fraunhofer-institute for Industrial Engineering IAO, **Nikolas Zimmermann**, Fraunhofer-institute for Industrial Engineering IAO, **Sven Schuler**, University of Stuttgart, Institute for Human Factors and Technology Management
3			Territorial Intelligence Project: a comparative study of the governance transformation in the urban-rural linkage pattern in Milan, Chennai, and Kolkata	**Antonella Contin**, Politecnico di Milano, Polimi · Department of Architecture and Urban Studies (DASTU) **Pedro B. Ortiz**, International Metropolitan Management and Planning Consultant (UN, WB, IDB, CAF, …) **Carolina Pacchi,** Politecnico di Milano, Polimi · Department of Architecture **Gioia Gibelli,** Politecnico di Milano, Polimi · Department of Architecture **Sandy Jiyoon Kim,** Polytechnic di Milano, Polimi · Department of Architecture **Iacovo Neri,** Politecnico di Milano, Polimi · Department of Architecture
4			E-Commerce for Megacities	**Althaf S,** School of Management Studies National Institute of Technology Calicut **Mohammad Sajjad Hussain**, Delhi School of Economics
5	Japan	Tokyo	Megacity study Tokyo	**Anjali K. Sharma**, Advance HE, UK **Aki Suwa,** Tokyo Women University **Kenji Inagaki, Tokyo Metropolitan Government**

(continued)

Table 1 (continued)

Chapter	Country	Megacity	Tentative chapter title	Authors
6	India	Delhi	Megacity study Delhi	**Shovan Kumar Saha**, School of Architecture and Planning, Sharada University **P S N Rao**, School of Planning and Architecture, Delhi **Vinod Sakle**, Delhi Development Authority **Rommel Mehta**, School of Planning and Architecture, Delhi **Chandrani Bandopadhyay**, Sharda University **Achintya Kumar Sen Gupta** Institute of Hygiene and Environmental Sanitation, New Delhi **Chandrani Bandopadhyay**, National Institute of Disaster Management, New Delhi
7	India	Mumbai	Megacity study Mumbai	**Amit Chatterjee**, School of Planning and Architecture, Bhopal **Binayak Choudhury**, School of Planning and Architecture, Bhopal **Premjeet Dasgupta**, School of Planning and Architecture, Bhopal **Gaurav Vaidya**, School of Planning and Architecture, Bhopal **Priya Mendiratta**, City and Industrial Development Corporation **Ravi Kumar**, City, and Industrial Development Corporation
6	USA	New York	Megacity study New York	**Sudeshna Ghosh**, Indiana University **Calvin Masilela,** Indiana University **Sweta Byahut**, Auburn University
9	China	Hongkong-Shenzhen	Megacity study Hongkong-Shenzhen	**Sujata Govada**, Institute of sustainable urbanisation **Leon Cheng**, Institute of sustainable urbanisation **Hillary Cheung**, Institute of sustainable urbanisation
10	India	Kolkata	Megacity study Kolkata	**Prabh Bedi**, Ansal University **Mahavir**, School of Planning and Architecture, Delhi

(continued)

Table 1 (continued)

Chapter	Country	Megacity	Tentative chapter title	Authors
11	India	Bangalore	Megacity study Bangalore	**Shovan Kumar Saha**, School of Architecture and Planning, Sharada University **Vidyadhar Wodeyar,** M/s ARCH PLAN Bangalore **A K Sen Gupta**, Institute of Hygiene and Environmental Sanitation, New Delhi **Chitra Chidambaram**, School of Architecture and Planning, Sharada University **Dipti Parashar**, School of Architecture and Planning, Sharada University **Shafia Ahmad**, School of Architecture and Planning, Sharada University
12	India	Hyderabad	Megacity study Hyderabad	**Kusum Lata,** Centre for Urban Studies, Indian Institute of Public Administration, New Delhi. **Priyanka Kumar,** Regional Centre for Urban and Environmental Studies, Lucknow. **Arpita Banerjee**, Indian Institute of Public Administration (IIPA), New Delhi
13	India	Chennai	Megacity study Chennai	**Kusumlata Khurana**, Centre for Urban Studies, Indian Institute of Public Administration, New Delhi. **Shoval Saha**, School of Architecture and Planning, School of Art, Design and Media Studies. Sharda University, Greater Noida **N.S.Periyaswamy,** Chennai Metropolitan Development Authority, Chennai **N. Muthusamy**, Tamil Nadu Institute of Urban Studies, Coimbatore, Tamil Nadu **Priyanka Kumar**, Regional Centre for Urban and Environmental Studies, Lucknow
14	India	Ahmedabad	Megacity study Ahmedabad	**Bhasker Bhatt**, Bhai kaka Centre for Human Settlements—APIED, Anand **Shashikant Kumar**, Department of Architecture and Planning, Parul University, Vadodara Gujarat, India

(continued)

Table 1 (continued)

Chapter	Country	Megacity	Tentative chapter title	Authors
15	India	Kochi—Kannur	Megacity study Kochi-Kannur	**T. M. Vinod Kumar**, School of Planning and Architecture, Delhi **Bimal P.**, National Institute of Technology, Calicut **Mohammed Firoz**, National Institute of Technology, Calicut **Chitra K.**, National Institute of Technology, Calicut **Deepak Lawrance**, National Institute of Technology, Calicut
16			Conclusion	**T.M. Vinod Kumar,** School of Planning and Architecture, Delhi

9.3 Role of Faculty

The faculty is the designer of the program within the framework of existing curricula in design studios and theory courses of each participating university.

I. The project duration is one academic year or two semesters.
II. They guide and monitor student work as usual as part of the academic programme.
III. They monitor students' input to the monthly progress report.
IV. They rewrite the output of the project for a book to be published by an international Publisher giving due credit to their work.

9.4 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:

I. Co-design the programme with the partner academic institutions.
II. Co-production of knowledge through an interactive process of sharing, reviewing, and finalizing research findings.
III. Within each partnering institution, co-design and co-production of knowledge can be implemented through design studio/laboratory work between faculty and students.

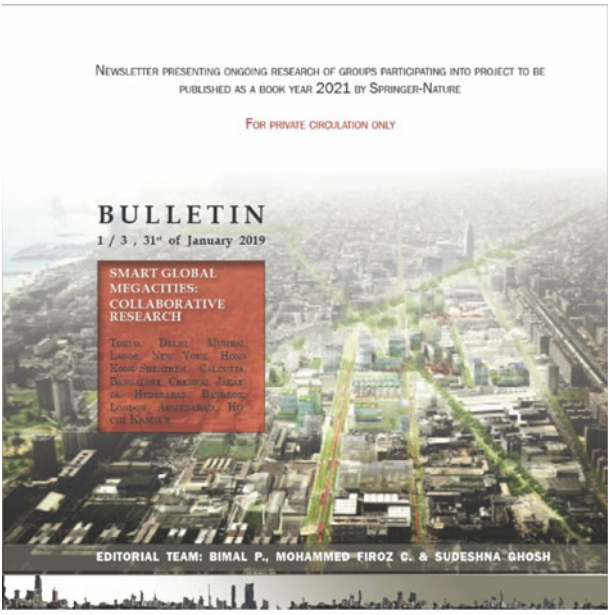
9.5 Research Output

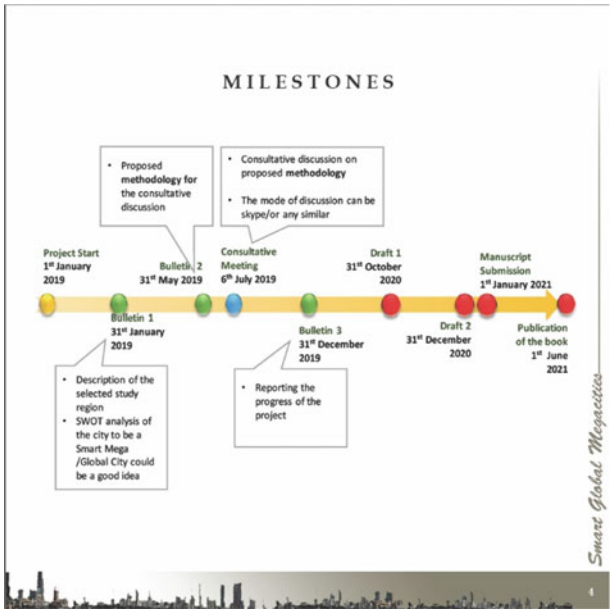
The key output of the "Smart global megacity" research programme will be these books edited by the coordinator Professor T.M. Vinod Kumar, to be published by Springer-Nature, an internationally reputed publisher in 2021.

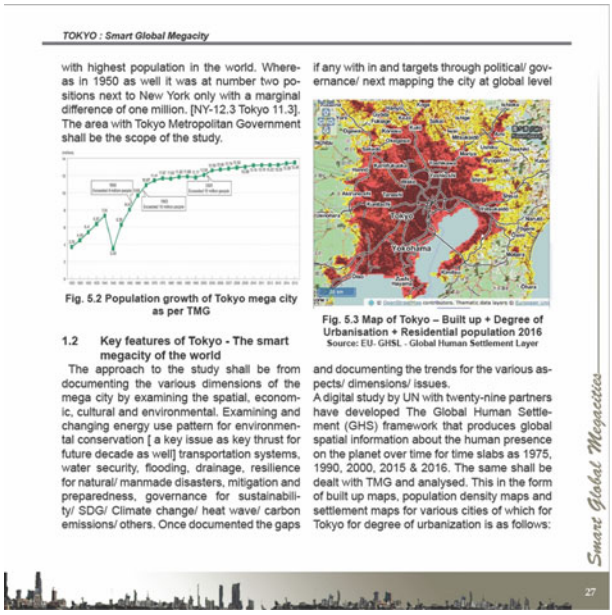
10 Bulletin

During the conduct of research about 24 months through in 2019–20, three Bulletin has been used to communicate with the international teams of researchers. These Bulletin highlights study city profiles selected by the various study teams independently and introduces to the research network the research methodologies adopted, and the profiles of authors of the research output for the book, "Smart global megacity". The Bulletin is jointly edited by a Bulletin team among authors, Bimal P (India), Mohammed Firoz (India) and Sudeshna Ghosh (USA).

