Chapter 15
Towards a Smart Metropolitan Regional Development—Spatial and Economic Design Strategies: Dakar

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Abstract Development of large metropolitan regions like Dakar constitutes economic and social opportunities as well as challenges depending on how the urban growth was planned designed and managed. The dynamic transformation of the Dakar Metropolitan Region from a population of 245,000 to 3.5 million inhabitants in 1950 and 2016 respectively has occurred in different paces, times and places in terms of numbers, urban form and structure (density distribution, and compactness). When a city reaches one million or more of population size, it becomes more complex for its planning, design and management compared to a small city. For instance, when a city reaches one million inhabitants, its accessibility will be largely determined by elements of its urban form and structure as well as elements of transport infrastructures and, recently, elements of Information and Communication Technologies (ICT). This accessibility determines in large the interaction between economic and spatial design strategies. After the introduction, this study is divided in six sections. **The first section** presents the "Conceptual framework of the Smart Metropolitan Regional Development" of the study; **The second section** presents "Urbanization of the Dakar Metropolitan Region in Time and Space"; **The third section** focuses on the "Urban Accessibility and Mobility"; **The fourth section** presents "Urbanization, Economic Growth and Metropolitan Regional Development" including economic growth, human development and sustainability,

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T. M. Vinod Kumar (ed.), *Smart Metropolitan Regional Development*,
Advances in 21st Century Human Settlements,
https://doi.org/10.1007/978-981-10-8588-8_15

inclusion, resilience and prosperity; **The fifth section** presents "Towards a Smart Metropolitan regional Development"; **The sixth section**, based on the development of the previous sections, presents the "Spatial and Economic Design Strategies for a Smart Dakar Metropolitan Regional Development".

Keywords Smart metropolitan region · Economic & spatial design strategies Urbanization · Urban system · Urban form and structure · Streets and other public spaces · Human development · Accessibility · Sustainable · Inclusive Resilience · Prosperity

15.1 Introduction

Development of large urban agglomerations as the Dakar Metropolitan Region constitutes economic and social opportunities as well as challenges depending on how the urban growth was planned and managed. Large urban agglomerations provide opportunities for economies of scale and agglomeration, but it will also call for large investments in infrastructures to respond to the increased demand for water, sanitation, solid management, energy, streets and public spaces, and mobility, etc. They will also require efficient institutions for the management of social demand and equity such as on education and health as well as protection of people against violence and insecurity. Economies of scale and agglomeration economies are, for instance, greater in metropolitan areas where accessibility infrastructures are able to answer accessibility to services' needs with higher access to markets and resources than those where accessibility is impeded by deficient accessibility infrastructures. Efficient accessibility infrastructures will allow large-scale production of goods and services that can be distributed within the metropolitan regions and beyond with time, cost and reliability opportunities [1]. Without efficient accessibility systems, a metropolitan region losses its economic power and remains just clusters of disconnected settlements. The latter is the situation of the Dakar metropolitan region as most African metropolitan regions.

Dakar has not been able so far to respond to growth in accessibility demand and several other needs such as access to water, sanitation, management of solid waste, and streets and other public spaces, key elements of a city foundation. From a population of about 214,000 in 1950, the Dakar Metropolitan Region has a population of 3.5 million in 2016. Since 1950 Dakar has been a primate city with more than half of the national urban population living in the urban agglomeration that occupies a very tiny proportion, 0.3%, of the national territory. This has occurred through spatial as well as economics transformation and mutation. Along with the population growth, the land used has grown from 35 km^2 in 1950 to 179 square in late 1990 (with the three departments: Dakar, Pikine and Guediawaye), and now the metropolitan region including the department of Rufisque occupies an area of 551 km^2. This has been mostly done through urban inclusion as well as leapfrogging. Two main factors that characterise this spatial transformation are:

(1) human settlements with high density such as in the departments of Dakar, Pikine and Guediawaye and low density settlements in the department of Rufisque; and (2) conservation of the onset monocentrism of the department where all formal administrative and commercial activities are concentrated in Dakar, leaving the other departments as suburbs in the Dakar metropolitan region. Not only they are suburbs, but they lack most of the basic services. Finally their city foundation is weak to foster sustainable urban development.

Recognizing the unbalanced Dakar metropolitan regional development, in one hand, and the multiple problems associated to lack of basic services, on the other hand the Senegalese government has taken bold actions to transform the urban landscape of the metropolitan region from a monocentric to a polycentric metropolitan region with the creation of urban centres to decongest the Dakar urban agglomeration. This new spatial re-organization is also accompanied with economic transformation through the ambitious economic development, the Plan Senegal Emergent. This is through key main complementary programmes, reforms and plans: (1) the Plan Senegal Emergent; (2) Act III of Decentralization; (3) Metropolitan Planning; (4) Dakar Urban Master Plan 2035; and (5) Digital Senegal Strategy 2016–2025. These urban policies and programmes aim to spatially and economically transform the Dakar Metropolitan Region to be smart, sustainable, inclusive, resilient and prosperous. They aim to transform the monocentric system to a polycentric system where every urban centre equally contributes to the development of the metropolitan region. They implicitly lie on the principles of a Smart Metropolitan Regional Development which will be presented in the "conceptual framework, methodology and data" section.

The Dakar case study will consist of analysing the economic and spatial strategies undertaken by national and local authorities for a Smart Dakar Metropolitan Regional Development under the context of the historical transformation of the metropolitan region in time and space. After the introduction, this study is divided in six sections.

The first section "Conceptual framework of the Smart Metropolitan Regional Development" is based on its City Foundation (urban planning, basic infrastructures and land tenure) and Institutions as well as on the Economic Development, the Infrastructure Development, Environmental Sustainability, the Social Development, the Social Inclusion, Disaster Risk Exposure and Resilience, and Peace and Security. One element of the City Foundation, which is the spatial design, and the element of Economic Development will play the role of interface vis-à-vis the other elements of the conceptual framework. Economic and Spatial Design Strategies along cannot make a regional metropolitan region smart, the way they interplay with the other dimensions are crucial.

The second section presents "Urbanization of the Dakar Metropolitan Region in Time and Space" covering: The Formation of the Dakar Metropolitan Region from 1950 to 2015; Senegal's Urban System with Dakar being a Permanent Primate City; spatial planning and change in urban land use of the Dakar Metropolitan Region, elements of the city foundation.

The third section focuses on the Urban Accessibility and Mobility: Streets as drivers of urban accessibility; and Transport modes and infrastructures, traditional focus of urban mobility studies. Though streets constitute a fundamental element the City Foundation as determinant of the urban form and structure, we have given preference here to the prominent role they play in urban accessibility along with transport modes and infrastructures.

The fourth section presents "Urbanization, Economic Growth and Metropolitan Regional Development" including economic growth, human development and sustainability, inclusion, resilience and prosperity. Though cities are potentially engine of prosperity with their power of economies of scale and agglomeration as well as of technology innovation and diffusion of ideas, the Relationship between urbanization and development had been uneven in the Dakar Metropolitan Region. This section will assess the main reasons, including the urban form and structure, and the urban accessibility that have contributed to the relatively low economic performance of the Dakar metropolitan region compared many cities with similar population size in other developed regions.

The fifth section presents "Towards a Smart Metropolitan regional Development" including Human Development, Environmental Sustainability and City Prosperity.

The sixth section, based on the development of the previous sections, presents the "Spatial and Economic Design Strategies for a Smart Dakar Metropolitan Regional Development". It is sub-divided in their sub-sections considering the holistic approach taken by the government of Senegal as the holistic conceptual framework of the study: (a) Decentralization of the Dakar Metropolitan Region; (b) Plan Senegal Emergent (PSE): Holistic approach of economic development regional; (c) Spatial Design Strategies for a Smart Dakar metropolitan regional; (d) Creation of digitally, economic and socially served urban centres: from Monocentric to Polycentric Dakar Metropolitan Regional development; (e) Emerging Trends: Linking the Dakar metropolitan region to other regions—The Corridor Dakar-Thies-Mbour and beyond; (f) Connecting economically and spatially distinct urban centres in the Dakar metropolitan region; (g) ICT for Smart Economic and Spatial design Strategies; and (h) Means of Implementing the Economic and Spatial Design Strategies.

15.2 Conceptual Framework, Methodology and Data

15.2.1 Smart Metropolitan Regional Development: Concepts and Components

The New Urban Agenda adopted in October 2016 in Quito encourages governments, including the government of Senegal as a member of the United Nations, to commit themselves to adopting a smart-city approach that makes use of

opportunities from digitalization, clean energy and technologies, as well as innovative transport technologies, thus providing options for inhabitants to make more environmentally friendly choices and boost sustainable economic growth, and enabling cities to improve their service delivery (NUA, paragraph 66) [2].

In our study, a smart metropolitan regional development is viewed as a sustainable, inclusive and prosperous metropolitan regional development that promotes a people-centric approach based on three core components—Smart Metropolitan Region Foundation, Information and Communications Technology (ICT) and Smart Institutions and Laws. Here The Metropolitan Region Foundation goes beyond the city foundation and includes elements of mobility across urban centres that form the metropolitan region. First each urban centre must have a smart city foundation and smartly connected to the other urban centres. Smart Metropolitan regional foundation, institutions and laws, and ICT are the pillars of the seven other dimensions of a smart metropolitan region: Infrastructure Development, Environmental Sustainability, Social Development, Social Inclusion, Disasters Exposure, Resilience, and Peace and Security. **Infrastructure Development** complements the basic infrastructure services under each smart metropolitan foundation and extends to actual investment and advancement of services such as transport, ICT, industrial energy, education, health, etc. **Environment Sustainability** is comprised of elements of Climate Change, Biodiversity, Waste Management, energy, transport, building and pollution. **Social Inclusion** includes aspects of participation in decision-makings as well as equal opportunities for growth and prosperity. **Social Development** encompasses elements of education, health, public space, social inclusion and social capital. **Disaster Exposure** incorporates elements of mitigation and adaptation to various disasters such as flooding, droughts, storms and earthquakes. **City Resilience** is composed of elements of city foundation, environment, social capital, and social development. **Peace & security** includes the elimination of all forms of discrimination and violence and conflicts, including domestic violence, violence in public places, crime, armed conflicts, terrorism, etc. An insecure metropolitan region limits opportunities for investment and economic growth and cannot be a smart metropolitan region (Fig. 15.1).

The opportunities for ICT to support the overall urban challenges and opportunities are enormous, and the Dakar Metropolitan Region must integrate and use ICT solutions to facilitate the greater provisioning of urban services. Following the exigency of the city of the 21st century that calls for sustainability, inclusion, resilience and prosperity, the planning and management of human settlements must take into consideration the gain in knowledge on various conditions that make cities smart, green, ecological, liveable and healthy. Through increased efficiency and innovation, ICT increases economies of scale and agglomeration, and promote diffusion of knowledge, even at the smaller human settlements. Small settlements as small firms are benefiting from ICT in making available their goods and services beyond their territories. Virtual offices, virtual networks, teleconferences are increasing large public participation and inclusion. Digital firms can start and scale up quickly with relatively little staffing or capital investment. ICTs harness the benefits of agglomeration economies in easing circulation of goods and services and encouraging polycentric urban development and allowing synergies between

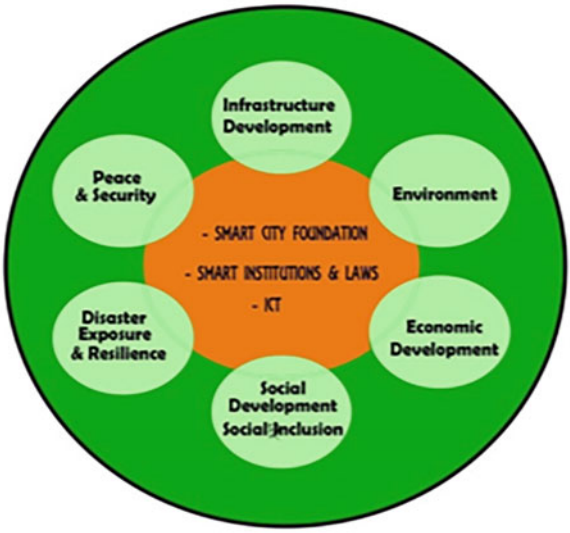

Fig. 15.1 Smart Dakar Metropolitan Regional Development Conceptual Framework. *Source* Adapted from Mboup, G. et al., 2016. Smart City Foundation—Drivers of Smart Cities. In Vinod et al., 2016. Smart Economy in Smart Cities, Springer

centres and sub-centres. They intensify urban nodes and corridors to maximize the benefits of concentration.

Numerous societal problems are explored and addressed in urban and regional planning agencies, including urban growth, unemployment and economic revitalization, transportation, environmental degradation and protection, neighbourhood decay and redevelopment, conservation of land and natural resources, provision of open space, parks and recreational facilities, etc. New urban planning instruments are becoming available with the worldwide spread of ICTs. They make it possible to adopt innovative e-planning approaches, strengthen communication between urban stakeholders, and make communication available at various stages of the planning process. Local governments can engage their citizens with real-time information to gain support for policy initiatives, identify unforeseen concerns, and recognize potential conflicts [3].

Cities are dynamic living organisms that are constantly evolving. ICT has begun to turn some places into real-time cities. This rapidly changing society makes the assessment and anticipation of future needs of city dwellers in terms of services, including transport, water, energy, employment, education and health, even more problematic. To address the complex problems of city planning it is not sufficient just to be concerned with the physical structure of the city; the interplay of intangible economic, social and environmental factors needs to be considered as well [4]. Planning procedures make use of models that show historic and present situations and communicate planned situations [5]. The introduction of ICTs allows planners and planning departments to carry out new actions or to implement conventional practices through new tools, such as GIS, virtual reality technologies, e-participation devices, including public participation GIS applications, among other tools, with the aim of improving conventional decision-making processes.

The provision of better planning and urban management services, more efficient, with lower costs and, at the same time, a more collaborative and participative, transparent and accountable planning decision-making process are some of the basic objectives usually associated with the move from conventional urban planning to e-planning [6, 7].

ICT also can increase economic productivity and competitiveness through increased smart mobility that reduces traffic congestion and commuting costs. Efficient and fast transport, in turn, can increase labour productivity by reducing commuting times, and increasing worker productivity. ICT reduces the use of motorized means and transport and promotes walking and cycling. This will improve the overall health of city residents, thereby reducing the health and economic costs of workers who are absent due to illness. Another important benefit is on consumer expenditure, as less is spent on cars and fuel. Non-motorized means of mobility support specific industries, such bicycle shops, tourism, retail activity, construction and real estate development that highlight liveability. It can also lead to a drop in the share of the household budget devoted to motorized means of transport, such as cars, which are expensive particularly in African countries.

The digital dividends are real and the Dakar metropolitan region must take the opportunity to efficiently integrate the use of ICT in all sectors of its development. From the beginning of the 21st century a digital citizenship, particularly the "Millennial" generation, has started to emerge in Dakar as in many African cities. The rapid adoption of digital technologies in the economy will have huge benefits directly as well as indirectly. However, ICT alone will produce little in the smart metropolitan regional development. 'Smart' is not an end in itself; It is the way ICT is integrated in the city development that will determine the city smartness. Maximizing the digital dividends requires better integration of ICTs with the other factors of smart cities such as: city foundation, infrastructure development, environment sustainability, social development, disaster prevention, resilience, peace and security. ICT can be seen as substitution and catalyst factors, but the other factors (or the analogue part) of the operation are crucial in making smart economy. Those factors include the city foundation, institutions and laws, infrastructure development, social development, social inclusion, environmental sustainability, disasters prevention and resilience (particularly in the context of climate change), peace and security. Most tasks have an aspect that cannot be automated by technologies and that requires human judgment, intuition, and discretion. This is where lies the crucial role of human capital associated with institutions and laws, efficient governance, management and administration. Without improvement on accountability at all levels, ICT alone cannot change the outcome of the economic productivity equation. African Countries that are able to swiftly adjust to this evolving digital economy will reap the greatest digital dividends, while the rest are likely to fall behind. This is the context where we are introducing economic and spatial design strategies for a smart metropolitan regional development to unlock the potential of Dakar metropolitan region to be smart, sustainable, inclusive, resilient and prosperous.