A cover page of the Bulletin 1/3, a page on milestones and one sample page of the Bulletin are given below.







A page of Bulletin is as shown below

The project Milestones with the expected outcome is diagrammatically given below.

One sample page of the Bulletin is given below.

11 Summary of Conclusions and City Case Studies

11.1 Conclusions Configuration of Megacities

11.1.1 Configuration Basics

1. No megacity is like any other megacity in all aspect except that the size of the population is equal or above 10 million. Delhi is not Mumbai and Tokyo is not New York. They are unique. They have a unique cultural system and ecological system. Their unique history has shaped them, and their configuration shall follow a unique path which cannot be cloned.
2. No megacity has got a constitutionally valid administrative boundary. For example, the largest administrative boundary in Mumbai cannot cover the whole megacity Mumbai. Tokyo Metropolitan Government does not cover the whole of megacity Tokyo.
3. While it is possible to keep a track of expanding megacities through Remote Sensing and GIS technologies, it is never used and kept track of possible megacity expansion. There are well tested predictive models of spatial megacities expansion it is never tried and updated in these megacities [9].
4. The GDP share of countries is mostly generated in the urban area than in a rural area. In India, it is 7 to 3 proportion although India is a country of villages. Megacities generate generally the maximum GDP in any country because of the consumption and production income flows of 10 million-plus population.
5. Majority of the counties do not compute GDP of megacities although India has 7 to probably 9 megacities no GDP statistics of megacities is available, they do not compute GDP of megacities instead they compute district GDP.
6. Although Indian census computes occupational structure, male and female workforce participation, main and marginal workforces, they do not account for the diversity of urban employment which defines a megacity.
7. Megacities have got two service areas unlike small cities like market Towns (Mandi) with one service area consisting of supply villages of agricultural commodities and the market town. One service area is within the country and the other outside country. The service areas are defined by intense interaction with communication and flow of money, goods, and service. The outside service areas are generally megacities and metropolitan cities which will have their service areas. These three levels or more of service area connection allow the flow of goods, services and communication and money flows uninterrupted if world trade is rule-based under, the World Trade Organisation and counties do not arbitrarily and independently make trade rules.
8. Megacity interactions and flows in several service areas generate two types of income the basic income from outside and non-basic income within the country. Smarter the megacity the proportion of basic income increases, and this book investigates such possibilities.

9. Megacities can be broadly classified into two mature megacities numbering 30 to 33 and emerging megacities 41–45. Mature megacities are those who had attained 10-million-mark population decades back and graduating towards meta city of 20 million population. Some of them may graduate, some may lose absolute population, and some may have less of growth rate all because of the levels of configuration applied and this is manageable. Emerging megacities are those who graduated from metro cities to megacities in the last decades. This may happen with nucleated one city growth or many metropolitan cities join. The latter is generally unaccounted in India because of the definition of Census Metropolitan agglomeration within a district. Many of them may have faster population growth than meta cities.
10. Megacities involve vast geographical area and diverse ecosystem, and positive and negative impact will have far more consequence than other smaller settlements. Same also with the successful environment resources management.

11.1.2 Building Information System for just in Time Decision Making for Smart Global Megacities

There are two sets of major decisions people of smart global megacities wants to make. They relate to smart living and smart working. The communist/socialist system of Governance the Communist party and bureaucracy decides on living and working which need not be realistic in a megacity but mostly autocratic or oligarchical. In some countries, people have the right through their democratic institutions to decide on their work and living as per the constitution of democracy. Majority of the countries participating in this project are democracies and will continue to the path of democratic smart global megacities, except for probably Kochi-Kannur where a democratically elected Marxist political party rules every alternate election and probably Hong Kong which may or may not follows one country two system policy of Deng in the future. The smart global megacity is community-driven.

1. The household and community around household about walking distance from the household support each other in achieving smart living and working. They also collectively develop and use information system for these purposes.
2. All community decisions shall be based on correct and the latest information collected to make decisions.
3. This is achieved by human and non-human sensors in a smart global megacity.
4. Non-human sensors are a set of appropriate IoT sensors located within the households and community.
5. These IoTs are interconnected and the information is stored in the cloud within learned institutions selected within the megacities or selectively commercial cloud storages such as Amazon, Microsoft, and others if politically acceptable.
6. The digitisation of information including Geographical Information System for the megacities will be developed by the community and households and updated from time to time as a community task.

7. The skilling for GIS database creation by local households and communities will be conducted by selected learned institutions within the megacity.
8. The spatial decision support system as smartphone apps required for making decisions will be developed by community and institutions selected for the purpose as part of extensions and shared.
9. They can also share similar decision support systems from other communities outside the megacities.
10. The community will have a middle range and long-range plan of action to strengthen community IoT-ICT based information system based on perceived needs of the community based on global reality and not based on any ideology coined by any thinker.

11.1.3 Homestead and Households as the Building Block of Smart Global Megacities

1. Household has a piece of land, a house to live in and household infrastructure which will be assessed and digitised in the information system of the community.
2. Existing land information system if any of the land revenue department of the Government will be digitized and used as the basis for updating information or developed from the actual measurement and digitizing by a smart community.
3. The skilling for the task for the community to digitize this information will be conducted by competent institutions nearby.
4. Solid waste disposal system of the household will be assessed, and possible improvement will be discussed by the community with the household.
5. Sewerage system such as a septic tank of the household will be assessed, and possible improvement will be discussed by the community with the household.
6. Drinking water sources such as well household will be assessed, and possible improvement will be discussed by the community with the household.
7. Community and households will discuss the maximum use of rooftop for a generation of surplus electricity using photovoltaic systems connected to a community microgrid.
8. Drainage system within the household will be evaluated and Community and households will discuss redesign.
9. Rooftop harvesting of rainwater will be designed by the community which will eventually be connected to rainwater-harvesting-community ICT-IoT operated water grid.
10. Based on E-Urban Land Management as Business for Umami developed in Chapter 19 of the book "Smart Economy for Smart Cities" the household will be educated on how they can prosper using the various non-cash based land management system [3].

11.1.4 Analysis of Existing Employment and Potential for Employment in the Smart Community

1. Employment in the smart community cannot be a uniform and the same pattern in every community in the megacity. There can be a specialisation of employment pattern.
2. Employment pattern need not be all in the formal sector. There can be formal and informal employment types as exists, and both can be global if required.
3. Employment in the Smart Community depends upon many factors. Dominant institutions nearby determine the possibility and types of employment jointly with the local community.
4. Employment in a smart community can be of two types; discoverable and those that can be invented through new products and service that do not exist.
5. Discoverable employment is that employment which meets the existing as well as projected demand for services based on population, biophysical, environmental, and cultural needs, income, and expenditure pattern of the population.
6. Invented products and services are arising out of the institutions nearby the smart community by the production of new products and services.
7. The smart community shall be skilled by competent institutions to assess employment potentials, employment budgeting and employment projection for the smart community
8. Using household statistics, the supply side of employment statistics of working age, as well as a senior citizen, shall be assessed by male and female and their skills, the employment potential can be assessed by the smart community.
9. 6. The community shall assess newer skill required to participate in inventible jobs and training programs may be organised locally.
10. 7. Emerging jobs like e-commerce seller, logistic services and electric vehicle shuttle services and many others may be investigated.
11. The smart community shall decide the strategy of balancing supply-side employment with demand-side jobs and find gaps to fill in through proactive inviting of immigrants with skill sets to settle within the community.
12. All global jobs can be identified, and it can be located by GIS-based suitability analysis.
13. The household shall be designated as a workplace using the internet. For the demand of shared employment activities with shared essential infrastructure for working the community shall identify shared workspaces for a differing mix of employment activities suitable for the community and developed as part of urban land management for the business indicated as above.

11.1.5 Making Megacity Global and Locating Global Employment

1. Making a Megacity, Global city is like telling the obvious that as a human being you have two eyes which are taken for granted since megacity is endowed with

a higher level of ICT, global physical connectivity with multiple international airports, harbours and road and rail connectivity, innovative Knowledgebase and globally standardised skill sets in IT, Finance, Accounting, and legal affairs with clusters of interrelated institutions of higher knowledge base and highest quantum of income, expenditure and savings of 10 million people and above taking place in a small geographic area. The only issue is the smart communities of megacity shall realise these facts and change their lifestyles and employment pattern to global and higher levels.

2. Every megacity has a service area within the country and outside. The certainty of the flow of goods and services from the megacity outwards within the country is faced with less uncertainty than outside. The potential of developing global flows of goods and services and local flows generates basic and non-basic employment respectively within households and the smart community. What remains is household and community decision making and enterprise and ability to take risks based on facts.
3. The ability of smart individuals and smart community with special orientations on providing specialised and often innovative goods and services largely depends upon the possible skilling in facing these uncertainties in the flows of goods and services. Community leadership is the required capability to meet these demands.
4. To uncover a global aspect of megacity one must systematically identify which community has higher potential to increase the type of activity in the global service area and develop it.
5. A multi-criteria locational decision need to be rationally executed preferably with GIS and SDSS to identify the potential specialisation for global service areas of goods and services of the smart community.
6. Then these smart communities need to be functionally related to university system located nearby that space with the capability to extend skills and upgrade these skills continuously of the smart community based on the generation of new knowledge on the product and services.
7. The current system of manufacturing such as Fab Lab of MIT makes it easy for any smart community to produce any new and innovative knowledge-based products, for example, a new electric vehicle or aeroplanes or drones in any smart community workspace. Such production is not depending on Henry Fords or Toyota motors factory space or big capital.
8. E-marketing which is direct to consumers can take over conventional marketing with many middlemen's where the smart community can be e sellers. E-Logistics and E-electric mobility can intelligently support it with the participation of the smart community.
9. Venture Capitalist or Government policies are there to provide capital for any ventures having the potential for a higher level of success. The smart community need not be rich by inheritance to run an enterprise.
10. E-Governance, Spatial Decision Support System and E-Democracy and use of artificial intelligence and blockchain in all aspects of Governance and regulations can replace expensive, often partisan and least efficient human-run

bureaucracy with high potential of corruption and nepotism to make smart community corruption-free at the same time a community that self-regulate and 100% law-abiding using electronic means.