15.2.2 ICT Institutional Development in Senegal

Since 2001, Senegalese national authorities have elaborated the legislative and regulatory component of new technologies to create a legal environment favourable to their development [8]. The first step was the establishment by law No. 2001-15 of December 27, 2001, as amended, of the Code of Telecommunications and the Regulatory Agency for Telecommunications and Posts "Autorité de Régulation des Télécommunications et des Postes (ARTP)' responsible for providing the telecommunications sector with an effective and transparent regulatory framework, promoting fair competition to the benefit of users of telecommunications networks and services [9]. Another key step in the process of ICT development in Senegal was the creation of the State Information Technology Agency "Agence de l'informatique de l'Etat (ADIE)" which has the mandate to stimulate public action in the treatment and dissemination of information in accordance with international legal and technical standards for quality, availability, safety and performance (decree N° 2004-1038 of 23 July 2004) [10]. ADIE launched a process that led to the adoption of appropriate laws and regulations in 2005, followed by several laws on: orientation law on information society (law No. 2008-10 of January 25, 2008); electronic transactions (law No. 2008-08 of January 25, 2008); Cybercrime (law No. 2008-11 of January 25, 2008); the protection of personal data (law No. 2008-12 of January 25, 2008); Establishment of a voluntary contribution of one per cent (1%) on public procurement of goods and digital services (law No. 2008-49 of September 23, 2008); Establishment of a royalty on access or use of public telecommunications network—RUTEL (law No. 2008-46 of September 3, 2008) and; Cryptology with the creation of a National Commission of Cryptology, attached to the General Secretariat of the Presidency of the Republic, and whose permanent secretariat is provided by the Central Technical Services of Numbers and Security of Information Systems—STCC (law No. 2008-41 of August 20, 2008). The Privacy Protection Commission (CDP) is an Independent Administrative Authority (IAA) established under Law No. 2008-12 of 25 January 2008 on the protection of personal data. The year 2011 marked the adoption of a telecommunication code implementing most of the directives adopted by the Economic and Monetary Union of West Africa (UEMOA) and additional acts that the Treaty of the Economic Community of African States (ECOWAS) to create a legal environment conducive to the emergence of a regional market [8].

Under the "Plan Senegal Emergent", the Senegalese Government has particularly initiated the large digital programme called Senegal Digital Strategic Plan 2025. The slogan of the Plan is "ICT for all and for all uses by 2025 in Senegal with a dynamic and innovative private sector in an efficient ecosystem". The government is also putting in place an ambitious project of a technology park in one of the urban centres, Diamniadio, called "Diamniadio Technology Park". The park is based on the Silicon Valley model and intends to promote data revolution and higher education centres.

Dakar Digital City "Dakar Ville Numerique: Along the government programmes and policies on ICT, the city authorities of Dakar have also introduced initiatives aiming to make Dakar a digital city. The city of Dakar has launched the project "SSID: City Wi-Fi Dakar" [11]. A pilot project to install Wi-Fi in large public places was initiated by the city of Dakar in partnership with the mobile operator Tigo, a subsidiary of Millicom International Cellular Group, to make so free Internet connection to the public. The Initiative will be also extended to the public transport buses with the network 3G+. This will contribute to the expansion of Internet in a country with the where the cost of connection to Internet is still high and the speed of the network slow. City authorities will need to develop and accurate transit maps and data and train transit agencies in the use of such maps and data. Methodologies and open-source software applications are available allowing the production of transit maps at low-cost and in a short period. This will allow city authorities of Dakar to make ambitious planning and investment decisions based on accurate, comprehensive transit data [12]. Development and use of transit maps and data are becoming common in cities of developing countries as in Manila (Philippines). Mobile Surveys Applications with the introduction of the smart phone allow to automatically collect route data in an open-data platform with and open-source software system, transit staff members simply to ride the routes and allow the GPS capability of the phone to generate route coordinates that were simultaneously transmitted to the database [13].

Along the government programmes and policies on ICT, there are several other initiatives by private sectors, NGOs, Civil society, Academic that invest on the expansion of ICT. An ICT Incubator, launched in 2011 assists ICT companies, Information Technology and Communication, as well as project leaders, in their stages of creation, development and growth. It offers businesses and to project the ICT infrastructure and services necessary to ensure sustained growth and sustainable. CTIC Dakar is an example of Public Private Partnership led by the ICT Incubators Foundation of Senegal (FICTIS). Partners and sponsors include both public and private international organizations. Across the city of Dakar, CTIC are incubating companies, running an accelerator programme and a pre-incubation programme with start-ups as well as on a broad range of sectors, primarily but not exclusively commercial. HubSocial works to develop social solutions for Senegal and West Africa, particularly on the just concluded MDGs, particularly on poverty reduction, health and education. A little different is Jjiguene Tech, a female-led organisation with a mission to encourage women and girls in ICT and to keep female ICT graduates and others actively involved in the ICT business [14]. Technology hub Bantalabs have established offices in Dakar to provide open source web development, consulting and training. Facebook also invests in Senegal to launch Internet.org (a project aimed at bringing Internet access to two thirds of the world that are not connected) as well as more than a dozen free basic services within the country. According to Facebook, the services will be available to Tigo SIM cardholders. Senegal is now the sixth country in Africa, and third country worldwide, where Internet.org is available. The free basic services that will be available through Internet.org to consumers with a Tigo SIM card will include:

AccuWeather, BabyCenter & MAMA, BBC News, BING, UNICEF, Ebola Info, Facebook, UNICED Facts for Life, Girl Effect by Nike Foundation, Malaria No More, Messenger, Wattpad, Wikipedia, Wiwisport, Dakaractu.com, Senjob. The E-Riders Senegal project aims to mentor a group of young Senegalese to make it free software developers and providers of ICT services by the organizations of the civil society [15]. Jokkolabs works to support ICT communities by targeting multiple creative sectors, not just techies and open source geeks. Finally Coders4Africa is a not-for-profit with a mission to create hubs and labs across Africa where technologists and others can receive advanced training and develop ICT tools that address community needs [16]. All these projects, though not well coordinated to increase synergy, witness the era of ICT revolution in Senegal, and particularly in Dakar.

The establishment of a legal and institutional framework for the administration, implementation and use of ICT infrastructure coupled with several private and public ICT initiatives show clearly that Senegal, particularly Dakar, is moving towards a digital era. If well coordinated and articulated all these initiatives should yield to a smart metropolitan regional development. Indeed, the establishments of various laws and institutions governing the use and the development of ICT has been followed by en effective integration of the ICT in several publics as well as private sectors with the adoption of: E-Governance, E-commerce, E-Education, E-infrastructure, etc.

15.2.3 State of ICTs in Dakar

ICT infrastructures have various components ranging from hardware categories such as mobile phone, computers and tablets to soft categories such as Internet connection, cloud storage and multiple applications. In this chapter, we present the basic components of ICT hardware, which are mobile phones and computers, as well as Internet connectivity that allows global and local inter-linkage. Whereas the other aspects are equally important, data on them is seldom available and comparable in the context of Dakar and will thus not be discussed here.

Data on mobile phone, computer and Internet had been collected in series of DHS conducted in Senegal over the past 20 years. The advantage of using the DHS surveys is that they allow for association of ICT components with economic as well as social variables such as education and literacy using the same source of information. The DHS data shows that, almost every household in Dakar has access to a mobile phone, easing potential access to Internet and multiple apps. With a level of 58% in 2005, the coverage of mobile phone is quasi universal in Dakar with a level of 99% in 2015. This spectacular boom of mobile phone makes some authors to feature Senegal as the next Silicon Valley. Recently it was demonstrated that revenues of the telecommunication companies are much higher that total costs of consumption of water and other basic goods, pointing that households in Dakar take communication via mobile top in their agenda compared to other household

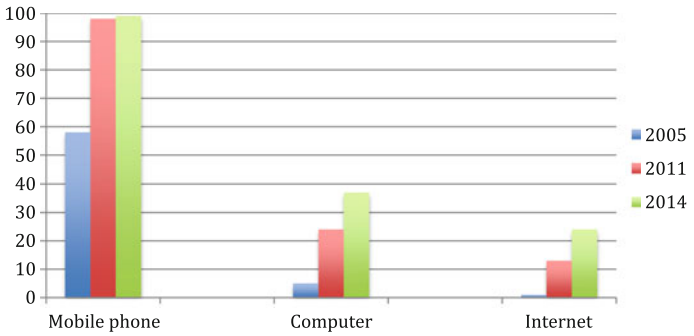

Fig. 15.2 Percentage of households with at least a mobile, a computer a connection to internet, Dakar 2005–2014

needs. Considering the fact that the mean household size in Dakar is 6, and considering the fact that each person has at least a mobile phone, we can forecast that there are at least 18 million mobile phones in the city of Dakar. This makes mobile phone business and mobile telecommunication very attractive in the city. In addition to making phone calls, the mobile phone are used to access various Internet based commercial opportunities (e.g. jobs, business opportunities through online trading etc.) as well as social communication platforms (e.g. Facebook, Viber, WhatsApp, etc.) (Fig. 15.2).

Along the boom of mobile phones, there is increase in other ICT infrastructure such as computer and accessibility to Internet, but in a lesser extent. With only 5% of level of possession in 2005, in 2015 more than one-third of people live in a household with at least a computer (37%). With similar trends, the coverage of computer is estimated at 57%, 75% and 92% in 2020, 2025 and 2030 respectively. The possession of a computer is not yet generalized in Dakar and feature in richest families and in household where some members are with high education. The association between computer possession and level of education shows that people with high education are more likely to live in a household with computer. In these households, computers may be needed for school as well as for work activities.

Access to Internet at the household level has also increased from less than 1% in 2005 to 13% in 2011 and 24% in 2014. The coverage of an Internet connection has drastically increased since 2005 where the percentage of people living in a household with an Internet connection was less than 5%. Six years later, the same percentage was multiplied by six with 24% of people living in a household with Internet in 2011. The trend is irreversible with an absolute increase of 13 points in 3 years; in 2014, more than third (37%) of people lived in a household with an Internet connection. With similar trends, this percentage of household with Internet connection will reach 62% in 2030 and 75% in 2035. However, with the desire to make Dakar a digital city, this trend can be boosted and the availability of an internet connection at the household level can be generalized way before the year 2030, and this will be in line with the increase in education and literacy observed in

Dakar during these past 20 years. Today 85% of young women and 95% of young men 15–19 years have at least a primary education level. Investing in infrastructure goes hand and hand with investing in education. Today there are 63% of young women 15-19 years and 71% of young men 15–19 years old who have an education level but live in a household where the Internet connection is not available. This represents a real missed opportunity from education. The situation is more dramatic if we consider that only 38% of young women 15–19 years old and 47% of men 15-years with secondary education or higher live in a household without accessibility to Internet. This represents a double miss of opportunity for ICT use as well as for ICT development. It is much easier to make the internet accessible to train educated people to use it and develop apps than otherwise [17]. There is also a missed opportunity with households that have computer but do not have access to Internet (13% of households). Finally the only option of these households is to use Internet via mobile phone as other households without a computer. With the boom of social media platform such as Facebook, WhatsApp and Viber, the use an Internet via mobile is almost universal in Dakar.

15.2.4 Urban Legislation, Rules and Regulation

Senegal's urban policy is institutionalized by the creation of a ministry in charge of urban issues in relation with other ministerial departments. In various forms, this ministry has always been part of the government structure since independence. Today, the Minister of Urban Renewal, Housing and Living Environment (MRUHCV), prepares and implements the policy defined by the Head of State in the areas of urban planning, restructuring and urban renewal, housing and construction [18]. The MRUHCV defines the framework for urban planning and ensures the development of cities and agglomerations, in cooperation with other ministries such as territorial planning and local communities, to the protection and enhancement of urban architectural heritage. Since independence, an arsenal of legislative and regulatory texts were prepared and adopted, including the adoption of the Urban Planning Code "Code d'Urbanisme") adopted in 2009. The Urban Planning Code defines the framework for the development of urban and peri-urban areas. It sets the rules for urban planning instruments and operations as well as other planning acts such as building permits and demolition. The provisions of this document must, however, be supplemented by other texts, in particular the law on the transfer of powers and the law on expropriation for reasons of public utility. The regulatory and legal framework of the urban sector is governed by a system related to land tenure, decentralization, planning code, etc. In the aftermath of independence, there was a diversity of tenure systems in Senegal, including the cohabitation of traditional land tenure and inherited colonization land tenure. At the time of the country's independence, the various measures taken to remedy this situation have resulted in a pluralist land system.

Along the urbanization process, national authorities have put in places planning guidelines through the Urban Master Plan of Dakar (Plan Directeur d'Urbanisme—PDU) 2035 and National Plan for Territorial Development "PNAT". The PDU 2035 aims promoting the at urban development of the region of Dakar and its surroundings by 2035. Its main objectives are: Sustainable Urban Development; Compact cities connected with a transport network; Robust and Resilient city and; Vibrant city with active interaction between information, goods and people. The PNAT proposes five development urban areas: Multifunctional urban areas; Areas for economic activities; Areas for agriculture activities; Areas for touristic activities; and Areas for conservation. The PNAT also identifies areas with high risk for habitation and any other activity. In these areas, modification of the land including by residential structure, or any cadastral operations is prohibited. This plan promotes green areas and other protected areas for environmental purposes or spaces with light recreational facilities, which, when well integrated enhance the character or the ecological value of the area. Specific focus areas of the PNAT also aim at: controlling the internal urban growth; reducing the proliferation of slums; promoting a balanced urban development; and meeting the housing demand.

The MRUHCV also develops tools, instruments and guidelines on how to design, plan and manage cities. From 1946 to 2015, there have been several urban Master Plans developed in 1946, 1961, 1967, 2000 and 2014 (revision of the PDU 2025) [19]. The PDU is a reference document that aims to plan and program the development of an agglomeration in short and medium terms (10 to 20 years), taking into account the global objectives of the regional development. It specifies the socio-economic and demographic perspectives of the region and the agglomeration and determines the means and strategies to be implemented in order to reach a harmonious and sustainable development. There are other sectorial plans, which have been also hardly implemented. The Master Plan for Urban Planning and Preservation of the Niayes and the Green Zones of Dakar (PDAS) has not played its role yet, in terms of overall urban planning. The PDAS is a specific plan for the Niayes (depressions zones) and Green Zones at the level of the Dakar Metropolitan Area, and has been validated since 2004. The Regional Land-Use Planning framework (SRAT) provides comprehensive guidelines, which are not compulsorily taken into account in the field. In fact, the SRAT is validated but the implementation does not really respect the prescriptions included in it. Finally, the actions planned in the Regional Integrated Development Plan (PRDI) finalized since 2004 are not implemented yet.

Since independence, the government of Senegal has also opted for a progressive and irreversible decentralization policy. The Act III of Decentralization adopted in December 2013 was the result of this long process. Under this Act each department of the Dakar Metropolitan Region, has been sub-divided into municipalities. Overall, the metropolitan region counts 49 municipalities. Each municipality is

headed by a mayor, who is responsible to, among other things, preserve, maintain and administer the properties and assets of the municipality, ensure municipal waste management and hygiene, protection and conservation of historic sites and monuments, promotion of national and local cultures, preparation and implementation of various kind of plans (including master plans and detailed urban plans), and management of health and education programmes. The Act further gives guidelines on municipal finance, which is key in the implementation of urban programmes. This is a clear demarcation of the original urban development management where administrative and financial management of municipalities was performed at the central level; it opens the road to polycentric specialized urban centres.

Senegal has also made a special commitment at the international level to promote sustainable and resilient urbanization as promulgated in the Sustainable Development Goals (SDGs) adopted in September 2015, the New Urban Agenda adopted in October 2016, the COP 21 (Paris Declaration), the Sendai Framework on Disaster Risk Reduction, the Addis Ababa Declaration on Population and Development and the Africa Agenda 2063.

Despite the existence of comprehensive urban legislation, rules and regulations, the urbanization of Dakar has been marked par proliferation of informal settlements. Indeed, a cumbersome regulatory approval process constrains the implementation of several urban policies and plans. The intermediate causes to this cumbersome approval process include: Lack of clarity of roles and responsibilities of various administrative structures; weak coordination between the Urban line Ministry and municipalities in charge of localization urban policies. In addition to that municipalities do not have the required skills and competencies to properly plan, design and manage their cities. Awareness and capacity building of local authorities and communities are key for the success of urban policies. Local authorities do not also have sufficient resources to implement urban policies. Urban issues are not well positioned in the competition of several other interests when it comes to economic development.

15.2.5 Methodology and Data

The Smart Metropolitan Regional Development is composed of several dimensions. Put them together to assess the degree of smartness will require the development of composite indices using sophisticated multi-level statistical analysis including Principal Component Analysis. The complexity of composite index is the fact that it is strongly influenced by several factors including: the normalization, the standardization, the degree of association between variables and the number of variables that compose the index. The analysis of the Dakar Smart Metropolitan Regional Development (SMRD) will consist first of the analysis of each of its components with the production of individual indicators such as the proportion of household with access to improved water, followed by a development of a composite index, the SMRD index (SMRDI) with sub indices such as the Smart City

Foundation Index (SCFI) built upon the spatial planning, the land tenure and the basic infrastructure indicators. However, an index can also be conceptualised differently using different variables. This calls for caution when interpreting a composite index. For instance the Quality of Life is conceptualised and measured in different ways across studies. The Human Development Index includes indicators of health and education, alongside an economic component (Gross Domestic Product or GDP); the Legatum Prosperity Index considers quality of life to be multidimensional, including both wealth and wellbeing; The Economist Intelligence Unit's Quality of Life Index links life satisfaction to health, family life and community life; and the OECD's Well-being Initiative has two dimensions: 'material living conditions' and 'quality of Life' [20]. The following section will provide the different components of the SMRDI and the variables used for their development.

Putting the dimensions together to develop the Smart Metropolitan Regional Development Index (SMRDI)

The SMRDI, which is built here, is meant to serve research as well as policies. For the latter, the SMRDI will be built using existing mechanisms of the production of indicators globally as well as nationally. Building the SMRDI through existing mechanism of development of indicators such as the monitoring of the Africa Agenda 2063, the Sustainable Development Goals (SDGs), the New Urban Agenda, the Sendai Framework, the COP21, the Addis Ababa Declaration on Population and Development as well as the monitoring of national programmes and plans such as of the Plan Senegal Emergent (PSE) will ease its implementation at the local level for SMRD policies. As part of the international communities, Senegal has also endorsed all the above global agendas. Box 15.1 provides for each dimension of the SMDR variables, quantitative or qualitative, included for its measurement.

Box 15.1 Smart Metropolitan Regional Development Index (SMRDI)

Dimensions	Definitions/variables
City Foundation	*Spatial planning* Planned settlements, Streets, Other Open Public Spaces *Land tenure* Land: Documentation or perceived eviction Housing: Proportion of urban population living in slums, informal settlements or inadequate housing *Basic infrastructures* Connection to piped water, Connection to sewerage system, Connection to electricity, management of solid waste

(continued)

(continued)

Dimensions	Definitions/variables
Institutions & Laws	Urban Planning Codes, Urban Policies, Urban Plans, Unplanned settlements, Resilient building codes, standards, development permits, land use by-laws and ordinances, and planning regulations;
ICT	Connection to internet, Mobile phone, Computer, Broadband
Infrastructure development	Transport and road infrastructure, Energy, Knowledge infrastructure, Health infrastructure
Environmental sustainability	Air quality (PM10), CO_2 emissions, energy and indoor pollution
Economic development	City product, Employment Primary, Secondary and Tertiary sectors
Social development	Education: literacy, primary, secondary and tertiary enrolment Health: life expectancy, under-five mortality rates, HIV/AIDS, morbidity and nutrition: Social capital, Public space
Social inclusion	Income/consumption Inequalities: Gini coefficient, Health, Education, Access to basic services
Disaster risk reduction/resilience Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population Adoption and Implementation of national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030 Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies
Peace & Security	Proportion of population that feel safe walking alone around the area they live; Proportion of women and girls aged 15 years and older subjected to sexual violence by persons other than an intimate partner in the previous 12 months, by age and place of occurrence; Proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the

(continued)

(continued)

Dimensions	Definitions/variables
	previous 12 months, by form of violence and by age; Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities; Proportion of population that feel safe walking alone around the area they live

Source Mboup et al. 2018 Forthcoming Relevance of the Concept of Smart City in the African Context. Springer. All the variables of this table are not included in the Dakar SMRDI due to lack of data

Data sources and quality assurance

Data are generally obtained from various sources depending on the level of analysis. For the SMRDI, as an impact product, population-based data is most indicated since they provide information on people's quality of life. Since 1976, Senegal has already conducted six censuses and several household surveys such as Demographic and Health Surveys, the Multiple Indicators Cluster Surveys, the Living Standard Measurement Survey and several other household surveys. They will constitute the principal data sources of the SMRDI. In addition to these population-based data, the analysis of spatial form such as density, compactness, streets call for the use of the Geographical Information System (GIS) for the analysis of remote sensing data with the integration of population-based data. The analysis of the component of the SMRDI such as Institutions and Laws call for a Policy Analysis of urban legislations, rules and regulations in Senegal, it is more a content analysis of administrative records rather than a spatial or a population-based analysis. Finally, the development of the SMRDI will be based on quantitative as well as qualitative data: population-based, spatial and content analysis, etc.

Challenges and emerging successes in the definition of urban components for the development of the SMRDI

The development of the SMRDI will face challenges such as data comparability, the delimitation of urban boundaries, etc. Critical issues and huge challenges the development of the SMRDI will face is the choice of data sources in the situation where it is noted significant discrepancies between national sources. Lack of data comparability and non-compliance with international standard make the development of SMRDI challenging. A lack of uniform definitions across data sources poses an even greater challenge for aggregating data and comparing levels of SMRDI [21]. Urban human settlements have various definitions: urban agglomeration, metropolitan region, city proper, municipalities, etc. These definitions also vary across countries [22]. The **urban agglomeration** is defined as the built-up or densely populated area containing the city proper; suburbs, and continuously settled

commuter areas. This may be smaller or larger than the metropolitan area. Other similar UN definition: Comprises a city or town proper and the suburban fringe or thickly settled territory lying outside, but adjacent to, its boundaries. A single large urban agglomeration may comprise several cities or towns and their suburban fringes. (United Nations. 1998. Principles and Recommendations for Population and Housing Censuses). This has been regularly published by UNDESA and it forms the official reference of urban population as in the Urbanization Prospects publication. The **metropolitan area** is the set of formal local government areas, which are normally taken to comprise the urban area as a whole and its primary commuter areas. The **city proper** is the single political jurisdiction, which contains the historical city centre [23].

All these three definitions of urban component have often interchangeably been used for the measurement of urban population, urban densities but referring the same name. For instance, the Dakar Metropolitan Region, administratively called region of Dakar, is sub-divided into four departments: Dakar, Pikine, Guediawaye and Rufisque. The first three departments and the urban areas of the department of Rufisque form the urban agglomeration of Dakar. The Department of Dakar forms the city of Dakar. Though they have distinct geographical boundaries, all three (the metropolitan, the agglomeration and the department of Dakar) have the same name, Dakar, making always confusion on the production and analysis of urban development statistics in the metropolitan region. For instance, in 2015 the population of the department of Dakar was 1.2 million, the population of the urban agglomeration of Dakar (excluding Rufisque) was 2.8 million, and the population of the Dakar Metropolitan Region was 3.3 million including all departments. To overcome such confusion, we will use the full name for each geographical entity.

Another important measurement, one can be interested is how the spatial growth occurs along the population growth, a crucial information for spatial planning. There is **emerging success in disaggregation of urban growth** made by UN-Habitat and partners using remote sensing and GIS to analyse changes in urban extent in different components such as infill, extension, inclusion and leapfrog. City growth within the same urban extent is considered as **city infill** that "consists of all built-up pixels added in the new period that occupy urbanized open space within the urban extent of the earlier period". City can also grow beyond its previous urban extent in a contiguous manner. This type of city growth is known as city **extension** that consists of all built-up pixels added in the new period that constitute **contiguous** urban clusters that are **attached** to the urban extent of the earlier period. The growth of city can also occur through **inclusion** that consists of all urban, rural, or suburban built-up pixels that were **outside** the urban extent in the earlier period and are now within the urban extent of the new period. There is also another trajectory of growth where city expand to **over rural open space** that were **not attached** to the urban extent of the earlier period or to new extension clusters. This is known as leapfrog [24]. All these categories of spatial growth have occurred along the urbanization of the Dakar Metropolitan Regional over a century and will be analysed here.

15.3 Dakar Metropolitan Region in Time and Space

15.3.1 History of the Formation of the Dakar Metropolitan Region

Cities form and grow in many different parts of the world for various different reasons such as rural-to-urban migration, natural population growth, economic opportunities, politics, environmental changes, social conflicts, etc. In a given country, the way these factors play are determinant for the size and the national distribution of cities that, in turn, form the urban system. The History of the Dakar Metropolitan Region is marked by several migrations dating back to the 14th century. The most prominent recorded settlements were however in the 15th and 16th centuries when the Lebou group settled in the area called "Yoff" located to the north of the city and in other areas such as Ouakam, Ngor and Camberene [25]. The second major settlement was recorded later in the 19th century when the French started to settle to the extreme south of the city, which later became the centre of the city—hosting most administrative and state buildings (*including the State house, the Parliament and the Court house*) [26]. The third major settlement was marked by huge migrations of population from rural as well as small towns to Dakar, but neither in the city centre nor in the indigenous settlements, but to the outskirts of the city forming the Pikine settlements, which are mostly unplanned and lack most basic services. These three settlement eras had varying influences on the form of Dakar metropolitan region, which has resulted into three unique spatial organization patterns—an organic pattern evident in the Yoff area, a grid system evident in the French occupied southern parts, and an irregular pattern in Pikine (Fig. 15.3).

Beside the difference in street design, the Lebou spatial design is fundamentally different from the French spatial design. The former favoured a polycentric system of governance, and promoted equality among community members, and the creation of autonomous villages, which was the opposite of the monocentric system introduced by the French. The Lebou system of governance is socially, economically and politically decentralized. Each settlement was under the leadership of the "Djaraf", assisted by the "Ndeye ji Rew" for interior and foreign affairs, and the "Saltigue" who was in charge of land, water, etc. With the influence of Islam, the function of Serigne Ndakarou was introduced in late 18th century to provide justice based on the Quran. Until today, the Lebou community conserves its socio-political structure where the Serigne Ndakarou and other local authorities still play a key role [27]. At the opposite of the indigenous' decentralized governance system, the settlement of the French brought forth a new form of monocentric system with the centre, "the Plateau", hosting large administrative buildings as well as the French residences, while the indigenous communities were moved to a newly formed settlement close to the centre, the Medina settlement [28]. The Medina settlement lacked most basic services such as piped water, sewerage systems, education facilities and health centres as well as administrative and commercial businesses. Being the only places where migrants were allowed to settle, it soon

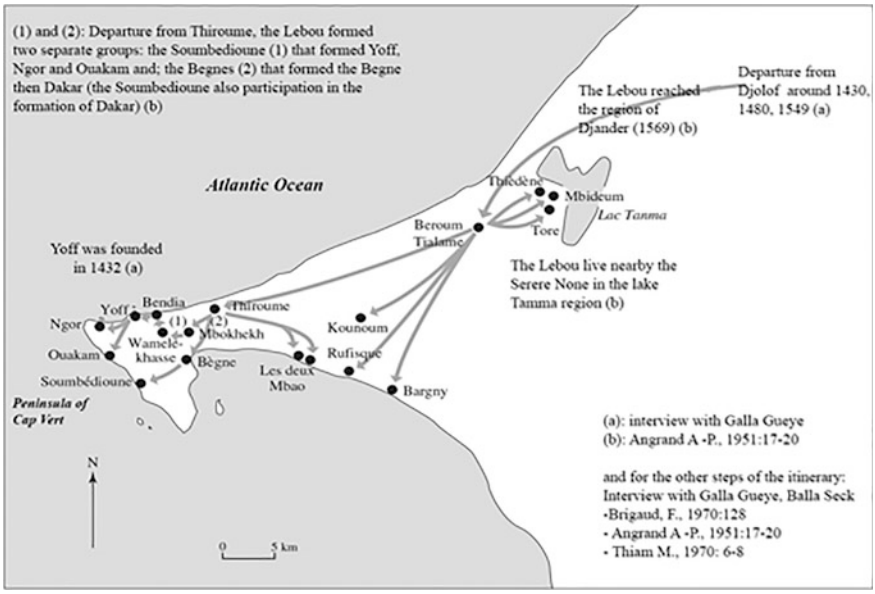

Fig. 15.3 Settlements of the Lebou group in 15th and 16th centuries in the Peninsula of Cap Vert (Dakar)

became densely populated, and since it lacked basic services, and disease outbreaks became the norm. In response, most migrants as well as indigenous communities were further relocated to the outskirts of the city, in a new settlement called Pikine. Just like Medina, the Pikine settlement was neither properly planned nor were there adequate basic service provisions. This marked the second phase of proliferation of slums that excluded the migrants as well as the indigenous communities from the comparative urban advantage a city can offer. Today, settlements of Pikine as well as Medina remain haunted by this early spatial and social segregation [29].

The Fig. 15.4 provides the historical spatial occupation of the Dakar Metropolitan Region in the 19th–21th centuries. The Dark colour illustrates settlements before 1923, with several areas of Yoff and Rufisque occupied by the Indigenous, as well as the centre of Dakar and the island of Goree mainly occupied by the French Colons. The Pink colour illustrates the development of Dakar between 1923 and 1953, particularly in the centre towards settlements of Medina and surrounding, and some dispersed settlements in the Yoff. The Statistics show that Dakar reached 214,000 of population size in 1950. Between 1954 and 1967, illustrated by the red colour, the city continued to develop with the appearance of new settlements, but concentrated near the city centre. This period also marks the development of new settlements in Pikine. In 1970, the Population of Dakar is estimated at 610,000 inhabitants. Between 1968 and 1976, the population growth was mainly in Pikine as illustrated by the dark orange colour. Between 1977 and 1980, there is further development of Medina, illustrated with the light orange

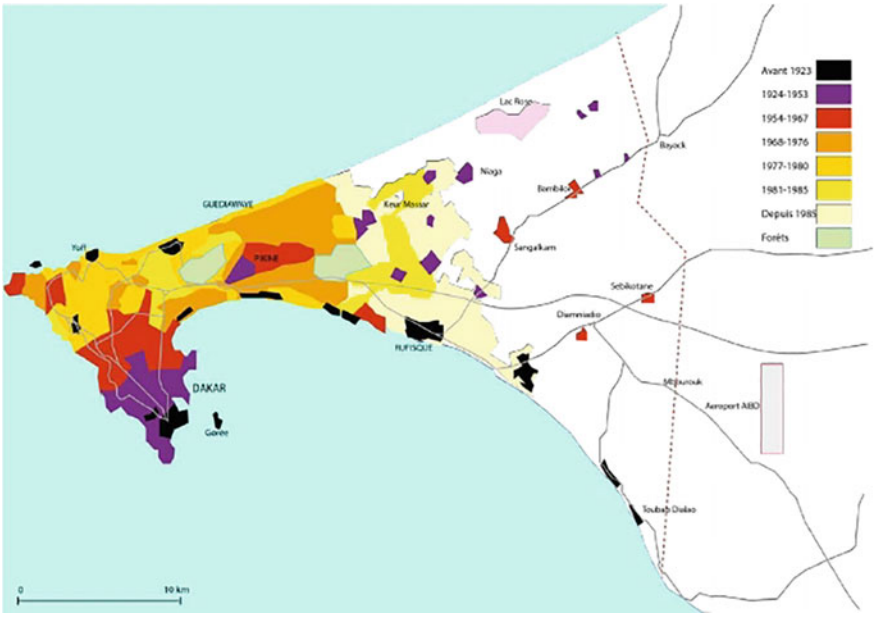

Fig. 15.4 Historical spatial development of the Dakar Metropolitan region (before 1923–since 1985). *Source* Republic of Senegal, 2014. Review of the Senegalese Urbanization

colour, with the appearance of Settlement in Gueule Tapee, Grand Dakar, Colobane, etc. In 1980, the population Dakar is estimated at 957,000 Inhabitants. Between 1981 and 1985, settlements in Pikine extended further to reach Keur Massar, illustrated by the dark yellow colour. In 1985, Dakar population reached the one million mark. Since 1985, most of the population growth of Dakar occurred in the department of Pikine towards the department of Rufisque as illustrated by the light yellow colour.