11.1.6 Smart Community Design

1. Smart Community in the megacity shall mutually support institutions nearby by providing suitable goods and services. It also allows productions related to the institute's specialisation. A good example of such a relationship is the relationship of Stanford University and Silicon Valley and MIT and Boston Corridor where many innovative industries came up. The institutions need not be university alone but can be related to health, recreation, tourism, or any aspect of megacity institutions.
2. How the human resources in the community can create jobs from all these opportunities and how the income derived from the job can be increased by skilling process the smart community shall consider.
3. The smart community shall start with major resources the community have and how it can be utilised to reap the best returns to the inhabitant. The urban land management coupled with urban management can be used. The landholding of the community can be pooled using well-known land management tools likes Land pooling and plot reconstitutions, etc. can be used to increase the income of the community if you make urban land management business of the community and not a government-dictated process.
4. Renewable energy such as electricity from photovoltaic shall be executed in a phased manner in a smart community such as maximum rooftop is utilised for this purpose eventually. The excess of energy can be channelized into a microgrid and the smart community can use it for local social and economic development and smart mobility using electric vehicles.
5. Rooftop rain harvesting system for the community shall be channelized into a water grid which can be managed by the community using IOTs and smartphone apps.
6. The drainage pattern of the community shall be planned, and water can be stored in retention and detention ponds to be used for livelihood and recreation in addition to managing the groundwater table.
7. The main sewerage system is a septic tank based and the main source of water supply is well water in Kerala. The septic tank can contaminate well water. A program of restructuring septic tanks for small-bore sewer system using water lagoon can be considered as a workable alternative by the smart community.
8. Every household will be a producer and consumer at the same time.
9. Mixed-use shall be propagated for all uses so that work and stay are adjacent to each other.
10. Public Realm shall be created in the community for all age group.

11.1.7 The Smart New Urbanism Principles

1. In this book, we propose to add smart as a prefix to well-accepted new urbanism principles which we call smart new urbanism.
2. The genesis of a smart community is the nexus of smart community infrastructure, related Analytics and Communication system which can even be voice-enable like Amazon Alexa in Echo for daily community life. Energy grid and water grid can be developed in a smart community using ICT and IoT and necessary scope for instant diagnosis and malady remedy systems using speech-enabled Alexa type speaker system by the housewife.
3. The smart infrastructure, devices and sensors and embedded processing can be used to measure; wide-area communication connectivity and data management can be used for management control requirements, preventing leaks, regulating flow to households and all leading towards Optimisation control and management.
4. What follows is new urbanism principles which will be adopted in the community design and can be made smart using ICT smartphone enabling.

(1) Design for pleasurable walkability within the community
(2) Design for maximising all types of connectivity
(3) Increasing density using various urban compaction tools by the community.
(4) Design for diversity and use of mixed-use as an important element of diversity
(5) Mixed housing was rich, middle income and low income live together using the same common services and facilities.
(6) Adopting quality architecture as related to cultural symbols, a way of life and climate and quality urban design to create a culturally acceptable public realm.
(7) Reinventing the traditional neighbourhood in the smart community which can be a made intelligent neighbourhood using ICT and IoT systems.
(8) Modifying the transport system using ICT so that we have just in the information that guides movements of goods and people with different modes of travel.
(9) Sustainable consideration is used to evaluate all aspects of the smart community.
(10) Benching marking of quality of life using robust indicators present and future.

11.1.8 Smart Community Vision that Integrates Zoning, Urban Compaction, Urban Land Management, and Form-Based Codes

Hybrid Form-Based Code (HFBC) is advocated for Smart Community spatial urban design. Elements of HFBC is tabulated below

ELEMENT	DESCRIPTION
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.
Building Form Standards	Regulations controlling the configuration, features, and functions of buildings that define and shape the public realm.
Public Space/Street Standards	Specifications for the elements within the public realm (e.g., sidewalks, travel lanes, street trees, street furniture, etc.).
Administration	A clearly defined application and project review process.
Architectural Standards	Regulations controlling external architectural materials and quality.
Landscaping Standards	Regulations controlling landscape design and plant materials on private property as they impact public spaces (e.g. regulations about parking lot screening and shading, maintaining sight lines, insuring unobstructed pedestrian movements, etc.).
Signage Standards	Regulations controlling allowable signage sizes, materials, illumination, and placement.
Environmental Resource Standards	Regulations controlling issues such as storm water drainage and infiltration, development on slopes, tree protection, solar access, etc.

Source [10]

1. The Smart Community shall have a vision of the smart community to collectively evolve.
2. This vision needs to be formulated as a five-year zonal plan prepared by the community which indicates broad land uses using a detailed GIS database of plots which the smart community shall be skilled to make. The vision plans shall have a community involvement strategy, Market demand analysis, infrastructure development and financing strategy, development incentives and finally consensus adoption by the smart community.
3. Various urban compaction approaches shall be evaluated for adoption to increase the household stocks for the future as well as providing a quality of life for the smart community. The smart community shall be skilled to adopt urban compaction involving their homesteads.

4. Various approaches available for urban land management shall be evaluated for adoption to increase the household stocks for the future as well as providing a quality of life for the smart community. The smart community shall be skilled to adopt urban land management tools involving their homesteads.
5. Various Form-Based Codes can be evaluated by the smart community evaluated for adoption to increase the household stocks for the future as well as providing a quality of life for the smart community. A regulation Plan based on community designed zonal plan which gives broad placement of standards discussed below and administrative process shall be detailed out at the start of community-based form-based coding which is an additional skill the community shall learn from competent professionals. They are summarised below and selected few are discussed further.

(1) **Building Form Standards**: It consists of an overview of the zonal plan including the use of space and placement of buildings, building form regulation, parking regulations, frontage types, allowed building types and allowed encroachments of public spaces.
(2) **Public Space Standards**: It consists of identifying public spaces within zonal plans and classifying by areal extent and use, specifying locational principles, general character, and potential use. It includes neighbourhood parks, playground by age group and open spaces for senior citizen and women group.
(3) **Architectural Standards**: It consists of specifying by community facade composition, door and windows types, material use, details of a porch, balcony, and galleries
(4) **Landscape standards**: Specification of landscape standards for pedestrian paths, cycle tracks, public space landscape, playground landscape by types, selection of point location for trees and other landscape elements, tree line along roads of different types, commercial area landscape, parking area landscape and irrigation plans and facilities.
(5) **Environment Standards**: Hierarchy of drainage system standards, stormwater system standards, rainwater harvesting standards, Retention and detention ponds standards, garbage disposal standards, solar panel standards and sewerage standards including retrofitting of septic tanks.

11.1.9 Configuring Mega City for Smart Mobility

1. A vast megacity area with 10 million-plus population and widely dispersed employment centres and many activities centres spread around requires a high level of mobility for people as well as goods. Sustainable mobility is ensured if this mobility is based on renewable energy and progressively reduce dependency on fossil fuels to near zero which is getting costlier and about to vanish.
2. A restructuring of the neighbourhood which makes walking and cycling a good experience shall be created using urban design, Form-Based Codes, Urban land management and site planning techniques and tools.

3. Household and institutional level renewable energy harvested from roof photovoltaic microgrid system shall be used to power e vehicle mobility managed by the smart community.
4. This renewable energy-based mobility shall take care of all regular work, school, and shopping trips/movement of the community.
5. Waterways and coastal shipping shall be explored and developed for less costly mobility.
6. Low-cost taxi system connecting airports may be explored for feasibility.
7. Renewable energy operated mobility using electric vehicle shall gradually replace in a phased manner all fossil fuel vehicles within the smart community. These e vehicles can be shared and owned by many households or total smart community
8. An integrated mobility plan with other modes of travel shall be designed for a megacity.
9. If the community produced a rooftop micro electric grid of the community shall be used for Vehicle mobility, then the community can plan to exempt payment to travel for a certain category of regular travellers like school children and senior citizen. Metro rail and light metro shall be encouraged and constructed to eliminate dependency on self-owned vehicles. The e-vehicles shall connect to metro rails and light metros transportation system.
10. All mobility of goods and people in the megacities shall have assistive smartphone apps to guide movement in the most efficient manner integrating all modes and types of movement.

11.1.10 Configuring Mega City for Smart Environment

1. Megacity provides for large-area smart environment management.
2. Flood water that is designed to connect large watersheds makes it easy to manage floods with collaborative institutions using a watershed-based ICT system.
3. Megacity generally has long seashores since most of the megacities located along seashores. Coastal zone protection shall be managed by the smart community.
4. Megacities generally have many river systems having vulnerable zones.
5. Using IOTs, sensors including human sensors these vulnerable areas can be monitored by all concerned including smart communities.
6. There are many legislations connected with coastal zones and river zones.
7. These laws can be codified as smartphone applications by local institutions and managed by the smart community.
8. Monitored environmental data can be used in spatial decision support system apps using smartphones or Alexa enabled smart speakers on environmental regulations can be utilised by smart communities affected by the calamity to get necessary administrative and policy supports.