15.3.2 The Urban Numbers of Dakar Metropolitan Region, 1950–2015

As illustrated in Fig. 15.5, the dynamic transformation of the Dakar Metropolitan Region has occurred in different paces, times and places in terms of urban form and structure: density distribution, and compactness. From a population of about 214,000 in 1950, the Dakar Metropolitan Region has a population of 3.5 million in 2016. In 65 years, the population of Dakar has been multiplied by more than 16 times particularly during post-independence. During the colonial period, Dakar attracted massive migrations from rural areas, people coming to seek jobs in the newly built city centre. This flux had amplified after Senegal became independent

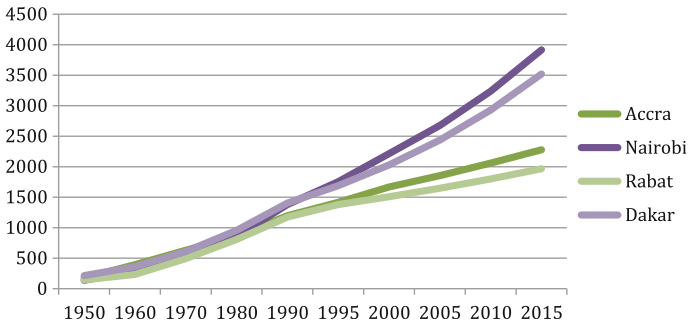

Fig. 15.5 Urban population growth of Dakar urban agglomeration and other African cities of similar sizes in 1950. *Source* Data from United Nations (2015) World Urbanization Prospects: The 2014 Revision, UNDESA, Population Division, New York, NY, http://esa.un.org/unpd/wup/index.htm

in 1960 with Dakar becoming the capital giving it an additional political function. In 1985, Dakar urban population reached the one million mark for the first time making it a large city that required more sophisticated infrastructures in terms of spatial planning, transport planning, etc. In 2000, another million was added to the Dakar urban population. In 2010, the Dakar population was nearly 3 million (2.9 million), and in 2015 it was estimated at 3.5 million. What do these figures tell us? It took 35 years for Dakar to reach the population of one million inhabitants in 1985 from a population of 214,000 inhabitants in 1950. But it took only 15 years from 1985 for another million inhabitants to be added to the Dakar population in 2000, and only 10 years for another million inhabitants to be added to the Dakar population in 2010. With this exponential population growth rate, the Dakar urban population will reach 5.6 million in 2030, and 7 million in 2040 (Fig. 15.6).

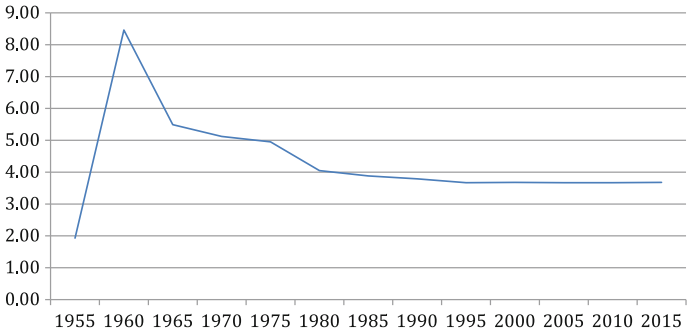

Fig. 15.6 Growth rates of the urban population of Dakar (1950–2015). *Source* Data from United Nations (2015) World Urbanization Prospects: The 2014 Revision, UNDESA, Population Division, New York, NY, http://esa.un.org/unpd/wup/index.htm

15.3.3 Urban Densities as Factor of Economies of Scale and Agglomeration

The population size is an important component of urbanization, but to address various questions in urban economics, environment and infrastructure development, information on density of the population is valuable [30]. Positive production or residential externalities, as well as negative externalities such as congestion, are function of density among others [31]. Various policy responses as well as programmes and projects such as on transport and infrastructure are subject to how population is distributed across a city. Important factors of land use such as land prices should be also considered in this exercise as part of elements that can feed the land legislation and investment in infrastructure [32]. From an economic point of view, the higher the density of an urban agglomeration is, the lower are the costs of transactions, and the more prosperous is the economy. A deficient spatial structure fragments labour and consumer markets into smaller less efficient markets; it contributes also to higher transactions costs by unnecessarily increasing distances between people and places. It increases the length of the city infrastructure network and therefore increases its capital and operating costs. Lower densities and segregated land uses increase economic costs in terms of average commuting distances, public utility provision, and energy consumption. From an environmental point of view, a deficient spatial structure can decrease the quality of life by increasing the time spent on transport, by increasing air pollution, and contributing to the unnecessary expansion of urbanized areas in natural sites. Poor environmental quality can also lower a city's productivity.

The Dakar metropolitan region displays high densities, particularly in the departments of Dakar, Pikine and Guediawaye where they are more than 15,000 inhabitants per km^2. These densities are largely sufficient to produce economies scale and agglomeration, support efficient urban transport and reduce the use of land. For the latter, with more than 50% of the national urban population, the Dakar metropolitan region occupies only 0.3% of the national land area. The first three departments, while hosting over 80% of the metropolitan region population occupies only one third of its land area (179 km^2 over 551 km^2, the total land area of the metropolitan region). However, except the economy in land use, since they are not well planned and managed, high densities have become liabilities to the city of Dakar. High densities not accompanied with provision of streets and other public spaces, and basic infrastructure often lead to high exposure to diseases and to epidemics such as cholera (Fig. 15.7).

When the densities are disaggregated across municipalities, there are huge disparities in the Dakar metropolitan area. However, these disparities do not follow the classical monocentric model of urban densities distribution, introduced by Colin Clark in 1951, that predicts a decline a density from the CDB to the suburbs. Two hypotheses are the basis of this model: (i) in all cities, excluding a business and commercial area, there are densely populated areas, which decrease when moving away from the centre, and (ii) in most of the cities, as time passes the density

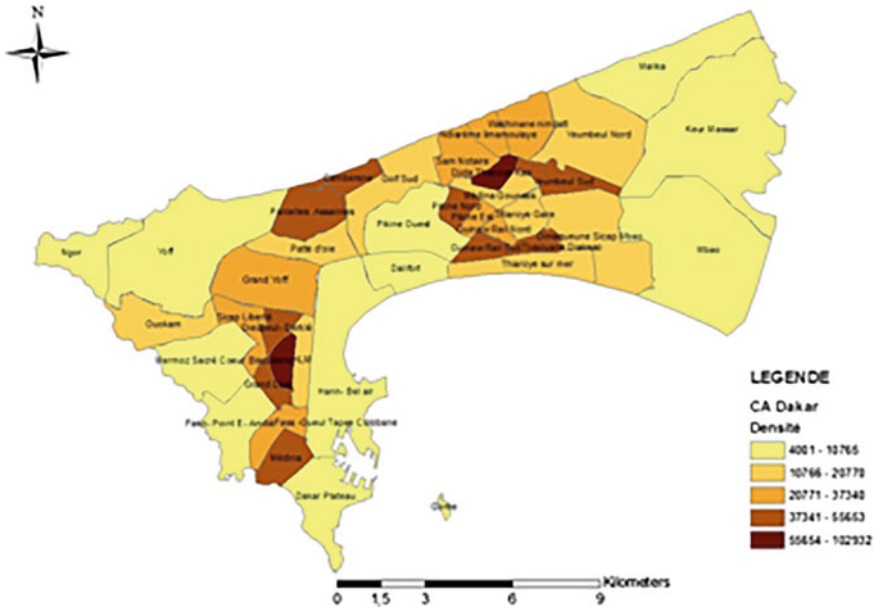

Fig. 15.7 Dakar population density map, 2015. *Source* Population density computed and geo-referenced using ARCGIS software by the authors applied to the ANSD 2015 Projection. Population, Housing, Agriculture and Livestock Census, 2013

decreases in the central areas and increases in the suburbs, thus producing a territorial expansion of the city [33]. The model proposed by Clark (1951) expresses the urban population density as negative function of the distance from the city centre as follow:

$$D = Doe^{-\gamma x},$$

D represents the population density at distance x from the centre of a city; Do is the density at the centre; e is the base of natural logarithms; γ is the distance gradient, or the rate at which density falls from the centre. The monocentric model supposes a city with constant returns Cobb-Douglas production functions for housing, consumers with identical tastes and incomes, and unit price elasticity of demand for housing [34]. Following Clark, several models have been developed that relax this strict monocentricity, including some that have two centres, some that have a centre and a beltline of employment, others that have multiple nodes or a beltline. Others related urban density to traffic planning [35], to housing market [36]. Some amenities can be of high quality of infrastructures—schools, health centres, etc.; alternatively they can be of poor quality clustering crime or pollution along with the lack of most basic services. In general, the classical theory predicts that variations in urban land cover, average density, and fragmentation among cities and countries, as well as their rates of change, can be largely explained by variations in city

population, household income, buildable land, the cost of agricultural land in the urban periphery, and the cost of urban transport [37].

To verify the model monocentric density distribution in Senegal, since the city of Dakar is not in a circular form due to its peninsular form, we have opted to subdivide Dakar in three main axes: Plateau-Almadies, Plateau-Grand Dakar and Plateau Camberene. In Dakar, considering the high level of business and commercial areas in the CBD, we have opted to start the series from Medina, which is just juxtaposed to the CBD. As noted in the historical formation of Dakar, Medina was formed by early development of Dakar with its high population density. It is a walking-distance to the CBD. Based on this, all densities in the axe is lower than the density of Medina, varying from 43,519 persons per square to less than 7000 persons per km^2 in the following municipalities except the density of the Municipality of Ouakam which is 27,747 persons per km^2. The high level of the density of Ouakam witnesses the fact that the municipality of Ouakam is populated by various social economic groups, kind of middle class while the other municipalities following Medina are mostly populated by high high-income group. Overall, the density distribution from Medina to Yoff follows more or less the density model of Colin Clark. When the municipality of Ouakam is excluded, the density model from Medina to Yoff is $D = 43519e^{-432x}$. The monocentric and other forms of urban density models have major limitations in other axes from the Dakar CBD (Fig. 15.8).

In the axes of Plateau-Grand Dakar and Plateau-Camberene, instead of observing a decline of density from the centre to the outskirts of the city, we witness a combination of changes in density. Lack of specific model of densities in these axes is due to, disconnected, unplanned settlements. In most of the municipalities in these axes, households settle generally first in unplanned settlements either at the

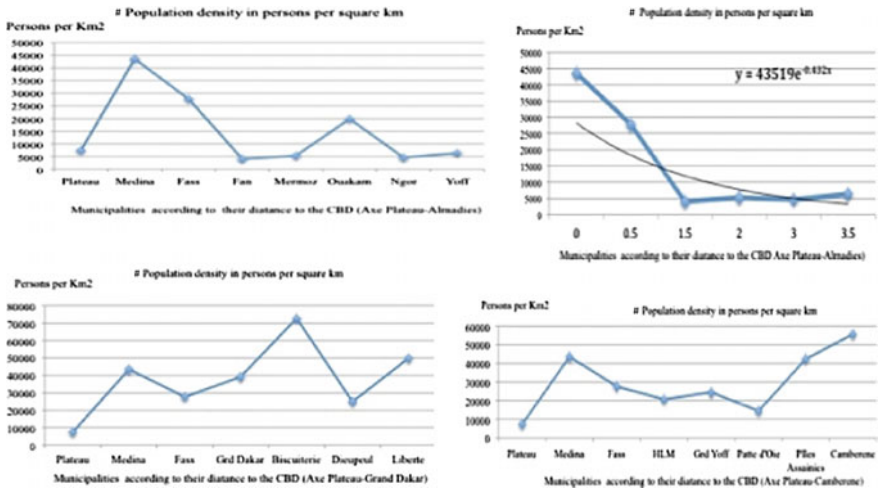

Fig. 15.8 Population density by distance to the city centre

outskirts or anywhere in the cities where there is space to settle. In these axes, poor families that are not able to afford the expensive costs of living of the city core live in densely populated sub-urban areas. While in these two axes, in one hand we found very high densities such as in Medina, Grand Dakar, Biscuiterie and Camberene with more than 40,000 inhabitants per km^2, on the other hand, the municipalities in the axe Medina-Yoff have densities as low as 10,000 inhabitants per km^2. These figures are indicative of a segregated city and point to a need for the national and local authorities to consider a balanced spatial planning of the city of Dakar coupled with provision of basic services in poor neighbourhoods.

The situation is alarming in many municipalities in Pikine where densities exceed 50,000 habitants per km^2. Yeumbeul Sud (51,468 habitants per km^2), Djidah Thiaroye Kao (102,932 habitants per km^2) and Pikine Sud (49,665 habitants per km^2) are among the municipalities with very high population densities in Pikine. In all these very highly populated settlements, few streets are built, and they are lacking other public spaces. This can explain the permanent high prevalence of infant and child diseases in Dakar compared to other cities and the rural areas of Senegal [38].

15.3.4 The Demographic Dividends of the Dakar Metropolitan Region from 1950 to 2015

The population of Dakar metropolitan region is relatively young as shown in the age pyramids (Fig. 15.9). The median age of the population varies from 20 years in the department of Rufisque and 21 years in the department of Pikine to 23 years and 25 years in the departments of Guediawaye and Dakar respectively [39]. The age pyramid with high proportion of young people age 20–29 years old shows clearly that migrant population for both sex from other regions of the country contribute substantially to the rapid growth of the agglomeration population, particularly in the department of Dakar, Pikine and Guediawaye. The department of Rufisque displays a demographic regime of high fertility without migration effect. In fact, the migrants mostly prefer to settle in the department of Dakar followed by the department of Pikine and Guediawaye. Whatever the reference period, 66% of migrants settle first in the department of Dakar, 18% in the department of Pikine, 10% in Guediawaye and only 6% in Rufisque. The main reason is that the department of Dakar is still the only place which is economically attractive to migrant and has at the same time poor neighbourhoods where migrants can settle with low cost housing as Pikine and Guediawaye offer.

With the right empowerment, Dakar's young population can lead the vision for the city of tomorrow and work for it. The ability of the youth, as the "Millennial", to adopt emerging technologies and transfer experiences from other parts of the world must be key drivers of Dakar's smartness in the long term. Various studies show that Africa's young people will be the driving force behind economic prosperity in

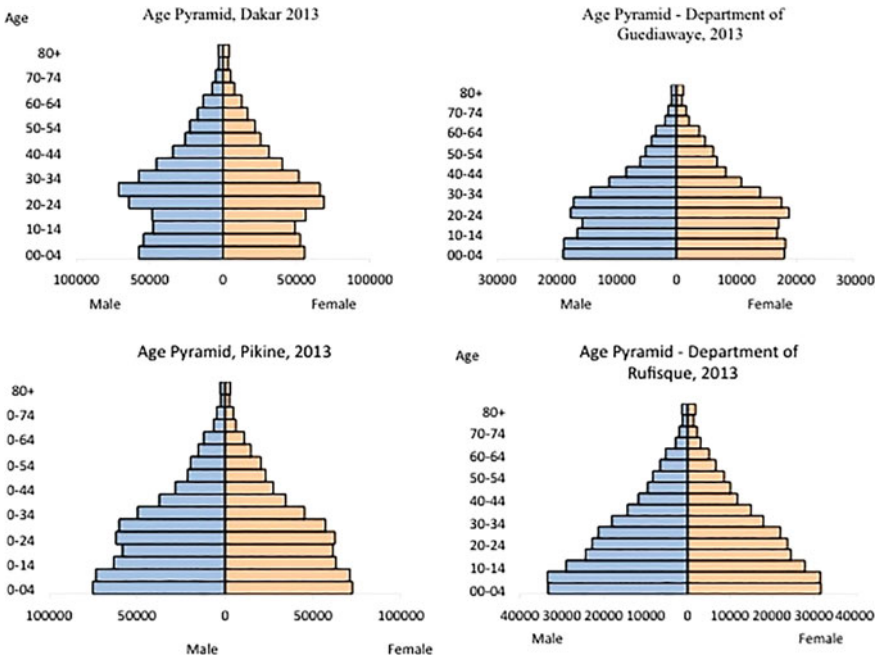

Fig. 15.9 Age pyramid Dakar Metropolitan Region. *Source* Data from ANSD, 2015. Senegal Population, Housing, Agriculture and Livestock Census, 2013

future decades, but only if policies and programmes are in place to enhance their opportunities [40]. These policies and programmes include factors such as a strong rule of law, efficient bureaucracies, government stability, lack of corruption, and a stable business environment that encourages domestic and foreign investors. In order to benefit from its youthful population, the Dakar metropolitan region must embrace smart education driven by the availability of ICT and respond to the requirement of the job market of the 21st century. It is also important to encourage young people's participation in public life, and in policies, programmes, and services. However, youthful population could also present a significant risk and threat to social cohesion and political stability if Dakar fails to create sufficient economic and employment opportunities to support decent living conditions for them [41].