9. These applications can be developed by competent institutions in collaboration with local smart communities.
10. The same approach developed for sale erosion and riverbank conservation can be extended to many other common megacity's environmental issues.

11.1.11 Configuring Mega City for Smart Economy

1. Both Industry and services in megacities are important in creating local and global jobs.
2. The industry tends to create more jobs in megacities than services barring a few sectors such as health care.
3. Factors of production and services and its comparative cost advantage and high international quality and reliability standards for industrial products determine the generation of employment in a megacity.
4. Surplus production of renewable energy in megacities can generate the lower cost of production and services if these employment sectors have access to community decided free renewable energy grids.
5. The above principles can be utilised for social welfare activities.
6. A balance of the cultural and ecological system of the megacity shall determine the industrial and services mix that can create employment.
7. There is no universal model such as China the world factory to dictate smart economic development.
8. The digitisation of all economic activities can be used to make economic activities more cost-effective and globally competitive.
9. Traditional extension of welfare measures as per religious practice and caste practice is more efficient and less corrupt than the bureaucratic delivery of welfare functions. This activity shall be outsourced by Government to them and further strengthen with Government help.
10. The smart economy shall be configured within the ecosystem of smart mobility, smart people, smart environment, smart living, smart and smart government.

11.1.12 Configuring Smart Megacity for Smart Governance

1. Megacities shall learn governance of megacities from the governance of the internet. It works despite not having a visible governing system existing with taxpayer's money. There is no systematic governance with administrative officers and brick and motor institutions, but it works effectively and never let you down in any of your activities.
2. The Smart Community will take a supportive role in all aspects of rule-based governance.
3. The smart communities will use ICT and IoTs and human sensors to monitor rule-based governance parameters. For example, If Coastal Regulation Zone is violated or river bed is encroached d upon, these violations will be geocoded in

a GIS-based rule-based decision support system and brought to the concerned administrators for administrative action in addition to community applying social pressure.

4. Direct value addition to the smart economy by governance is zero or always negative expenditure on Governance should be reduced using minimum government officers and maximum governance using electronic means, use of blockchains and artificial intelligence.
5. Most of the administrative activities can be outsourced eliminating the permanent cadre of administrative staff in Government like passport issue in India by Government using Tata Consultancy Services has made an issue of passport more efficient and expenditure on Governance less. Such experience shall be continued in all walks of administration.
6. The existing E-Governance application accessible to internet and smartphone-only constitutes less than 25% which needs to be made at least 75% in the megacities.
7. Cash transaction in the economy shall be progressively reduced replacing with digital cash transactions like Unified Payment Infrastructure UPI. The achievement of Reserve Bank of India in propagating core banking facilities, UPI to all banks and people and Income Tax and Goods and Service Tax moving towards electronic payment system is a notable achievement and policy tweaks can reduce the cash transaction in economy considerably.
8. Amazon Echo the talking interface has an open SDK and therefore many more smart speakers for definite Governance functions can be made by local academic institutions managed by housewives. Such devices shall be used widely by human sensors in the household for governance purpose.
9. There is the widespread use of websites by Government but most of them provide information and, but it is not enough. These websites should perform governing functions and shall be interactive. There shall be an evaluation of the website and award for best Government website which will help in improving the delivery of Governance a great deal.

11.1.13 Configuring Smart Megacity for Smart Living

1. The foundation of smart living is the biophysical, environmental, mental, and social health of a people.
2. Since humans being are part of the ecology, ecological health is equally important. This means living and non-living entity connected to an individual in megacity affect the foundation of living. If you decrease the migratory bird's arrival in some part of the city if you pollute the air, water and land and if you deliberatively change the climate by disrespecting ecology, you are doing a disservice to your very foundation of life.
3. The biological system of a human being if functioning abnormally it may be partly genetical or because of the health-related components discussed above. Remedial action needs to be taken which can be curative or preventive.

4. The megacity can be configured to achieve the preventive aspect of health considerably.
5. This configuration can be based on Regeneration of smart spaces for smart living in any megacity
6. The regeneration of megacity shall use urban land management tools enriched by ICT applications that benefit financially local population and aim at maximising the human physical and electronic contacts by opening public realm for all age groups, sex and income group in a locality at walkable distance.
7. These public realms shall be endowed with suitable infrastructure to make it most sought-after locations in a city for human interaction which can remove depression and suicidal tendencies and can make your health with playgrounds and enrich local culture and provides opportunities to have ethnic exotic food and view music, drama and dances along with a cinema.
8. To augment a healthy living the access to this public realm shall be by walking or cycling and shall be creatively designed and landscaped that gives the most memorable experience of the megacity.
9. The security of these open spaces shall be ensured by e-Governance apps in the smartphone by easily pressing the button of panic there.
10. E-Democracy apps related to open spaces can be used for the easy gathering of the people and enact various activities there in the public realm.

11.1.14 Conclusion

1. The configuring of a smart global megacity may vary depending upon the cultural and ecosystem of the city. This aspect ensures the diversity of smart global megacities.
2. Sharing and not owning is the fundamental philosophy of smart cities. Airbnb, Uber, and all aspects of smart are sharing.
3. Open sourcing of Spatial Decision Support for smart city decision making is yet another speeder option for the smart community and linked institutions. Smartphone apps are developed by competent persons in a common platform and shared not only within megacities but also outside.
4. The Smart community is on a continuous path of skilling. The skill themselves in developing E-Urban Land Management, Form-Based Codes for the smart communities, and gets skilled in smart economic activities such as an e- seller or innovative product developments and commercialisations.
5. A balanced view of six systems of a smart city will be executed and for example, smart economic goals of wealth creation need not diminish natural capitals and smart environmental goals.
6. Under the rights to livelihood given in the constitution, Government or its set procedures of planning board will not dictate what smart community shall do. They decide themselves what is good for themselves.

7. The smart community shall collaborate with traditional religious or caste-based community programs which were in existence in many centuries.
8. The renewable resource-based smart city will be attempted which are sustainable. Therefore, in community design, there shall be rainwater harvesting and community use and harvesting of solar energy for electric generation, grid management and common use.
9. Megacity shall aim at the complete transition from fossil-based fuel to renewable energy for all types of mobility in a phased manner.
10. The smart community shall not be only concerned about smart people but also trees, animal and birds and all non-living things like river coastal zones and so on.

What follows Sect. 1 of the book is a series of studies which will discuss these aspects in length.

11.2 E-Commerce and the City: Vignettes from Kozhikode, India

Electronic Commerce has made rapid inroads into even deeper pockets of the Indian markets, thanks to the advancements in logistics, infrastructure and technology. The new'digital markets' have different mechanisms of price discovery, patterns of competition and types of intermediation when compared to the conventional markets. Intense competitive rivalries among the e-commerce giants have led to substantial gains for the customer and in reducing search costs for both buyers and sellers. The current research focuses on one particular externality of these competitive online commerce markets- its impact on the local retailer in the cities and their coping strategies. Focusing on a south Indian Tier-II city, we see how the local retailer feels the heat of the growth of e-tailing and intense competition in the e-commerce market. We also see how the local initiatives harness the internet/mobile-based technology and mobilize the solidarity and the empathy for the 'local' of the local retailer and the buyer. We understand these underlying patterns through the elaborate case-studies of four 'local' e-commerce initiatives from the Kozhikode city, namely, Masalakada.com, Fixso commerce, Potato and Slash. These indigenous e-commerce platforms arose as 'hyperlocal' entrepreneurial efforts of individuals from the Kozhikode city most of whom belong to the lineage of the traditional trading communities in this erstwhile vibrant port-city on the Western coast. They were directly or indirectly affected by the onslaught of online commerce and they believed in the viability of a hyperlocal initiative in these markets despite the presence of global giants. Their entrepreneurial journeys are eventful with their learning experiences and struggle to adapt and survive while facing hurdles such as the non-existence of markets and the need to create a new market for their venture to operate and the predatory onslaught of the national and global players to the same markets. Their experiences testify that it is not always 'advantage globally'. There is still room for smaller 'hyperlocal' players from the city

in the emerging digital markets and they would play a pivotal role in the 'smartening' of the city bottom-up. In cities where commerce thrived for centuries owing centuries-old trust and informal social control, 'hyperlocal' e-commerce platforms are here to stay.

11.3 Territorial Intelligence Project: A Comparative Study of the Governance Transformation in the Urban-Rural Linkage Pattern in Milan, Chennai, and Kolkata

Urban growth processes lead to the expansion of the metropolis to the megalopolis, impacting the balance of the ecosystem and social development. Sustainable development must plan an equitable distribution of metropolitan services for society, acting on environmental and social variables.

The issue to be addressed. The endemic increase in inequalities; the hunger scandal; the recurrence of financial crises of vast proportions; the bursting of identity conflicts that add to the well-known conflicts of interest the paradoxes of happiness; the sustainability of development, are all new problems in our societies. If we want to attack ultimately, we must take a standby choosing the point of observation from which to shake reality. Otherwise, Urban and Architectural disciplines will also continue to expand and increase their technical-analytical apparatus. However, if they do not come out of self-referentiality, they will be less and less able to take hold of reality, and therefore, less and less suggest effective lines of action. Today, the ambition of neoliberalism to become the model of absolute government failed. According to our hypothesis, this matter today gives strength to alternatives, a different political economy model than the neo-liberal economy, and different policies needed for a different metropolis and megalopolis patterns.

Methods and context. Our question of research rises from the physical dimension of the metropolitan city analysis as the point of action of our Methodology. That has been tested in metropolitan contexts characterized by a confrontation between rural areas and new urban settlements; in territories where the megalopolis' infrastructure impacts the natural system of diverse States and geographical regions generating new hybrid landscapes where metropolitan citizens live. Nevertheless, Megalopolis territories are also the most vulnerable places because of the climate change that has exasperated their fragility, which we read through the three categories of exposure, sensitivity and adaptability. The decision-makers need new tools to read, understand, design and govern trans-regional projects and their impacts.

Results. It is difficult to assess the vulnerability of the metropolis and megalopolis through the limited availability of data. However, social analysis provides some ideas and reflections on the quality of essential services and their accessibility. At the same time, it is related to the social perspective of the distribution and accessibility of services to achieve Environmental and Spatial Justice. A study focusing on the environmental, social, political and economic management issues of the exposed

metropolis and megalopolis' contexts and new mapping tools (Metropolitan Cartography) could be the key to promoting more specific and inclusive policies. Through spatial representations (Green-Grey Infrastructure, Urban Metabolism and Environmental Justice Protocol Maps) related to case studies, we enlighten the impact of mega projects at the local scale.

To address the current uncertainty issue, we also deal with the lower local scale, particularly the water system of our territories, the river valleys and the Desakota region, trying to figure out the mediation code that allows giving an expressive tone to the today public realm space. We argue on the reasons for the inaccessibility of the services, cultural and environmental resources of the metropolis and megalopolis areas to foreign workers, migrants, and refugees in high social exclusion conditions.

The Metropolitan Cartography's potential as a tool of our Metro-radiology is expressed in the research and analysis of open-source data. It can express the intrinsic meaning of the data, not only the alphanumeric descriptive ones but also those containing the relational and spatializing value of the implicit properties of that huge hybrid territories. That allows us to analyze the territory at different scales, also.

In the future, we must work out new research to answer how can metropolis and megalopolis citizens land in this mega space. In short, how can they interpret it to immediately understand what tone of behaviour to adopt to make a pact among different citizenships: understanding it to adapt and perceive a feeling of adequacy even at the mega scale. the urban-rural linkage pattern in Milan, Chennai, and Kolkata

11.4 Megacity Study Tokyo

This chapter enumerates the status of the global megacity of Tokyo reigning as the largest mega city since 1990 onward. Globalization propelled the rate of urbanization with megacities accommodating a large share of the domestic population. Further, these megacities have unanimously accepted for setting thresholds and norms for lifestyles, cultures, strongly underpinned by the global economy and the infrastructure facilities and information technology regulating for innovation and updates frequently and typically the megacities are quick to respond such. Conventionally all the global megacities are the economic power magnets and thus their respective standpoint and position for global issues like climate change and related environmental concerns being foremost. Due to their economic stability, they are the key driver and consumers of resources both natural and manmade specifically human resource.

The case example of Tokyo demonstrates how good governance with a robust approach has put Tokyo in the most populated among the global megacities of the world. Though it is questionable whether it is sustainable, or even possible, to keep the position, the key observed strength of TMG to date is its resilient nature and quick response to the changing needs while addressing the human behaviour connotation as well.

With the blessed position of being the hub of the economic Centre of the country, Tokyo has been enjoying the affluent fiscal budget, compared to other local governments. The wealthy budget enables TMG to exercise and experiment with progressive policies. Recognizing that Tokyo has been the aggregation of energy and electricity demand, TMG addresses a series of policy measures to exercise collective action to reduce, purchase, manage and generate energy.

The checks and balances at TMG are democratic and upgraded regularly irrespective of the time frame. The staff is an integral part of the governance system and with measures starts with the recruitment process wherein the best candidates from reputed universities are selected and groomed with the work culture that gives them opportunities like travelling across the globe to observe, know, understand, and participate with other staff members delivering similar tasks. Having imbibed the knowledge base, they are facilitated at a platform wherein the experiences are shared and debated to add value to the existing systems at TMG and often the outcomes are dovetailed within the annual proposal submitted to TMG; were revisions and upgrading process is implemented. Next, there is a system wherein each of the staff members is to shift roles within the organization and centres' this sensitizes the members for other roles and increases the awareness, which helps in building them a team player with mutual respect that each one develops also gets reflected when they develop the annual proposals'. On the other hand, the TMG officials along with the relevant institutional staff typically support a bottom-up approach, rather than the top-down command that proposes environmental policy formulation, the implementation of the environmental and sustainability policies. While drafting the annual proposals being essentially bottoms-up approach, allows each member across the hierarchy to participate and put forth the creative ideas and with such process in progress, each member developed a sense of self-worth which builds their self-esteem and self-confidence as well. With such a backdrop the personal growth occurs through promotions that recognize personal initiatives and deliverables for the organization coupled with formal examination as well: written, interview including their hands-on work. Such a setup has proven to be ideal for sustainable growth with a strong sense of belonging to the organization, city and nation at large.

The decision-making is democratic as when the bids are submitted to each department within TMG the respective department has the authority to award the bids based on the framework arrived through consensus. Such an arrangement creates a healthy environment for competitions amongst various departments. With each member so vigil the thresholds within the organization are upscaled and improving with time especially for the reduction of carbon emission and thrust for maximizing renewable resources. With such a setup TMG has proved to be a pioneer for setting standards for other cities within the country and even globally. TMG goes further to work in coordination with external agencies i.e. EPSC has a technical group, which carries out energy management and conservation diagnostics services to the local businesses and factories and the service is free-of-charge. Tokyo, the global megacity is truly a unique example and to acknowledge as best practice is well earned by the city and its proud inhabitants.

11.5 Megacity Study Mumbai

Background

Mumbai, one of three coastal megacities in India, located along the Arabian Sea, has had a unique place in the country's economy by its being the financial and commercial capital. Historically having originated as a port city from its southern tip, wherefrom international maritime trade flourished especially after the opening up of the Suez Canal in 1869, it has moved from being a city of textile mills to a manufacturing and pharmaceutical hub to a financial centre with IT centres. Post-independence, the city witnessed large immigration, both national and international, as a centre of employment and business hub and thereby, spread northwards and towards the mainland, along the suburban rail corridors, encompassing many existing towns. It is spread over an area of about 603 Km^2 between the sea and the creek, interspersed with north-south trending hills, having moderate hot and humid climate. The need for a second seaport in 1989 and a second airport in the last decade is testimony to the urban agglomeration's sustenance as a thriving economy and its launch into a new growth trajectory.

The Metropolitan Region was delineated in the 1970s after the Government decision to decongest the island city by linking it to the mainland, today comprising a total of nine Municipal Corporations and Municipal Councils each in addition to over a 1000 villages in Thane, Raigad and Palghar districts; with a total population of 23.6 million, as per the 2011 Census.

SWOT

The SWOT is a conventional analytical tool to assess the growth potential of a region, in the context of this book, as a smart and global city.

Strengths

The city has a wide range of employment base in its industry as well as the financial and service sectors. From a planning perspective, the city has the advantage of having the richest Municipal Corporation (MCGM) today that was established almost a century and a half ago in 1872, and the Region has had a development authority (MMRDA) in place over the last five decades. Besides the strong institutional setup, the megacity also has the privilege of being home to the premier education and health infrastructure, like the IIT Bombay, TISS, JJ College of Architecture, Government Law College, the Jaslok or the Bombay or the Tata Memorial Hospital. The city is also well known for its heritage buildings and sea line, besides the efficient public transport network, particularly the suburban railway, commonly known with a tag as "the lifeline of Mumbai". The national park is also a unique feature in a megapolis that serves as the essential lungs for the city.

Weaknesses

Mumbai is a congregation of seven islands, made into a single landmass by reclaiming areas between them. The geographical features of the city have constrained it to have

linear traffic flows, whereby the supply of developable land is limited, giving rise to high land and real estate values and congested roads. Initially, the Central Business District (CBD) at the southernmost tip of the city at the Nariman Point, Fort or Colaba, while the residential areas are towards the north. This has aggravated the traffic woes and vehicular emissions and noise pollution. The limited supply of land resulted in high land values and affordable housing was beyond the purchasing power of many. This gave rise to a large section of the population (@42%) residing in slums, particularly the informal sector that formed a bulk of the workforce. This situation has also resulted in horizontal expansion along the major transportation corridors (ribbon development) and opening up agricultural lands for non-agricultural purposes. Being a historical city, many of the buildings here are old and dilapidated, and therefore ready for redevelopment. This is also true of the city's infrastructure, particularly the roads and the stormwater drains that are unable to service the high population, particularly during the high tides in the heavy monsoons experienced in this part of the country. Similarly, the suburban railway is overcrowded at all times of the day, and need to be augmented to retain acceptable service levels. Although the megacity has good power supply grid and lakes to fulfil its water requirements, other services, particularly solid waste management through landfill sites also needs to be revamped. With all these things put together, the city though the desired destination for many, has a low world ranking, both concerning the Quality of Life Index and the Ease of Doing Business, thereby facing stiff competition from other upcoming cities in the country.

Opportunities

Development of the prime lands occupied by the defunct mills, port and railway lands by linking to the city's transportation networks and providing the necessary social infrastructure and open spaces in the city will go a long way to its emergence as an international financial and tourist centre. Designing of the eastern waterfront as a marina, and operation of cruise ships therefrom will give a boost to the tourism potential of the city. Further, there is an opportunity to develop water transport between Mumbai and Navi Mumbai and other suburban areas. Growing demand for IT and ITES will also add to the city's economy and result in the decentralisation of its CBDs throughout the Region, particularly the MIDC pockets in Andheri and the Thane Belapur belt. The upcoming second airport in Navi Mumbai will ease the air passenger overload on the existing international airport in the city. The road and suburban rail traffic is being augmented through several grade separators, interchanges, and the mono and metro rail linkages connecting the western and the eastern inhabited corridors in the city. Also, the improved ship berthing and cargo handling capacity of the modern Jawarharlal Nehru Port Trust (JNPT) on the mainland with better road and rail connectivity in the state and other parts of the country through the Multi-Modal Corridor (MMC) linking to the NH8 leading to Ahmedabad and the Dedicated Freight Corridor (DFC) linking to Dadri (Punjab) in the north expected to reduce the transportation time and improve the trade and commerce in the Region as well as the country.