15.3.5 Senegal Urban System: Dakar the Permanent Primate City

The spatial distribution of cities of different sizes throughout the national space constitutes a country's urban system. The urban system is determined by the way cities are geographically distributed in the country according to their size. In the urbanization process, some countries were able to develop a balanced system of

cities with no city does predominantly hold a large share of the urban population while others concentrate their population in one city that become a primate city. The conditions under which urban primacy emerges can vary greatly and evolve with country size, population density, and the stage in its urbanization process, among other factors [42]. Changes in primacy can be affected by all of the factors affecting urbanization more generally, including natural growth, migration and reclassification of settlements from rural to urban. A country's urban system can be linked to the organization of the government at the national, regional, and local levels [43]. The share of city to the total urban population can be a good indicator of a city performance, attractiveness or a simple political preference [44]. In turn, the urban system may determine the need for specific urban development policies, consistent with the size, growth and function of each city. For instance, when all the national investments, all health, education and commercial infrastructures are vested in a particular city, such as Dakar, people do not have other choices except moving to Dakar.

The Urban primacy as defined here characterizes the urbanization process in Senegal during the last 60 years where Dakar has been a primate city with more than half of the national urban population living in the urban agglomeration. With a level of 50% in 1950, the share of Dakar in the national urban population decreased and stabilized at 48% until 1990. However, from 1990, this share continuously increased until it reaches its highest level since 2010 (54%). The permanent primacy status of Dakar is opposite from most cities in East Africa where though they were primate cities at the onset had lost their primacy along the urbanization process. For instance in Kenya, the share of Nairobi in the national population was 49% in 1960, but in 2015 Nairobi represented only 33% of the national population. In Ethiopia there was a drastic reduction of the demographic power of Addis Ababa from 47 to 17% (Figs. 15.10 and 15.11). In North Africa, expect in Egypt there is no single country that hold a share in the national urban population that reached 30%.

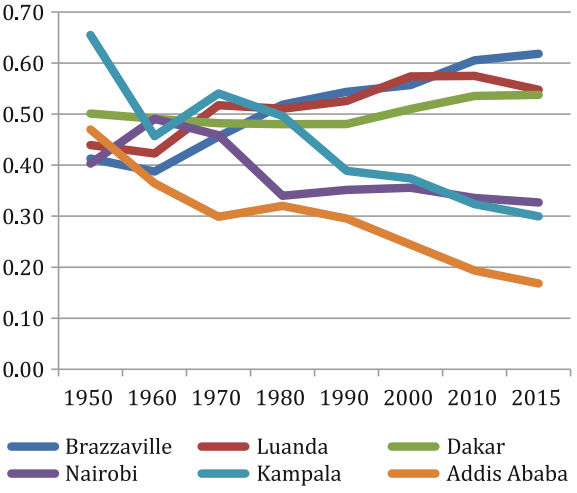

Fig. 15.10 Share of Dakar and other African cities in the national urban population (1950–2015). *Source* Computed using data from United Nations (2012) World Urbanization Prospects: The 2014 Revision, UNDESA, Population Division, New York, NY, http://esa.un.org/unpd/wup/index.htm

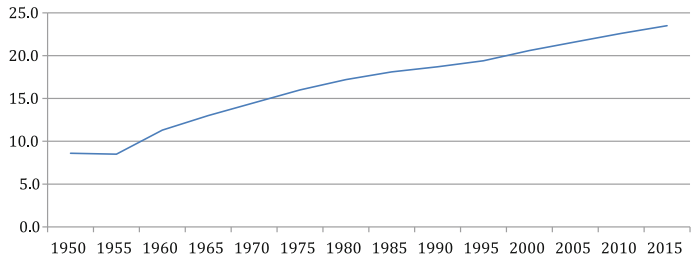

Fig. 15.11 Percentage of the total population residing in Dakar urban agglomeration (1950–2015)

The Fig. 15.12 illustrates two type of information: the size of population measured by the size of the circle and the population growth measured by the colour of the circle. The bigger the circle, the larger the size of the population with the metropolitan region of Dakar having the larger circle with its population of 3.5 million, followed by the city of Touba with its population of 817,000 inhabitants. All other cities have a population of less than 300,000 inhabitants. The highest population growth rate is observed in the city of Touba, more than 4.1%, followed by the city of Mbour with a population growth rate between 3 and 4.1% and Dakar

Fig. 15.12 Senegalese agglomerations with a population of 10,000 inhabitants or more in 2013 and Population growth rate between 1998 and 2010 of agglomerations with a population of 10,000 inhabitants or more. *Source* Republic of Senegal, 2014. Review of the Senegalese Urbanization

with a population growth rate of 2.5%. In the next decade, the population of Touba will exceed the million Mark and call for an adequate urban planning, design and management, a sufficient provision of basic services, a well-administered land tenure, an efficient mobility system, etc.

High primacy shares may imply a high concentration of persons in one city as observed with Dakar, enabling cities to benefit from the positive effects of high density such as economies of scale and agglomeration, diffusion of ideas and innovation. While there is evidence to support such a positive relationship between concentration of people and economic efficiency, research has also found that city primacy can create an unbalance in the urban hierarchy and bias development processes [45]. All this depends on various conditions including the country's level of economic development and size as well as urban policies and programmes [46]. The economic benefits of urban primacy should be supported by evidence that some primate cities are such because of distorted and unequal political consideration, which is the case of Dakar. Primate cities that receive preferential consideration by the state disadvantage smaller cities, are harmful to efficiency and nation-wide development, and could lead to spatial inequality [47].

15.3.6 The Dakar Metropolitan Regional Foundation

15.3.6.1 Dakar—A Monocentric Metropolitan Region

Today, the Dakar Metropolitan Region, administratively called region of Dakar, is sub-divided into four departments: Dakar, Pikine, Guediawaye and Rufisque. The first three departments and the city of Rufisque form the urban agglomeration of Dakar. However, most of the administrative, commercial and industrial services are located in the department of Dakar as a result of the monocentric system introduced by the French in 19th–20th centuries. Figure 15.13 illustrates the concentration of

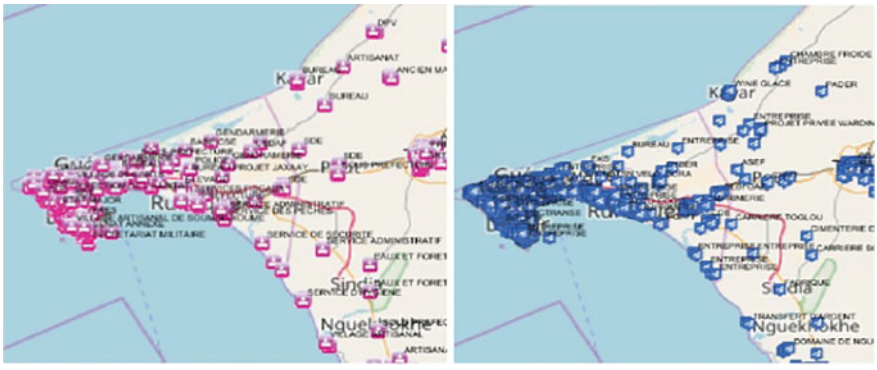

Fig. 15.13 Concentration of administrative services and companies in the city centre

administrative services in the Dakar city centre. This monocentrism of Dakar dated back the colonialism period and had been pursued by the Senegalese government after independence. Residential areas were also designed along economic class lines. This has led to social and economic fragmentation that disadvantage lower income groups in accessing basic services such as public transport, and prevent social interaction and integration. This has impacted the traffic with people having to share a main street network to and from Central Business Districts. This has led to congestion and long trips from the periphery to the centre [48] (Fig. 15.13).

Efforts have been made to decentralize the Metropolitan region with success observed with the decentralization of the financial systems.

15.3.6.2 Proliferation of Unplanned Settlements and Lack of Security of Tenure

The Urban Master Plan of Dakar has established criteria to classify houses and building on the following categories: Individual house type villa; Planned housing type real estate company; Regular spontaneous Habitat; Irregular Spontaneous Habitat; Habitat type buildings and; Village dwelling. The **Individual house type villa** consists of villa of high standing with a maximum of three levels, with very good-asphalted roads, and most sidewalks are paved. **Planned housing type real estate Company**: These are housing programs carried out by public or private bodies specialized in real estate development. This type of habitat has asphalted roads for the main streets. **Regular spontaneous Habitat**: This type of habitat, realized in self-construction on approved subdivisions, is constituted of so-called popular districts such as Medina, Gueule Tapée, Colobane, Grand Dakar and certain districts of Pikine and Guediawaye. High densities characterize this type of habitat. **Irregular Spontaneous Habitat**: This type of habitat is manifested by an anarchic and unauthorized occupation of public spaces and land, especially in the urban peripheries. It is made up of poor quality buildings, more or less precarious, sometimes even slum type, where the problems of lack of infrastructure and public facilities are acute. The streets are narrow, sandy and difficult to access for motorized vehicles. **Habitat type buildings**: buildings exceeding three floors characterize this type of housing. It is generally located in the city centre and is the administrative district of the Plateau. It has the particularity of being located in buildings with a large proportion of offices, as well as commercial premises (on the ground floor). The road is paved and the sidewalks are all paved. **Village dwelling**: These are mainly "traditional villages" in Dakar (Ngor, Yoff, Ouakam, Hann, Cambérène) and Pikine (Keur Massar, Thiaroye sur Mer, Mbao and Keur Mbaye Fall). These villages are characterized by a habitat of summary materials gradually replaced by permanent dwellings. The streets are narrow and sandy for the most part, only the primary road is paved. The shape of the lots is not regular and the houses are grouped around small squares or around a mosque. The government has also classified settlements based on their coverage in terms of infrastructures. It has classified them as: settlements with infrastructures, settlements with limited

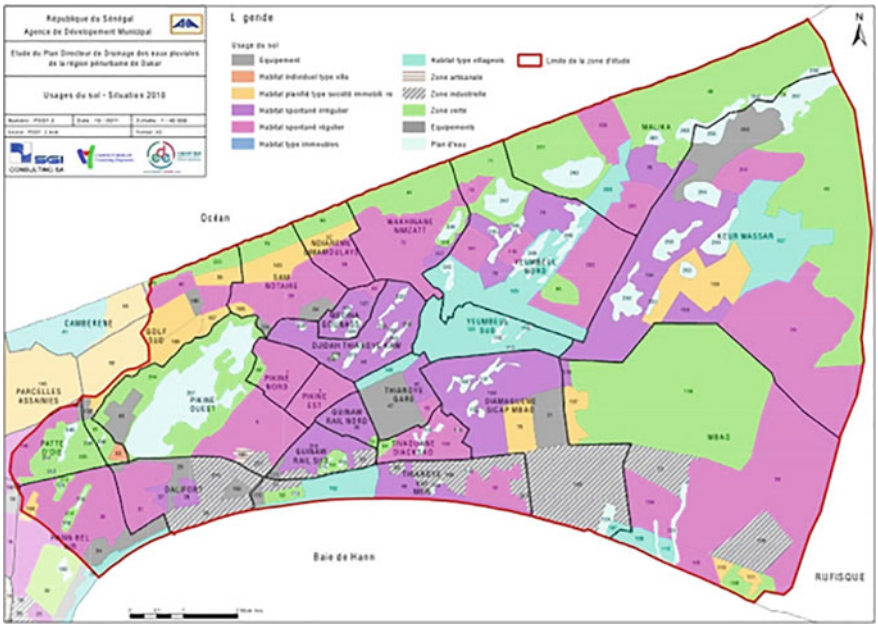

Fig. 15.14 Classification of land use in the peri-urban of Dakar

infrastructures, and irregular settlements. The 19 municipalities of the department Dakar were distributed according to these types of settlements (Fig. 15.14).

Based on the above classification of settlements, official information indicated that the percentage of population living in regular areas is 60% in Dakar, 35.8% in Pikine, and 30% in Guédiawaye. Another study "Cities of Senegal without slums" revealed that there were 49 spontaneous settlements in the city core of Dakar, covering a total area of 418 ha; and 47 large spontaneous settlements in the suburbs of Dakar covering a total area of 1856 ha. In the urban audit conducted in the city of Dakar in 2001 [49], equipped settlements were defined as settlements within a radius of 500 m that have an elementary school and a health centre in addition to be connected to water, electricity and a paved street network. This type of settlements covers an area of 1917.56 ha in 2001, i.e. 57.8% of the total built up area of the core of Dakar. Under equipped settlements, defined as settlements that do not have these infrastructures or are far away from them, cover an area of 1029.96 ha, i.e. 31.1% of the total built area of Dakar. Others are considered irregular planned settlements with traditional structures, which mostly are the first settlements of Dakar, cover an area of 367.15 ha, i.e. 11.1% of the total built up area of the core of Dakar. However, it is important to note that these settlements considered are irregular in terms of planning such as Ngor are also those hosting now wealthy people. The indigenous have sold their land to wealthy people who settled without changing the layout of the neighbourhood. Other irregular settlements are in areas such as Camberene where mainly lively some indigenous people and poor migrants that

cannot afford the cost of living in the centre of Dakar. These settlements have an irregular planning and lack most of the basic infrastructures. This again supports our assumption that irregularity in Dakar does not necessary means poverty. Irregular settlements can host rich families as well as poor families. As we previously state it, informal land tenure in Dakar does not concern only the poor, but also the rich; it is across social classes. Without access to financial market households are obliged to build based on their capacity. Mortgaged houses are about 5% in Senegal.

15.3.6.3 Basic Infrastructures

In a smart city foundation, basic infrastructure such as piped water services, sewerage facilities electricity sources and solid management are considered along the city planning. They are part of the city planning prior to settlements of households. In a sustainable city foundation, use of improved water from piped water services, sewerage facilities, solid waste management, energy for lightning is quasi universal. For the city of Dakar only connections to piped water facilities and to electricity are quasi universal with levels of 92 and 95% respectively. The coverage of sewerage facilities and solid waste management is still very low, below 50% in 2015 (Figs. 15.15 and 15.16).

During these past 20 years, there is steady progress in the coverage of water connection from 64% in 1993 to 77% in 1997 and 90% in 2005. At this level, it is clear that the coverage of connection to water facilities and to electricity sources did not follow the rapid progress of unplanned settlements characterized by lack of documented land tenure. Considering that the water and electricity services are governed by public administrations until recently, their high level of coverage shows a de facto secure tenure, which was highlighted earlier. Indeed, in order to have connection to these services, the application must obtain the approval of the Ministry in charge of housing and urban development.