Threats

The city's high-intensity rainfall, especially when coupled with the high tide, causes floods during the monsoons those stretch over a good four months, disrupting the routine life in the megacity every year. The suburban rail service as also the road traffic is, therefore, adversely affected during this period due to bad road conditions. The collapsing of shanties in the slums on the encroached hills and the dilapidated structures also result in casualties during this season. Terrorism has also raised alarm as another potential threat in the megacity, having been affected therefrom on more than one occasion, particularly in crowded transportation routes relating to the suburban rail. Increasing migration trends and the growing population demand for basic services, like drinking water, shelter, power supply. The water and power supplies to the Region, therefore, need to be augmented in the future through sustainable measures like rainwater harvesting, recycling methods, which is being incentivised by the Municipal authorities; rather than through construction of dams requiring land acquisition and rehabilitation that has become tougher through new legislation. The rise in ownership of vehicles is causing consumption of more fossil fuels and release of high emissions and noise pollution, apart from leading to woeful traffic snarls and increased travel time, especially during peak hours. This has also led to the disintegration of the compact and efficient urban structure for which this megacity was famous and appreciated. The rise in per capita income and decrease in familial liabilities has given rise to high spending capacity, the trend of investing in second and weekend homes, further straining the infrastructure networks and ecological stability of the vulnerable Western Ghats. Last but not the least, it is causing the conversion of agricultural lands on the urban periphery, adversely affecting the self-sustainability in the Metropolitan Region, in absence of scientific inputs and stringent measures for conservation of agriculture lands.

Strategy as a Smart Mega City

ICT and IoT technologies have the potential to leverage the opportunities and strengths of the Region and to comprehensively address the weaknesses and threats therein. Urban areas across the world have turned to the digital platform and are focussing on compiling a database concerning different service verticals with the aim of 'ease of doing business'. The development of mobile applications at the global and local levels, like Google Maps to know the route between two locations, along with the traffic intensity thereon; and m-indicator for information on the timings of available suburban rail services on the different rail corridors and the stations between the origin-destination points, also enabling the purchase of tickets thereon, using real-time data has facilitated the everyday routine for the common man. Besides, the use of ICT for online payment processes and money transfers through user-friendly Graphical User Interface (GUI) has now become commonplace. This has gone a long way to reduce the trips generated, enabling the common citizen to save on both time and energy. However, data security issues have led to cybercrimes and impinged on individual privacy.

In the MMR, different organisations are responsible for providing an array of public services. Considering the multiplicity of organisations functioning here, a unified data repository of their respective domain is essential. Access to such a data repository would facilitate coordination for improved services to the citizens. Creation of a unified base map including the infrastructure networks using GIS and linking of the land records and other attribute data using ERP solutions to form a comprehensive database concerning public amenities and resources forms the bedrock for the smooth functioning of the multi-institutional framework created for the smooth functioning of the Region. The integration of the data-rich GIS maps with building plan approval systems can streamline the entire demand-supply chain through a single window, and ensure that the investments by the citizen in real estate are protected. Further, being a coastal city, it is also essential for Mumbai to have a Coastal Zone Management Plan (CZMP) and share it with the citizens through the websites of the Municipal Corporations.

The rising land values in the city and an increase in private vehicle ownership have led to the unabated urban agglomeration. This has led to a decline in the population density in urban areas, whereby the advantages resulting from the economies of scale are lost. It will therefore be essential to monitor the conversion of agricultural and forested lands as well as wastelands at the urban periphery. However, being a limited resource, land utilisation needs to be considered comprehensively, and not as per the market values thereof. The analysis of temporal changes in the urban morphology changing needs to be analysed through the continuous supply of satellite images for appropriate and timely policy interventions.

The State Government's timely initiative in the early 2000s to promote Information Technology in the state led to the immediate formulation of a policy framework and the corresponding provisions in the development process led to emergence and establishment of several IT corridors in and around Mumbai. The establishment of the Dhirubhai Ambani Knowledge City (DAKC) along Thane Belapur Industrial belt has attracted young and talented workforce across the nation and globe. Similarly, many organisations have established their IT centres in these IT corridors and controlling several operations across the globe

Specific transportation planning software is used to store, display, manage and analyse transportation data for travel-demand modelling, planning and logistics functions for improved performance of complex road networks. Similarly, traffic simulation is also used for route identification and design. CCTVs installed at traffic junctions help to generate real-time data and monitor traffic lights. Coupled with sensors, they are also used to regulate the flow of traffic.

However, it is not enough for the Region to be smart alone, as long as the entire urban system is not integrated smoothly to be sustainable. Different software is therefore deployed to design, build and efficiently operate the various infrastructure verticals, not only to sustain the consumption of natural resources but also to abate air and water pollution resulting therefrom. One such chain extends from the tapping of water from the source to the reservoir for supply to the different end-users, followed by its segregation at source, and treatment for re-use or disposal. Water-metering and monitoring pilferage by installing sensors; flood monitoring and developing

disaster management techniques are application areas for water conservation. The green certification of projects comprises similar chains in solid waste and stormwater management. An integrated system can model the respective sub-systems and document workflows across verticals for projects of any size and complexity. So far, each of these sectors has been successful in adopting the IoT solutions in Mumbai to different extents. However, the integration of different utility verticals is essential to ensure resource conservation and enable transparency in decision making.

Uninterrupted power supply and data connectivity are challenging. The power sector in Mumbai is handled by more than one operator like the BEST, MSEDCL, Reliance and the Tatas. In the domain of power, its generation, distribution and consumption can be monitored through SCADA (Supervisory Control and Data Acquisition), a control system architecture comprising computers, networked data communications and (GUI) for high-level process supervisory management at the urban level. Such measures help to reduce losses and power thefts.

Last but not the least; public awareness and participation are essential in making Mumbai truly a smart and resilient city.

Strategy as a Global Mega City

The economic liberalisation for globalisation policy of India at the turn of the century has further aligned Mumbai in the spotlight to the world as a centre for several key businesses and trades, competing with various other countries. The formation of Special Economic Zones (SEZs) and Foreign Direct Investments (FDIs) have changed the entire fabric of the city by a proliferation of multinational companies for establishing their regional offices. This was augmented by the ICT and the Business Processing Offices (BPOs). *Further, the city adapted by becoming multi-nucleated to overcome this shortcoming the fanning out of the industry and offices to other parts of the city and the development of the Bandra Kurla Complex, SEEPZ and other pockets of the MIDC.*

The Special Township policy further enabled the developers to consolidate the private land parcels and build gated communities away from the centre of the city along the prominent transport corridors, taking a cue from the Western world. This was further abetted through FDI and the easing of housing finance options both for the developers and the buyers so that the double income in the new generation enabled it to think of second homes or weekend homes on the urban periphery. However, the lessons to be learnt here in terms of the environmental losses through the ghost cities in China are yet to tickle in and percolate. Recently, the Government of India under Sagarmala programme has established Coastal Economic Zones (SEZs), opening up seafronts for more business activities.

Under the umbrella of the 'Smart Global Mega Cities' research project, 'Mumbai' emerges as one of the well-deserving and promising Global Megapolis and certainly a widely acknowledged economic hub of south-east Asia. At the same time, in the context of national and regional economic development, the potential of Greater Mumbai's economic stature is assessed in this study by its evolution as an economic centre, followed by the identification of main actors for its growth story, reviewing

establishment of Mumbai as an economic hub and finally envisioning it as a smart global megacity.

The transport sector is now among the top three industrial sectors to embrace the shared economy model with digital platforms like Ola, Uber, Rapido, etc., having successfully penetrated the urban markets. With the help of ICT at service provider's ends and smart devices at user ends to aggregate multiple modes of transports on single application platforms, putting the user at the centre of mobility services can address this dynamic change in demand in real-time. The study focused on how to translate the sustainability criteria while designing and implementing Mobility as a Service (MaaS) for Mumbai. In the case of Mumbai, applications like M-Indicator have already been functioning and are popular in tracking suburban railways and buses. Private operators such as Ola, Uber, and various other applications to book a car or taxi or rickshaw have gained popularity over the past decade. Such platforms allow a passenger to opt and balance between time and convenience for various trips with real-time information. Some of them enable personalized payment and ticketing for particular trips as per the user's preference with suitable available options for individual ticketing and payment system. The future MaaS ecosystem can be conceived of as a network of levels and domains with clearly defined functions emerging at the intersection of each. Apart from challenges for implementing the MaaS ecosystem for Mumbai, the authors identified the future roadmap with the following goals: (i) making a user-centric system; (ii) establishing a system of integrators, and (iii) sustainability criteria such as upgrading traditional vehicles and carriages to an environment-friendly technology, upgrading and equipping existing vehicles and carriages to a smart technology etc.

11.6 Planning for Resiliency and Climate Protection in the New York Megacity

New York (NY) metro region is one of the oldest megacities in the world, maintaining a population of more than 10 million since the 1950s. The city has also long dominated the world economy and consistently ranked as one of the top 3 global cities. Historically, being the largest city in the United States and one of the most racially, ethnically and culturally diverse city in the world, NY metro region observed revolutionary urban ideas, policies and agendas being implemented through many decades and centuries of planning practice. The 18th and 19th century New York witnessed the construction of major urban infrastructure and sanitation projects, the building of architectural landmarks and public squares as part of Urban Arts and City Beautiful movement, creation of public classic public parks during the urban parks' movement, implementation of strong zoning regulations, land use control and building bye-laws, creation of garden-cities and subdivision style suburban neighbourhoods, development of parkways and expressways to improve regional mobility, and design of influential urban renewal projects. New York still cherishes the planning legacies

of some of the pioneering urban planners and thinkers in the world who envisioned and exhibited how urban living can be shaped in the 18th and 19th century.