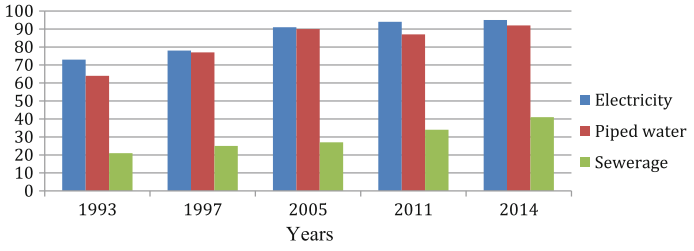

Fig. 15.15 Percentage of household connected to electricity sources, water piped and sewerage facilities, Dakar 1993–2014. *Source* Computed from Senegal demographic and health surveys (1993–2104)

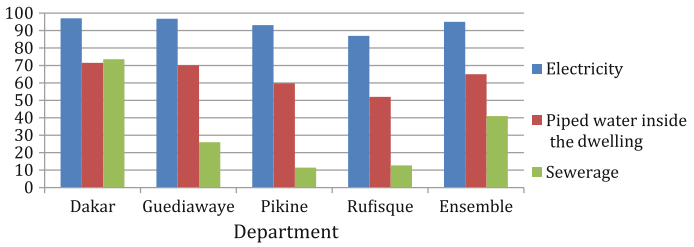

Fig. 15.16 Percentage of household connected to electricity sources, water piped inside the dwelling and sewerage facilities, Dakar 2013. *Source* ANSD, 2015. RGPHE 2013

Connections to water services and to energy sources often go together though processed by two different entities, the SDE (Sénégalaise des eaux) and the SENELEC (Société nationale d'électricité du Sénégal) respectively. Therefore it is not surprising to have similar figures for both amenities. Here the only problems that arise are during the supply, which is more, a demand–supply equation than a city foundation matter. During the foundation of the city what was important was to ensure that connection to water services and electricity are established along the planning of the city. For instance due to poor infrastructure development, many households of Dakar may stay one week without water according to the Demographic and Health Survey conducted in 2014 in Dakar [50]. Though connection to water exists, the use is not neither sufficient nor affordable [51]. Similar situation occurs for the electricity where households can stay hours and days without electricity.

Sewerage facilities are fundamental for Dakar smartness

Data on connection to sewerage facilities have been collected from the Demographic and Health Surveys held in Dakar between 1990 and 2015. During the last twenty years, there has been important progress on the connection to sewerage facilities with the proportion of people living in household connected to sewerage facilities almost doubling from 21% in 1993 to 41% in 2014. With similar progress, it is expected that by 2020, 2030 and 2035, the coverage of connection to sewerage facilities will be 49, 64 and 72% respectively. However, with an aggressive sanitation programme, this progress can be boosted and the majority of households connected to sewerage facilities before 2020, and the universal access before the year 2035. The achievement of this will however require re-planning of the city of Dakar. At the moment, the majority of the city residents rely on sanitation facilities such as septic tanks and pit latrines. Along with the lack of sewerage system, the city of Dakar lacks a properly developed drainage system—both in the rich and poor neighbourhoods. Lack of adequate investment in these two basic infrastructure components exposes the city to challenges such as management of surface water, flooding, and vulnerability of the population to water-borne diseases,

especially during the rainy seasons. In Dakar as in most cities of developing regions where there are few streets built, sewerage facilities and storm drainage are not factored during the planning of the city. The situation is worse in the suburb of Pikine where the level of connection to a sewerage facility is less than 10% in most settlements. To be a smart city, Dakar needs to take into consideration the urgent need of a sewer system.

Lack of access to sewer system in overcrowded urban areas has negative impact on health as a factor of proliferation of diseases. Waterborne diseases such as diarrhoea and respiratory infections are frequent in cities. A series of demographic and health surveys conducted in the city of Dakar during these last twenty years show consistently high levels of diarrhoea diseases and respiratory infections than in the rural areas [52]. This can be associated to low coverage of sewerage facilities, with its correlate, high frequency of floods during raining seasons. In addition to that, households are frequently crowded in tiny houses hosting kitchens without adequate ventilation.

Management of solid waste

One main characteristic of Dakar's weak city foundation is poor waste management. Due to lack of a comprehensive drainage system, wastewater flows in the streets of Dakar. Senegalese municipalities have major difficulties to cope with the waste. In Senegal, 2438 tons of solid waste is collected every day in the municipalities, or 0.5 kg per resident per day. This waste mainly comprises of organic waste (44%), paper (10%), plastic (3%), glass (3%), metals (1%) and other types of waste—textile, electronic, medical, industrial, etc. (39%) [53]. Dakar's main solid waste disposal site, the Mbeubeuss, (located in Pikine) receives 475,000 tons of garbage per year from both domestic and industrial sources [54]; yet its designation as the city's dumpsite in 1968 was not well informed by robust feasibility studies. To date, the landfill remains as an unfenced open pit where garbage is not covered with an inert material and where intense recovery activities are practiced. Proposals are however being developed to start the conversion of the waste in the dumpsite to wealth through recycling and other means. Currently, Mbeubeuss receives on average of 3500 people per day (33% of recyclers, resellers and other buyers of recovered materials) whose activities mobilize financial mass of nearly thirteen million francs (13 million FCFA) [54].

Due to lack of regular solid waste collection, household waste also finds its way to the streets. Indeed, Dakar has very limited waste disposal sites, and the few that exist are poorly managed. Poor management of waste impacts negatively on people's health and exposes children to multiple diseases. Senegalese Demographic and Health Surveys conducted in 1993, 1997 and 2005 constantly show that diarrhoea and acute respiratory infections are more frequent among children living in Dakar than those living in rural areas [55]. This high exposure to diseases in Dakar is also associated with the fact that households are overcrowded and are more affected by indoor as well as outdoor pollution than their counterparts in the rural areas and small towns.

15.3.6.4 The City Foundation: Spatial Planning, Land Tenure and Basic Infrastructures

For a city foundation to be smart, it must be inclusive at the onset of the urban planning and promotes mixed neighbourhoods where social clustering is discouraged. Having all the poor living together creates slums and fuels instability and insecurity. Inclusive urban planning eases access to basic services (water, sanitation, housing, education and health) and to decent employment for all. A key element of smart urban planning is a smart street network that reduces travel time and encourages walking and social interactions. Smart urban planning enhances infrastructure development, environmental sustainability, economic and social development; makes cities resilient and prepared to overcome natural disasters; and promotes mixed neighbourhoods where services are walking distances from people's residences. Overall the metropolitan region is not smart; disaggregated data reveal huge disparities across departments in favour of the department of Dakar (Fig. 15.17).

Using the three main components of the city foundation, we have computed a composite index that represents the overall city foundation, the City Foundation Index (CFI) with values varying from 0 to 1. A value closes to 0 means that a city lacks most of the elements of the city foundation elements, and a value closes to 1 means that a city enjoys most of the elements of the city foundation. While the CFI of the department of Dakar is estimated at 0.723, the CFIs of Pikine, Guediawaye and Rufisque are estimated at 0.402, 0.432 and 0.425 respectively. The low level of the CFI of Pikine, Guediawaye and Rufisque is due to low coverage of a sewerage system, less than 30% compared to 74% in the department of Dakar. The three departments also perform poorly in land governance and administration with a proliferation of informal settlements. While in Dakar, the majority of households enjoy security of tenure, in the three departments less than the third of households

Fig. 15.17 City foundation conceptual framework. *Source* Mboup, G. et al., 2016. Smart City Foundation —Drivers of Smart Cities. In Vinod et al., 2016. Smart Economy in Smart Cities, Springer

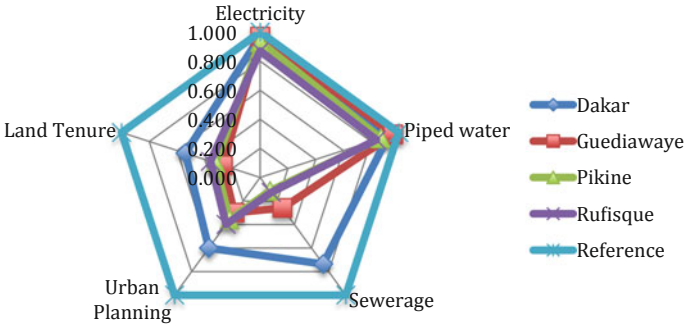

Fig. 15.18 Components of the Dakar Metropolitan Region city foundation index. *Source* Computed by the authors

have security of tenure. However, the department of Dakar is unequally served with settlements in the CBD and Fann/Point E, enjoying fully all elements that make a city foundation smart against Colobane, Grand Dakar with similar situations as observed in Pikine, Guediawaye and Rufisque. The CFI in the department of Dakar varies from 0.903 in the wealthiest municipalities to 0.207 in the poorest municipalities (Fig. 15.18).

National and local authorities must improve the foundation of the city of Dakar with smart planning, smart basic infrastructure and smart institutions and laws. Smart basic infrastructures, which are particularly of great urgency in the city, include connection to water, connection to sewerage facilities and connection to energy sources, as well as development of efficient waste management systems. Effecting these changes will enhance the economic value of land, encourage investments, reduce risks from natural hazards, increase resilience and minimize the costs of infrastructure maintenance among various other positive impacts. This calls for use of ICT and GIS in space planning, land tenure governance and administration, and management and monitoring of the provision of basic infrastructures.

15.4 Urban Accessibility and Mobility

Development of large metropolitan regions like Dakar constitutes economic and social opportunities as well as challenges depending on how the urban growth was planned and managed. It provides opportunities for economies of scale and agglomeration as well as for diffusion of ideas and innovations, but it will also call for large investments in infrastructures to respond to the increased demand for water, sanitation, solid management, energy and mobility, etc. It will particularly come with increased demand on mobility that must be satisfied with an efficient

public transit accompanied with increased spaces for pedestrians and cyclists in order to safeguard the environment while creating economic growth. Economies of scale and agglomeration economies are greater in metropolitan areas where transportation infrastructures are able to answer mobility needs with higher access to markets and resources than those where people mobility is impeded by deficient transportation infrastructures. Efficient mobility will allow large-scale production of goods and services that can be distributed within the metropolitan regions and beyond with time, cost and reliability opportunities [56]. Without efficient mobility, a metropolitan region losses its economic power and remains just clusters of disconnected settlements. The latter is the situation in Dakar as in most African cities, marked by frequent traffic congestions, a major indication of the disjuncture between land-use planning and transport systems in the city. It not only exposes the limitation of a transport-oriented bias to mobility, but also reveals the inefficiency of land-use systems in Dakar.

15.4.1 Streets Key Components for Urban Accessibility

Urban accessibility is shaped by both spatial planning elements such as: density, compactness, type of city (monocentric or polycentric) and streets, and transport planning elements such as the streets infrastructures and the transport infrastructures. The first three elements of spatial planning—density, compactness, and type of city (monocentric or polycentric)—are presented in Sect. 15.3. This section will address one important element of spatial planning—streets—and elements of transport planning and system.

The Dakar metropolitan region is not benefiting from all the multiple advantages associated with well-connected streets. Dakar suffers from traffic congestion along with the exclusion of pedestrians and other non-motorized means, and further marginalization of the most vulnerable segments of society who rely the most on foot and public transports if they are affordable. The suburbs of Dakar allocate less then 5% of their land to streets compared to a level of 15% in the city core as illustrated in Fig. 15.19. In most Dakar suburbs, there is no space left for mobility except very tiny streets where people have to squeeze through. The streets are also narrow, not paved, and lack sidewalks; this result in competition for space with motorists, often exposing pedestrians to accidents. While Dakar as in many African cities has high pedestrian flows, less than 20% have pedestrian footpaths [57]. In many of these settlements, public transport services are accessible in few arterial streets where people have to walk several kilometres to reach them. During the raining season, the already limited walking spaces are flooded, forcing people to stay at home, losing many productive hours. This in turn has serious social and economic impacts on the city's economy.

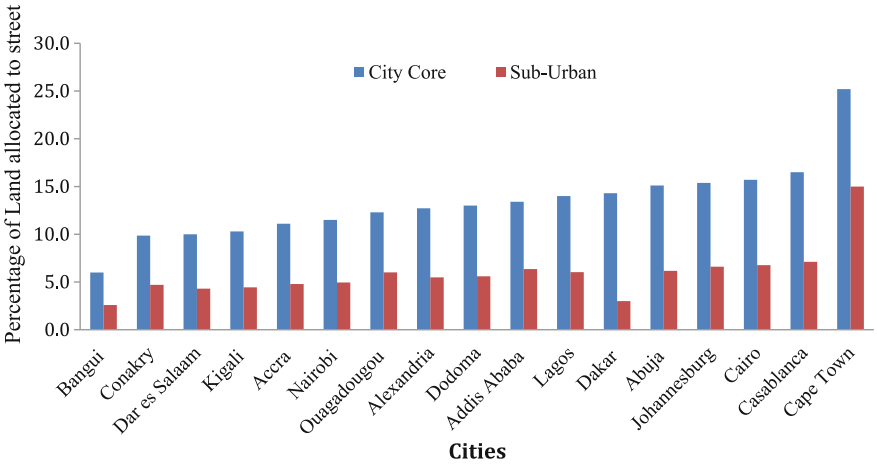

Fig. 15.19 Land allocated to street (LAS) in African cities. *Source* Figure prepared from Mboup, G. et al., 2016. Smart City Foundation—Drivers of Smart Cities. In Vinod et al., 2016. Smart Economy in Smart Cities, Springer

Composite Street Connectivity Index

Street connectivity is determined by the amount of land allocated to streets, the length of the street network and the number of intersections along the network. The proportion of land allocated to streets and the length of the street network is not sufficient to assess street connectivity. A city with wide streets within a very limited street network and low intersection density is considered a city with low street connectivity because the width of the streets is not complemented by a larger street network and higher street density. Similarly, a city with a lengthy street network and dense intersections may not qualify as a city with high connectivity if the streets are very narrow. The Composite Street Connectivity Index (CSCI) aims to assess the connectivity of a street considering its width, its length and the number of intersections, all in relation to the total land area of a city. Interestingly, some cities in this group have low levels of land allocated to streets, but higher intersection density (ID) increases the value of their CSCI. For instance, Dakar city core has a LAS index moderately low (15%), but due to its high ID, it has a CSCI similar to the other cities with higher LAS but insufficient ID. The city core of Dakar is planned in grid pattern that favours good connectivity. However, the Dakar suburbs suffer from low LAS, limited street density with few intersections Cities in this group have very poor street connectivity due to low levels of land allocated to streets, low street density and low intersection density. Their CSCI is less than half the highest level of the CSCI, which is 1. In these suburbs, which are mainly unplanned, provisions of basic services as well as means of transport remain challenges. Comprehensive city planning programmes are needed in these suburbs to improve the lives of urban dwellers.

Fig. 15.20 Composite Street Connectivity Index (CSCI)

Dakar is among the five African cities (Cairo, Alexandria, Casablanca and Johannesburg) with **a CSCI of between 0.500 and 0.650.** Their level of connectivity in the city core is sufficient to promote infrastructure development and to ease connections to basic services, such water, sanitation facilities as well as drainage systems. However, their suburban areas are very poorly connectivity, with a CSCI of below 0.300. Only one African city, Cape Town, features in the group with **Cities with a CSCI equal to or above 0.800** along with cities in developed countries. It has streets sufficiently wide to accommodate all types of users, sufficient to reach most neighbourhoods, and sufficient intersections to accommodate all users (Fig. 15.20).

Streets where the needs of all users are considered and factored (ages, gender, economic status, modal means, etc.) are urgently needed in Dakar. Mobility must be multidimensional, easy, comfortable, and safe [58]. Within the existing street network, Dakar must re-design its streets by allocating more spaces for walking, cycling and promoting the use of public spaces. On a smaller scale, Dakar is redesigning streets, particularly in new settlements to allow pedestrians and cyclists to share space with motor vehicles. Design measures that enhance the pedestrian environment include expanding sidewalks, planting trees and installing benches or other seating. In existing settlements, the master plan has introduced the redesign of certain intersections. All these initiatives have a common set of objectives: to reduce use of motorized transport modes and enhance environmental sustainability and social interaction. However, these initiatives are still not addressing problems faced by the urban poor who live in suburban areas and slums. Most suburban areas and slums are poorly served with streets; this further hinders accessibility to urban public transport [59].

Along the reduction of land allocated to streets, there is also reduction of other open public spaces as illustrated in the Fig. 15.21.