The post-industrial New York though witnessed its phase of economic and urban decline, also demonstrated rapid restructuring of its economy and urban landscape to meet the emerging needs of the new global economy since the 1980–90 s. NY metro region continued its innovative planning efforts in the 21st century to maintain its competitive position in the world economy and to create an attractive environment for the global elites and specialized service firms. Since the 2000s, planning initiatives in NY metro region exhibited strong commitment towards economic growth, inclusiveness and diversity, environment and sustainability, as well as climate resiliency. New York's commitment towards economic growth and sustainable built environment, is strongly evident in the recent times as the city becomes one of the epicentres for cutting-edge urban redevelopment, real estate, and smart city projects. Examples of Highline Park and Hudson Yards project are iconic and exemplary in these aspects, however, such planning endeavours have failed to address the equitable, inclusiveness, and affordability objectives of the megacity.

Climate resiliency planning and adaptation and mitigation strategies for climate protection received huge momentum after the historic Hurricane Sandy in 2012 that caused billions of dollars in damages for the megacity. The city thus became more proactive in mobilizing its resources, public agencies, private stakeholders, and communities to come up with smarter, more innovative and inclusive approaches to protect its built environment and people from the risks of changing climate, rising sea levels and increasing damages from natural disasters. The recent comprehensive plans of New York City, PlaNYC in 2007, PlaNYC update in 2011, OneNYC in 2015 and OneNYC update in 2018 envisioned future economic growth in sustainable ways and become more resilient in the wake of climate change challenges. The comprehensive plans of NYC have evolved over the decade to embrace the city's greatest and unique assets of diversity and to reinforce strategies to achieve equitable, sustainable and resiliency goals for its diverse citizens. As part of these comprehensive plans, numerous public agencies, stakeholders, and community members within the NY metro region came together to develop pro-active design guidelines, zoning regulations, housing, urban greening, urban agricultural, and infrastructural projects that promote sustainability and resiliency. Adaption and mitigation strategies, including new building design guidelines, zoning regulations, flood and climate risk mapping, protection for the city's critical infrastructure and vulnerable communities, have been formulated, adopted and already implemented in many parts of the city.

New York City Department of Environmental Protection (NYCDEP)'s Climate Change Task Force, formed in 2004, and the formation of New York City Panel on Climate Change (NPCC) in 2008, initiated by the Mayor's Office of Sustainability was the early steps in process of climate resiliency planning at a city-wide scale. NYCDEP's Task Force that evolved into a Climate Change Program focused on understanding the effects of climate change on planning and management of NYC's water supply, sewer, and wastewater treatment systems, while NPCC's task was to provide stakeholders with the required information and adaptation techniques for management of New York's critical infrastructure. NPCC was reorganized as the

second panel on climate change in 2013 after Hurricane Sandy to further emphasize on adaption strategies. These programs strongly applied cutting-edge technologies and focused on comprehensive approaches to developing risk management plans based on climate change forecast scenario predictions, future risk maps, and estimations of inundation zones. At the State level, Community Risk and Resiliency Act (CRRA) and "Climate Smart NY" programs further resulted in various state agencies develop their climate action planning implementation guidelines and review procedures. In 2018, the State Department of Environmental Conservation also drafted flood risk management guidance at the state level for implementation of CRRA and provided guidelines for structures and buildings located in tidal and non-tidal areas throughout the state, although these guidelines were challenges at the New York city level citing imprecise ways of modelling and assessing future climate risks.

From Climate Mitigation Planning perspective, New York City is working ambitiously enough to reduce the carbon footprint significantly relative to the baseline year of 2005 and with a low carbon intensity scenario, the city is on track to achieving its interim goal of reducing the emissions 40% by 2030 and reaching the ultimate 80 X 50 goal of reducing GHG emissions by 80% by 2050. From adaptation and resiliency perspectives, NPCC developed a risk management approach, Flexible Adaptation Pathways in 2010 modelled based on adaptation planning for the Thames Barrier in London. NPCC stressed that while current sea level rise may seem manageable for adaptation planning as of now, unpredicted changes in sea level rise due to land-based ice melting in Greenland and the Arctic may pose severe planning challenges later in the 21st century. The Flexible Adaptation Pathways thus focused on a risk-management approach that is flexible, dynamic and evolves. Post-Hurricane Sandy, adaptation strategies further gained momentum to protect the vulnerable areas and critical infrastructure of the city. The second New York City Panel on Climate Change (NPCC2) and a Special Initiative for Rebuilding and Resiliency (SIRR), established a combination of building technologically advanced and manmade devices, such as floodwalls, tide gates, reinforced bulkheads, off-shore breakwaters, as well as building natural areas such as expanded green infrastructure, restoring and developing wetland areas, developing sand-filled beaches and dunes, were outlined as critical measures for the protection of coastal communities in NYC. Funding sources and means for these adaptation and resiliency measures were also outlined for efficient implementation of these projects.

Protection of the critical infrastructure, e.g. transportation, water, waste, energy and communication, was further emphasized in the post-Sandy based on the earlier plans from NPCC and NYCDEP. A large number of adaptation strategies in the transportation infrastructure included elevating, flood-proofing and adding heat-resistant materials to the existing structures, some existing transportation facilities have already been retrofitted with various adaptation measures since 2010. For water and waste infrastructure, NYCDEP's Climate Change Program included infrastructure investments in form of storm surge barriers and floodwalls that can protect the city's WPCPs, as some of them are located in high-risk zones. The program also proposed relocation of the city's emergency pumping stations and sewer system changes, and increasing pumping capacities as a response to sea-level rise and storm

surges. NYCDEP approximately allotted a decadal budget of $20 billion to maintain its water supply-related infrastructure. Also, NPCC outlined specific adaptation strategies that included leak repairing in the water supply pipelines to prevent saltwater entry into the system and efficient functioning of the tide gates. NYC's WPCPs were also identified as the major emitters within the NYCDEP system and therefore, Greenhouse Gas Management Plans were formulated for the GHG reductions at the WPCP facilities. For energy and communication infrastructure, storm surge barriers are proposed to protect the power plants that are located along shorelines or close to shorelines.

Adaptation and resiliency planning at the community level was strongly visible through changes in zoning regulations and building codes in the post-Sandy era. NYC Department of Buildings implemented emergency building codes in 2013 to include flood-resistant construction, wind and wind-driven rain resistance, making building codes consistent with FEMA's National Flood Insurance Program (NFIP) requirements. Nevertheless, there is a considerable mismatch between the flood-resistant construction standards and the current zoning. The 2013 Flood Text limits investments in resilient building, as it does not provide enough flexibility in the building envelope. The updated PFIRMs have been challenged by the City of New York and are currently set to be adopted in 2024. The Build It Back program effectively used the 2013 Flood Text and the 2015 Recovery Text to elevate and rebuilt approximately 8,300 property owners of 1–4 unit buildings to flood-resistant construction standards. Nevertheless, the 2013 Flood Text expired in July 2020 and the 2015 Recovery Text is set to expire 1 year after updated preliminary FIRM maps are adopted (which is set for 2024).

New York City has proposed new Zoning for Coastal Flood Resiliency to reduce damage from future floods, guide long-term resiliency in the city's current and future floodplains, reduce regulatory obstacles, save on flood insurance costs, and encourage building owners to invest incrementally in adaptation and resiliency improvements. With future projections of flood and sea-level rise risks, the need for improved and more affordable insurance programs, specifically for the majority of the low-income population, was realized by the city. The SIRR's adaptation measures for high-risk communities also guaranteed a significant reduction in flood insurance premiums and reduced uncertainty in insurance coverage for vulnerable communities under high-loss scenarios.

The recent initiatives of adaptation and resiliency planning in New York demonstrate the city's political and community will to build a resilient city. NY metro region has indeed shown many success stories with its recent plans, policies and programs to address various challenges. However, challenges of continued economic growth and inclusive economy for all (challenges for economic sustainability), gentrification, homelessness, racial and ethnic segregation, inadequate low-income housing (challenges for social sustainability), hurricanes, flooding and natural disasters (challenges for environmental sustainability) remain a significant concern for the entire region. Gaps and mismatches between existing regulations and proposed future strategies are still persistent in many planning areas. To what extent, and how efficiently the

city can address these challenges will determine the success and sustainability of the city in the future decades to come.

11.7 Towards a Smart Mega City: Hong Kong and Shenzhen

The historic importance of being a gateway between China and China's opening up to the rest of the world, Hong Kong and Shenzhen flourish as the most competitive cities in the world in the old and new economy. Despite their differences in culture, regulations and administrative system, with both cities' relative advantages, they are better off working in partnership and could come together as a smart global megacity that will be incomparable to others. It is suggested that closer collaboration between Hong Kong and Shenzhen could maximise the strengths and minimize the weaknesses of Hong Kong and Shenzhen while complementing each other.

Each having a unique trajectory of development from a small fishing village to a world-class city, both Hong Kong and Shenzhen are potentially the most important cities and the key economic drivers of the GBA within South China. According to data compiled by the Hong Kong Trade Development Council, Hong Kong and Shenzhen each account for 21.8 and 23.2% of the GDP in GBA in 2019. Having worked closely together since Shenzhen's designation as SEZ, the Hong Kong-Shenzhen partnership continues with each specializing in different functions as both cities grow. Despite being outgrown by Shenzhen recently, Hong Kong plays an important role in bringing foreign investments to Shenzhen. Adopting the Smart and Sustainable City Framework developed by UDP International and Institute for Sustainable Urbanisation (ISU), this chapter builds on the analysis previously done in the book series and evaluates Hong Kong and Shenzhen based on the six Smart City Elements, namely Smart Living, Smart Environment, Smart Mobility, Smart Infrastructure, Smart Economy and Smart Governance.