Fig. 15.21 Spatial distribution of public spaces in Dakar—A qualitative assessment

15.4.2 Transport Modes and Infrastructures Are Key Urban Accessibility

Cities are locations having a high level of **accumulation** and **concentration** of economic activities and are complex spatial structures that are supported by transport systems. The larger the city, the greater is its complexity and the potential for disruptions, particularly when this complexity is not effectively managed. The most important transport problems are often related to urban areas and take place when transport systems, for a variety of reasons, cannot satisfy the numerous requirements of urban mobility. The Sustainable Development Goals (SDGs) recognize that sustainable transport is crucial for urban economic development. With Goal 11 of the SDGs "*Make cities and human settlements inclusive, safe, resilient and sustainable*", member states have committed themselves to "by 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries. Member States have further committed to support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning, and by 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, …" [60].

15.4.2.1 State of Urban Mobility in Dakar Metropolitan Region

"No aspect of urban form and travel has been more closely studied than the influences of urban densities on public transport ridership. It is widely accepted that high densities are essential for sustaining cost effective public transport services. The impact of densities on travel modes gained particular attention in the 1990s, in the wake of a global energy crisis and economic recession. Rail, with its high up-front capital costs and economies of scale, needs to attain a threshold density of trips, in order to cost less than accommodating the same trips by car or bus. The reliance of public transport on urban densities has prompted efforts to define the minimum density thresholds required to support successful public transport services. Cities need to average 3000 inhabitants per km^2 to support reasonably cost-effective public transport services" [61]. With low density, neither the investment required for BRT, nor that for rail, is likely to be viable because stations will lack sufficient proximate populations to generate demand. In spread-out cities, public transport has a difficult time competing with the private car for the middle and upper economic or walking for the urban poor. Public transport that is cost-effective can only be achieved through high urban densities and a large share of jobs and retail activities concentrated in the urban core, or in polycentric cities with multi-directional travel patterns [61]. In Dakar metropolitan region, the population density exceeds this threshold indicating that Dakar metropolitan region transport problem is not associated to low density but to other urban form components such as a low coverage street network, urban monocentrism, etc.

Infrastructure Development is one the component of a smart metropolitan regional development. It is composed of several elements including transport, energy and ICT. Here, our focus is on the first element, which is transport. While transport data has been gathered for most cities in developed countries, information on transport is scarce in African cities, and when it exists it is poorly documented; metadata providing definition, method of measurement and sources of information is rarely available. The lack of reliable data on transport has held back the development of effective urban policies aimed to effectively tackle deficient transport systems in African cities. The most common available statistics are the distribution of trips by transport modes (large buses, minibuses, private cars, motorcycles, and walking). However, this information does not make distinction on the type of trips. Are they for going to work, to the health centres, to the school, to the market, or all together [62]. In the era of data revolution, this information must be processed, analysed in association with social, economic and demographic information and used to guide transport policies and planning in an open platform accessible to all stakeholders including the public. This information will help to overcome transportation challenges in African cities through informed planning, real-time monitoring and management that take into account multidimensional variables beyond the transport sector.

Though the statistics may be from different sources, there is a common finding which is that in most sub-Saharan African cities, people have limited mobility choice in getting to work: either they ride minibuses or they use their foot. Data

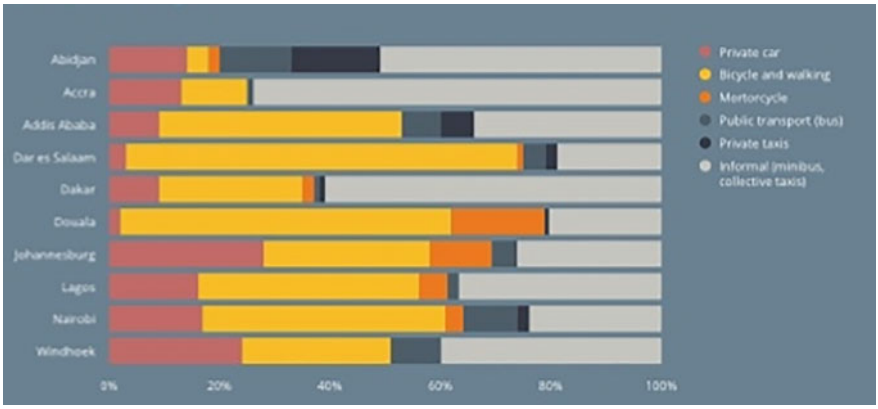

Fig. 15.22 Distribution of trips in selected African cities by modes of transport. *Source* From Lal. SV. et al. 2017 citing International Association of Public Transport 2010

collected in Dakar show that the share of minibuses in the public transport exceeds 90%. Despite various efforts taken by national and local authorities to boost the formal public transport, it remains with a very low share in Dakar, less than 5% in the total public transport, which is heavily dominated by informal means of mobility. Most of the formal public transport sector is composed with few medium-sized buses that must follow a specific itinerary, but they are barely seen in the streets submerged with the informal motorized means of transport. As illustrated in Fig. 15.22, the share of minibuses is high in Dakar, 63% in all mobility modes. Among the motorized means of mobility, this figure represents 89%.

15.4.2.2 Formal Public Transport

Despite various efforts taken by national and local authorities to boost the formal public transport, it remains with a very low share (5%) in the total public transport, which is heavily dominated by informal means of mobility. There was a subsidized public transport with the public company SOTRAC with buses in early 1970. But it was discontinued during the structural adjustment period imposed to Senegal as in many African countries by the IMF and the World Bank in mid 1980s. However, in 2001 public transport was reinforced with the introduction of newly public transport company named "Dakar Dem Dikk" (3D), with the share of three quarters from public resources and the rest from private investors [63]. The 3D is essentially composed of few medium-sized buses that must follow a specific itinerary, but they are barely seen in the streets submerged with the informal motorized means of transport. The efficiency of the public company 3D has faced, indeed, various difficulties to be sustainable in terms of supply as well as in terms of demand: lack of institutional coordination between the city council and the company 3D; structural deficit associated to the gap between the affordable fares and the operating

costs leading to operating deficit; and poor operational and commercial performances associated to public service obligations without the corresponding resources. Other constraints are low commercial returns in congested roads, low productivity of employees, and attempt to serve the whole urban area without having enough buses. Other formal public transport means is the railway composed by the urban train created in 1998 "Petit Train de Banlieue" with a little share (less than 1% in 2009) to the total public transport. Efforts to modernize the urban train under the Urban Mobility Improvement Programme, "Programme d'Amélioration de la Mobilité Urbaine- PAMU" include transfer of track provision and maintenance to Transrail, a new autonomous body for operation, track improvement, and building fences along the track (compensated by new footbridges) [64]. Despite all these efforts, the share of the railway in the public transport remains little compared to the demand of passengers from Dakar to its suburbs.

15.4.2.3 Informal Public Transport

Considering the lack of capacity by the formal public transport systems to meet the mobility demand of the residents of Dakar, dominance of the informal sector operators remains irreversible. The informal transport sector, composed of small-scale economic activities with unregulated employment, is largely dominated by buses operated by private entrepreneurs It represents 95% of the public transport. It supplies small-vehicles with low investment and minimal public support, low-performance services that fill the niche between formal taxis and the 3D buses [65]. They are mainly composed of minibuses called "Car Rapide", "Ndiaga Ndiaye" and "Tata". Their operational status is legal, as the vehicles are licensed for the purpose of public transport with a specific capacity limit. Informal fleets can be a lifeline to making a living where poor municipal public transport resources have led to limited or no service to outlying residential areas and high fares. It represents the only accessible means available to the poor and provides an important service that is often well adapted to local conditions. It delivers affordable services in instances where scarce municipal resources have led to a deteriorating service and higher fares. Informal fleets reach outlying residences in sprawling areas.

However, the buses as means of public transport come with enormous externalities that authorities must not overlook in the transport planning process. In this sector, most vehicles do not fit to be in the road technically and with respect to traffic rules and regulations (technical control, license, insurance, etc.). This contributes significantly to congestion, air and noise pollution and traffic accidents. In addition, passengers, particularly women are exposed to harassment from the bus operators and other passengers. Violence against women is common in the public transport sector [66]. In a city like Dakar where the formal public transport sector is quasi absent, the role of informal transport in generating broader social and economic benefits must be assessed together with the costs entailed. Prohibiting informal transport is not a viable solution as it destroys jobs and blocks access to

employment, but externalities must be assessed and reduced significantly. A combination of valuing the service and regulating them can be effective in managing related issues, such as traffic congestion, accidents and pollution.

15.4.2.4 Increased Use of Private Cars Hampers Efforts to Make Dakar a Smart Metropolitan Region

In absence of reliable public transport systems, households that can afford it, usually the upper middle class and the richest, possess private means of transportation or use taxis, which offer comfort compared to the public means of transport. The perceived advantages of convenience, privacy and status continue to make the private car an attractive means of transport in Dakar as in many African cities [67]. The growth of private motorized transport during the twentieth century had major impacts on the growth and development of the city of Dakar as many cities in developing countries. The rate of motor vehicle ownership in Dakar has significantly increased during these past 20 years, from 5% in 1995 to 13% 2014. The major factor behind the growth of car ownership in Dakar is at a cost that is becoming affordable for a growing number of people of the middle class that cannot tolerate the discomfort of the public transport with the "car rapide" and seek individual freedom. With the continuous urban growth, it is expected that Dakar will be an exclusive motorized city if the public transport is not reinforced and mixed neighbourhood promoted, considering the creation of six new urban centres as part the extension of Dakar [68].

While private cars offer the convenience of individual choice, this advantage is traded for much more land being used for road space and parking. Cars' land consumption and infrastructure costs can be a significant part of a city's budget and this costs heavily subsidized by both drivers and passengers. Emissions of pollutants in Dakar seem to be higher than the thresholds defined by international standards. Estimates of safety costs from the World Bank show that in Dakar these costs represent 2.7% of the national GDP [69]. A city submerged with cars is prone to more accidents, which generate economic and human costs. Without adequate public transport systems in place, and good planning choices that increase connectivity and proximity, congestion, pollution and energy consumption will also increase exponentially with the growth in car ownership. Unless authorities introduce rules and regulations such as road pricing, parking management and circulation policies to reduce car demand, ownership of private will continue to rise.

The monocentrism of the city of Dakar is a source of traffic congestion and an obstacle to smartness. The mobility in Dakar is heavily affected by the fact the city was conceived as a monocentric city where residential areas and workplaces are distinct, with the later concentrated in the centre of the city. Residential areas were also designed along economic class lines. This has led to social and economic fragmentation that disadvantage lower income group in accessing basic services and prevent social interaction and integration. This has impacted the traffic with every

morning and evening people have to share a main street network to and from the downtown of Dakar, which is named the "Plateau". The urban structure of Dakar illustrates an unsustainable travel structure of the city, focuses on the historic centre called Plateau that hosts the main commercial and administrative services. This leads to congestion and long trips from the periphery (Pikine, Guediawaye and Rufisque) to the centre. However, this monocentrism has started to erode with the emerging on new commercial and administrative centres outside the Plateau.

Two major impacts associated with low coverage of formal public transport and increased use of private cars are traffic congestion and pollution. Traffic congestion is a major indication of the disjuncture between land-use planning and transport systems. It not only exposes the limitation of a transport-oriented bias to mobility, but also reveals the inefficiency of land-use systems in a given city. Limited road capacity, in the face of growing demand for motorized mobility, partly explains deteriorating traffic conditions. Congestion has widespread impacts on the urban quality of life, consumption of fossil fuels, air pollution and economic growth and prosperity. Congestion accounts for significant percentages of the gross domestic product in many major African cities as noted in World Bank studies from the 1990s. About 90% of the cost comes from the value of the time lost by residents, 7% from the fuel consumed and 3% from gas emissions. In addition to economic costs, congestion causes significant numbers of early deaths from respiratory illnesses, stress and physical and mental fatigue. It also degrades green areas, which, in turn, diminishes their carbon sequestration properties.

15.4.2.5 Walking—Key for Dakar Smartness

In absence of affordable, reliable public transport, various options exist depending on level of economic conditions or purchasing power. Those that can afford it will own a car or ride a taxi, while those that cannot afford it, who constitute the majority, will use their foot. Those using their foot have limited opportunities compared to others that have access to public transport. They won't accept job where they have to walk very long distance, or if they accept job far away from their residence, they will encounter several days of absenteeism, and they end up by quitting the job. Despite lack of comparative data, it seems that the share of walking to access services remains the first option in Dakar due two main factors, namely: low coverage of public transport infrastructure and unaffordability of public transport for the poor where various needs compete. While in cities of developed countries, it is assumed that a walkable street is more attractive to people for various reasons and even defines the "liveability" of a city, in the city of Dakar walking is not a choice, but a necessity due to lack of other affordable transport alternatives.

Available information shows that 60% of residents of the city of Dakar walk either to their place of work or to health centres, to schools, or to the market. However, the streets of Dakar are not designed for pedestrian use. First, the land allocated to the streets is low, only 15% in the city core and less than 5% in many sub-urban settlements. The streets are also narrow, not paved, lack sidewalks. This

results in competition for space with motorists, often exposing pedestrians to accidents. It is also noted that in many African cities, 95% of the city streets also have high pedestrian flows but only 20% have pedestrian footpaths [67]. In addition, streets in the suburbs are poorly connected with less than 40 intersections per km^2. Lack of sufficient intersections make the street network of Dakar not friendly to pedestrians. It is demonstrated that for a street network to be well connected and walkable, at least 100 intersections per km^2 are required [70]. In areas such as Yeumbeul Nord, Camberene and Colobane, which are densely populated with densities of more than 50,000 inhabitants per km^2, there is no space left for mobility except very tiny streets where people have to squeeze through. In many settlements, public transport services are accessible in few arterial streets where people have to walk several kilometres to reach them. During the raining season, the already limited walking spaces are flooded, forcing people to stay at home, losing many productive hours. This in turn has serious social and economic impacts on the city's economy.

Despite challenges, walking has enormous economic, social and environmental advantages. Dakar of the 21st century must be planned as walkable with affordable means of public transport. Walking is an enabler of social cohesion and environmental sustainability with enormous social, Economic and Environmental benefits. In addition to its social and economic benefits, walking has a major advantage in reducing energy consumption, greenhouse gas emissions and pollution (air, water and noise) substantially, as it does not rely on fossil fuels unlike other modes of transport in cities. Furthermore, as walking requires significantly less road space and parking, it enables the preservation of natural habitats and open spaces. Walking also provides the daily physical activity required for a healthy lifestyle. Based on this, many motorized cities of developed countries have been changing their street planning and designing, and promoting public transport in order to reduce private motorized use and boost walking and cycling. With the 60% of people that are already walking in city, Dakar is indeed in a good position for a healthy society in a sustainable environment. However, in order to sustain this advantage, it is high time to give to pedestrians their right share in the transport infrastructure. Providing adequate infrastructures to pedestrians is cost-effective considering the enormous benefits from walking.

Integrating public transport, walking and cycling in the extension of the city of Dakar

Though Dakar is a large agglomeration, it does not benefit from the multiple advantages of high density due its unplanned urban growth and land expansion. While the advantage of a dense settlement is to ease accessibility, reduce cost of provision of basic infrastructures and other urban services, reduce erosion of natural resources, lower business costs and improve social equality, in Dakar none of these benefits are present or they are little. Considering the very high population density in many unplanned settlements of Dakar where the urban growth still high (more than 2% annual growth), it is urgent to develop and implement city extension at the fringes of the built-up area.

15.5 Urbanization, Economic Growth and Metropolitan Regional Development

Dakar as a coastal city offers multiple opportunities as a hub of economic activities as well as a link to local, regional and global economies. Today, it has an added advantage associated with its high population density and its youthful population, two important drivers of economic productivity and growth. One of the components of a Smart Metropolitan Regional Development is Economic Development, which is analysed in this section.