Both cities have done poorly in providing affordable housing, one of the important criteria of Smart Living, with both being ranked as one of the most unaffordable cities in the world in owning a housing property. Despite efforts from the governments in providing affordable housing from the public sector, more needs to be done to alleviate the current housing affordability issues. Shenzhen has been struggling to increase the ratio of development land for residential uses, while Hong Kong also faces difficulty in finding available land for public housing as well as private developments. On another aspect of smart living, Hong Kong has its edge in comparison to its neighbouring Shenzhen. Hong Kong has more to offer in terms of heritage, art and culture, with a more vibrant creative, art and culture scene and attractiveness for global artists to hold or participate in cultural events. With some existing colonial-style buildings and heritage, Hong Kong will be welcoming new contemporary art museum M+, and the Hong Kong Palace Museum in West Kowloon Cultural District. With better awareness of the Hong Kong government in preserving cultural heritage, as well as bottom-up initiatives such as Smart Cultural Precinct @ Central by ISU, Hong Kong has a richer cultural foundation than Shenzhen, which has come onto the

world stage in less than 40 years. Hong Kong's distinctive skyline across Victoria Harbour and its unique Peak View are world-famous. Nevertheless, Shenzhen has been an inviting playground for architects as the city is hungry for masterpieces to decorate its skyline. Hong Kong also has better health care, with affordable public health care as a safety net with additional choices in private hospitals and clinics. Hong Kong also performs better in education than Shenzhen with more world-class universities and academic exchanges with other higher education institutions in the world.

Cities should be conscious in managing the resources and the natural environment in their endeavour towards Smart Environment. With a recycling rate of 30% in Hong Kong in 2018, similar to that of Shenzhen of about 30%, both cities have to need to use their resources better and also improve their waste reduction strategies. Nevertheless, there are smart initiatives for the environment to improve air pollution problem in Shenzhen including subsidizing electric car owners and using electric vehicles in public services, such as bus fleet. On the other hand, the Hong Kong Chief Executive Carrie Lam has set a target of achieving carbon neutrality in 2050 in her 2020 Policy Address with more in-depth environmental policies to follow, which include the promotion of electric cars. On provision of green spaces, Shenzhen has put a lot of efforts in making the city greener (41.2% coverage of forest) and it is now dubbed the "National Forest City" in China. By the end of 2019, the number of parks in Shenzhen had reached 1,090 according to the Shenzhen Municipal People's Government. However, the distribution of green spaces in Shenzhen was not as even as Hong Kong where people can easily enter one of its country parks with public transport within an hour from the urban areas.

On Smart Mobility's end, both cities are very well served by public transport with modes ranging from metro, buses, with real-time schedules available with the aid of an app, and on-demand services like taxis and more recently ride-sharing, which is more common in Shenzhen as ride-sharing in Hong Kong are officially illegal. Underpinned by the cities' compactness and the availability to commute without a vehicle, Hong Kong and Shenzhen are regarded as very walkable, despite Hong Kong is not as cycle-friendly as its neighbour with hilly terrain and compact built environment in the city centre.

Openness and connectivity of a city are one of the indicators for Smart Economy as it facilitates the fluent flow of communication and exchange of ideas. Having long been a global financial hub, Hong Kong has established good connectivity with the rest of the world, while Shenzhen has plenty of direct domestic flights, the cooperation of the two airports could bring synergy to the whole region. Probably a victim of its success, Hong Kong has been struggling to diversify its industry from predominantly financial services and trading to be more innovation-driven. Shenzhen has successfully transformed itself as the "Silicon Valley of China" and moved to the upper echelon of the global value chain. It is also evident that the entrepreneurship and start-up culture with competitive, well-educated young population have paved the way for Shenzhen's "smarter" economy.

It is widely agreed that transparency is an important element of Smart Governance as the government has to be made accountable for its decisions and it lays

the foundation of public participation. Hong Kong is relatively transparent with a wide range of easily accessible information on public services, policies, and even data measuring the efficiency of the government in both Chinese and English. Statistics of market conditions are also regularly updated for easy compilation of market intelligence. Public participation is evolving in Hong Kong as most policy initiatives include public consultation exercises and relevant statutory consultations bodies such as District Council would be normally consulted. Shenzhen is far less transparent in its governance with a limited release of information with most information only available in Chinese, not to mention the limited channels for engaging the public. Indeed, the Shenzhen's governance could improve as the central government has recently given more autonomy on aspects including intellectual property protection, economic legislation and talent attraction.

Both cities are working towards "Smarter" Infrastructure. Hong Kong has relied on coal for half of its electricity generation, with the rest being natural gas and imported nuclear power each accounting for 25%. Despite the Hong Kong government's effort in promoting renewable energy, it seems not to be bearing fruit without fundamental changes. Shenzhen has seen a decrease in reliance on coal with less than 15% of the power generated from it. Shenzhen showed higher acceptance towards nuclear power which accounts for more than 45% of electricity generated. Aside from utilities, Hong Kong has a strong basis in its ICT infrastructure and digital connectivity. With 11 submarine optic-fibre cables interconnected with other continents, Hong Kong is in a pole position for developing data centres and the hub for cloud computing. Achieving full 5G coverage across the city in August 2020, Shenzhen has also announced its ambitious plan to be one of the world's leading 5G cities with the largest scale and highest innovation level of "new infrastructure". With each city excelling in different aspects, by tying closer the two cities together, the formation of a megacity could unleash the largest potential of Hong Kong and Shenzhen and could be more beneficial to each of them than working on their own.

The formation of Hong Kong and Shenzhen as a Smart Mega-City would also ensure a much smoother transition leading up to 2047. However, this would require further collaboration and integration at various levels including physical, socio-economic, environmental, community and administrative aspects. Physically, being the connecting points of Hong Kong and Shenzhen and well connected with transit, the Border Control Points (BCPs) should be activated as nodes and act as the starting points of physical integration. Visa and immigration process for trips between two cities should be friendlier and easier with initiatives or policies allowing a smoother flow of personnel with lower time and money cost. By integrating physically and having a collaborated planning approach for development and growth and managing infrastructure needs, the cities could better utilize man-made and natural resources and have potential to move towards becoming "smarter" and sustainable cities. On the socio-economic aspect, both cities can take their strengths to improve the weaknesses of each other, such as providing better education and health care, increasing synergy between technological innovation, financing and other professional services, and attracting foreign investors to fund smart initiatives and technological developments with better connection with the global financial market. Environmentally,

Hong Kong would be able to provide the outdoor experience for parts of Shenzhen which are nature-deprived, as the green spaces in Shenzhen are not evenly distributed. While Shenzhen has less to offer in arts, culture and heritage, Hong Kong can comfortably serve as the tourism outlet with richer cultural offerings in the unified megacity. Aside from different elements and characteristics of both cities, bringing the people together is also important. Therefore, community engagement should be proactively done to educate, raise awareness, and obtain feedback from the various key stakeholders on both sides. Lastly, administrative integration should be achieved through collaborations of both city governments and working together to formulate a strategic plan through a holistic approach. By combining the resources, working closely in partnership with both sides of the government, and engaging the public sector, private sector, community, academia and other relevant key stakeholders of both cities, a smart global megacity can be formed with Hong Kong and Shenzhen viewed together with a focus on People, Place, and Planet. Other cities in GBA can follow suit and pair up for more synergies and develop together smartly and sustainably.

11.8 Spatial Strategy for Megacity Study Kolkata

The metropolitan scale creates challenges in planning, management and governance. A metropolis is an area of continuous spread of cities and intervening rural areas. These become areas of accumulation of resources. Metropolitan regions witness increasing linkages with the global economy as well as competition among themselves for attracting investments. Some of the metropolitan cities and regions have grown in megacities on account of the population exceeding ten million people. Metropolitan governance in India is attributed to multiple organisations and overlapping jurisdictions. However, these are also characterized by an absence of cooperation, coordination and competition. These are essentially polycentric. Through the research in this chapter focusing on the case of Kolkata, the polycentric nature has been demonstrated. An attempt has been made to find the solution to the metropolitan governance issue in consolidation and strengthening or coordination and cooperation of the existing fragmented setups.

Kolkata metropolitan area has been holding the position of primacy. While the metropolitan population is 15.5 million, Kolkata city has 4.48 million, which is twice the population of the next largest city in the entire eastern region, establishing its primacy in the region. The KMA is governed by many local governments in different administrative zones. However, for the overall management of the development of this area, a statutory authority (KMDA; formerly CMDA) was established in the year 1970. KMDA has been involved in multiple activities in the region and is primarily engaged in carrying out different levels of planning-exercises from the perspective plan to formulation of investment programs in the KMA.

74th CAA has not brought any significant changes to the existing arrangements in metropolitan governance. It has been observed by Sivarakrishnan the governance system in the metropolitan areas is no different from what existed in the pre-amendment era. There is still the predominance of fractured systems, which are a collection of parastatals and agencies having overlapping sectoral and spatial jurisdictions [11].

There is going to be no reversal to the urbanisation trend in India and neither so in the world. As stated by Kübler and Lefèvre [12] the twenty-first century will be an urban century and more and more the century of megacities and these cities will be crucial for the national economic well-being and will feature as the most important nodes of international economic, cultural and political exchange, which mandates the need for an innovative system of governance for the megacities.

It is a required conclusion of this research that the megacities need to have a spatial connotation as well. As of date the megacity is defined based on the population and exists within the defined metropolitan region. In other words, it is just a very large urban settlement. It has been observed the problems of the megacity are similar to those of the metropolitan cities. However, the solution to these mega problems of the megacities does not lie in those adopted by the settlements of a smaller scale. Most of the problems are due to the lack of coordination between the participating agencies, which can be overcome by either adopting such governance systems that are built on accountability, transparency and coordination or by creating one megacity government that looks into all the aspects including planning, implementation, management and governance.

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