15.5.1 Urbanization and Economic Growth

Cities are potentially engine of prosperity due their power of economies of scale and agglomeration as well as of technology innovation and diffusion of ideas. High densities of cities also reduce transaction costs, make public spending on infrastructure and services more economically viable. Urban agglomerations with adequate urban planning and management coupled with good governance will produce wealth and sustain economic and social development [71]. The metropolitan of Dakar yet occupies a pivotal place in the national trade sector both nationally and internationally. Its autonomous ports (for coastal cities), international airports, international trade centres, touristic sites and commercial centres are assets economic growth. The Report of the Business General Census of 2016 has allowed to identify 407,882 economic units in Senegal, with the Dakar Metropolitan Region having the highest share of 40% (160,963 units), followed by the region of Thies (12%), Diourbel (9%) and Kaolack (6%); all other regions have each less 5% of national economic units. Furthermore, three-quarters of formal economic units are located in Dakar (Fig. 15.23). The metropolitan region also employed 87% of the formal sector. This shows clearly hat Dakar is the engine of the Senegalese economy. While in the Dakar metropolitan region, 52% are employed in the formal sector, in other regions, except Saint Louis and Thies (22 and 14% respectively), this figure is less than 10% [72].

The majority of economic units in Dakar are in the commercial sector (52%). The industry sector (food, textile and others) has a share of 25% in the economic units. It is important to underscore that 92% of large-size company, 88% of medium-size company and 66% of small size company are located in the Dakar Metropolitan Region (Fig. 15.24).

Industry in the Dakar Metropolitan Region is confronted with several challenges that include low production levels, inadequate competitiveness of the local market, lack of capacities of industrial firms to upgrade their production systems, geographical and structural weakness of the industrial fabric. In operational terms, initiatives concerning partnership between the State and the private sector are still minimal, particularly with regard to the promotion of entrepreneurial initiatives, the

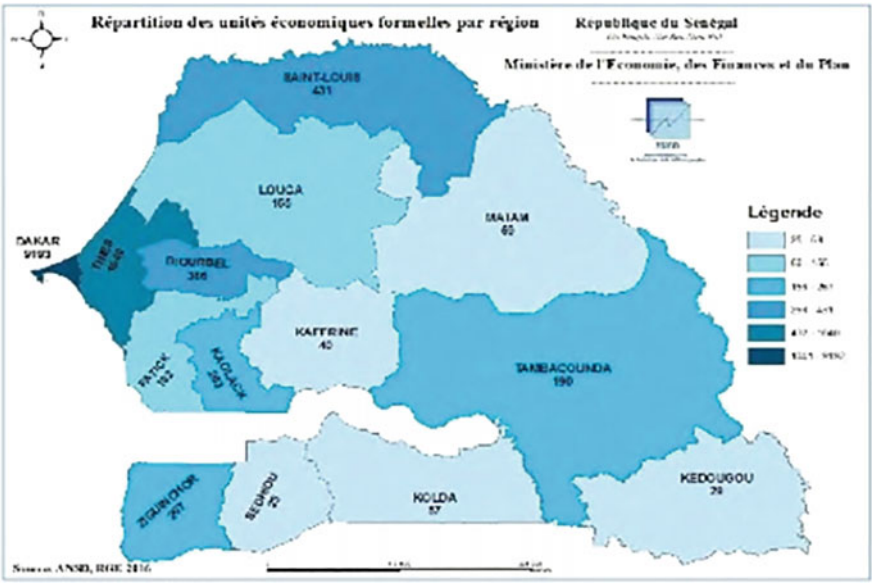

Fig. 15.23 Distribution of formal economic units by region, RGE 2016. *Source* Republic of Senegal, 2017. Recensement General des Entreprises 2016

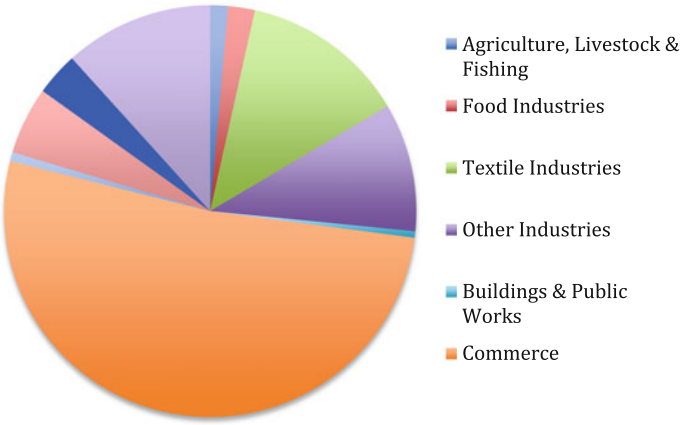

Fig. 15.24 Distribution of economic units by Sector, Dakar 2016. *Source* Data from ANSD/RGE, 2016

development of innovation through research application, the creation of integrated competitiveness poles and the training of future champions of the different sectors and the development of venture capital. The shortage and unreliability of power supply and the weak infrastructural platforms cripple the performance and competitiveness of industries, causing substantial additional costs. In addition to these drawbacks, industrial production suffers significantly from its strong concentration in the Dakar area as mentioned above, hampering the potential of provincial economic zones, as well as from lack of diversification and a system of product quality certification. Against this background, industry has not paid attention to the need to protect the environment as a general concept, but also as a strategy to improve their productivity and competitiveness. Environmental issues are generally perceived by industry as causing additional production costs to a sector that is faced with many other challenges [73].

The metropolitan of Dakar contributes up to 55% of the national Gross Domestic Product (GDP) [74]. Up to nine out of ten national civil servants, and from 50 to 90% employees in national's trade, transport, banking and industrial enterprises are in cities. However, most these urban advantages are concentrated in the city of Dakar. Though the Dakar Metropolitan Region had been administratively divided in four departments, in reality the other three departments act as suburbs of the department of Dakar, where the main commercial and administrative businesses are concentrated. The other three departments remain haunted by the early spatial and social division; they are not well planned, and they lack sufficient land allocated to streets, other public spaces, basic infrastructure and security of tenure.

Though Dakar metropolitan region is engine of national economies, association between urbanization and GDP around the world shows that the Dakar metropolitan region as many African metropolitan regions perform much less than its counterparts in other regions. Relationship between urbanization and economic development had been uneven in the Dakar Metropolitan Region. In Senegal, urbanization has not led to expected economic growth as shown in Fig. 15.25, with Senegal below the curve of association between GDP per capita and urbanization.

While countries in Asia such as China, Indonesia, Malaysia, Thailand and Vietnam and in LAC such as Mexico, Costa Rica and Argentina display an increase in GDP per capita associated to high urbanization rates, a similar association between GDP per capita and urbanization was not observed in most sub-Saharan African countries among them Senegal, Togo, Liberia and Burundi. In most of African countries, capital cities were not able to produce and distribute wealth nation-wide. Dakar has not been able to fully transform its large population in terms of economies of scale and agglomeration economies as many Europeans and American cities did more than 50 years ago, and LAC cities and Asian are recently doing. The low productivity of Dakar lies to several factors including those spatial and mobility planning presented in previous sections as well as other factors associated to urban legislation and governance and financial capacities. Unbalanced urban system, unplanned dense settlements without basic services, poor street connectivity, and poor transport infrastructures impeded Dakar economies of scale and agglomeration potential, and create scale and agglomeration diseconomies.

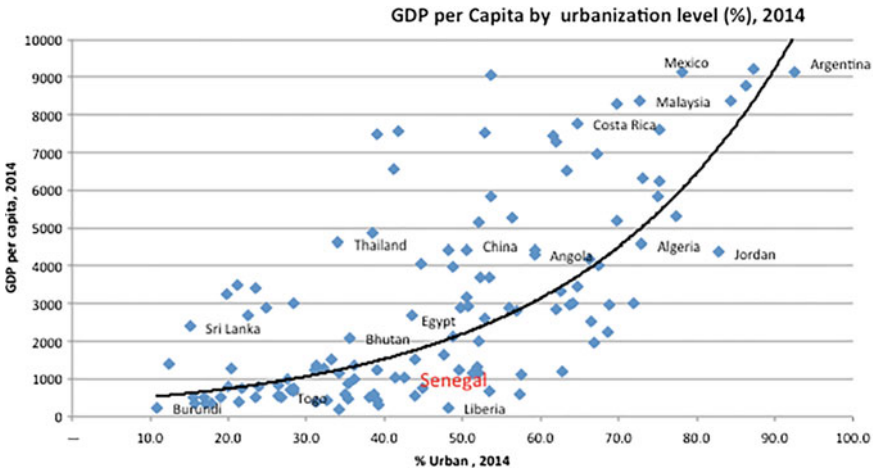

Fig. 15.25 GDP per capita by urbanization level (%), Country with GDP below US$10,000. *Source* % urban (UNDESA), GDP per Capita (World Bank)

Agglomeration diseconomies

With its permanent urban primacy status, Dakar has not been able to satisfy the employment demand, particularly from young people. The Dakar job market is, finally, predominantly informal. In addition to that, due to a deficient urban mobility, Dakar has not been able to create conditions for specialization. While urban agglomeration allows for job specialization, efficient market transactions and knowledge diffusion, if concentrated growth is not well planned—such as the integration of urban growth with efficient public transit investments, the resulting economic benefits tend to erode. Agglomeration diseconomies—i.e. the inefficiency and loss resulting from poorly planned concentrations—are expressed in the form of lost labour productivity from extreme traffic congestion, increasing air pollution and an overall decline in the quality of urban living [75]. This is the case in Dakar as in many African cities with poor connectivity leading to disconnected settlements.

Economic inequalities are also very high in the Dakar Metropolitan Region leaving municipalities with high unemployment and low access to basic services unable to afford many subsistence needs as illustrated in the Fig. 15.14. The Population of Dakar was classified according to their degree of poverty (Fig. 15.26), from to the highest living standard (blue colour) to the poorest living standard (red colour). Qualitative assessment of the Fig. 15.26 points out the fact that most of the population of Rufisque and Pikine have a very poor living standard (red colour). The orange colour that features category of families that have high living standard in Dakar, most of them are in the city core of Dakar along with families with the highest living standard. The department of Pikine, Guediawaye and Rufisque are predominantly populated with families with poor or moderate living standards.

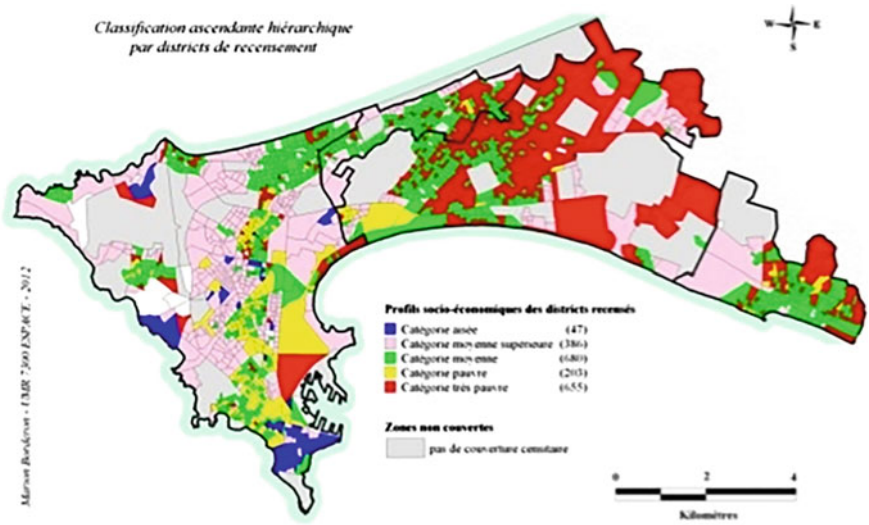

Fig. 15.26 Economic inequalities in Dakar metropolitan region. *Source* Republic of Senegal, 2014. Review of the Senegalese Urbanization

15.5.2 The Economics of Urban Land—the Hidden Assets

15.5.2.1 The State of Land Tenure

The smartness of Dakar Metropolitan Region has been long time hampered by weak institutions and laws holding back various factors of the smart city framework, making informality the norms in many sectors starting with the city foundation surrounded by informal settlements with irregular land tenure. Secure tenure goes beyond protection against eviction and includes economic and financial advantages. *Tapping in the Triangle of Economic Productivity—People, Land & Infrastructures* will create sustainable, inclusive prosperous and resilient cities. With functioning institutions and laws, land and housing assets can contribute to the planning, management and provision of services in settlements. However, in absence of functioning institutions and laws providing legal propriety rights, as observed in Dakar, most of these assets remain dead investments sheltering only people. To tap into the potential of high densities, the Dakar metropolitan must formalize its land system, which will be the driver of many other components of their foundation such as streets and public spaces, provision of basic infrastructures such as water, sanitation and energy, and waste management. It is urgent that national and local authorities recognize the wealth of their citizens and involve them in the planning, the building and the management of their city. No city can claim to be sustainable, inclusive, prosperous and resilient, when the wealth of its citizens is not fully taken into consideration in the economy. Dakar as most African Capital

cities are not, however, fully benefiting from its land assets due to the fact that most of its land is considered as irregularly acquired and lacks legal ownership document such as a title deed.

Possession of ownership or tenancy document is low in Dakar where, according the Demographic and Health Surveys conducted in 2005, only 54% had a proof of legal ownership: title deed, sale certificate, power bill or other documents [76]. When disaggregated, less than 15% of the household reported having a title deed, which is considered the most secure document. However, it is interesting to note that in the city of Dakar, despite the low proportion of households with ownership or tenancy document, a large proportion feel protected against eviction (77%). Measures to reduce the risk and stress associated with lack of documents and fear of eviction are based on recognizing and respecting a plurality of tenure systems, including intermediate forms of tenure arrangements and alternative forms of land administration and land records [77]. The legal institutional framework in a given country or city plays a key role on various elements of security of tenure such as acquisition or adjudication which is the process of final and authoritative determination of the existing rights and claims of people to land.

15.5.2.2 Economic and Social Costs of Settling in Unplanned, Informal Land Areas

Due to poor land administration and governance, there is no compliance with standards of occupancy of the space leading to a high building density and irregularity of the urban fabric. Wetlands in Dakar cover an area of 40 square km of which nearly 72% (29 km^2) are hosting human settlements [78]. From 1954 to 2003, 95% of these areas have been converted into habitation [79]. The population of Dakar has been constantly exposed to flooding during raining season. Apart from habitat degradation, floods cause considerable economic losses on the various activities performed by people across various income and social connections. The impacts of floods on people and communities are enormous ranging from economic, social and health issues to environmental aspects. Asset losses degrade the quality of life of households and reduce the housing value. By Affecting social development with inaccessibility to most services, the economic development is also severely affected with significant decline of productivity of the active population. In 2009, the Post-Disaster Needs Assessment (PDNA) estimated damage and losses to total 44.5 billion FCFA nationwide (US$89 million), of which 35.5 billion FCFA (US$71 million) was for damage and loss in the Dakar region alone, with the most significant damage being on housing (61%), Transport (11%) and health (10%) [80, 81]. In terms of losses, the trade sector suffered the most losses, with 23% (mostly informal trade), followed by housing (18%), urban community infrastructure (18%), energy (17%), and transport (16%) sectors. At the household levels, an estimated 30,000 houses were affected in the Dakar region, most of which are now uninhabitable and often abandoned [82], and nearly 360,000 people representing 44% of the population of Pikine were affected. The impact of flooding related

disasters remains a significant challenge to sustainable development of the city of Dakar [83]. Faced with recurring floods in most cities across the country and especially in the Dakar region, public authorities felt the urgent need to find a solution in 2009. In August 2010, the Government of Senegal decided to prepare an urban development project for rainwater management and climate change adaptation, known as PROGEP, aiming to reduce floods through an integrated and sustainable approach [84]. However, all these projects require financial supports that divert funds from other priorities and needs. For instance, the PROGEP is a five-year project (2013–2017) funded for USD 72, 9 million [85].

15.5.2.3 Provisional Estimates of Land Value of Dakar

Under its Disaster Risk Reduction (DRR) strategy as part of its Poverty Reduction Strategy (PRS) process (IMF 2007), land has been given a central place. The DRR team combined hazard and population maps, land price data, and land cover information to derive the exposure of different variables in different locations. It is estimated that the Dakar city area represents a total land value of $44 billion. This figure represents 8 times the city GDP. Considering the level of informality of 37%, we can assert that US$17.4 billion out of the US$44 billion of land value of Dakar is not convertible in the financial market to secure marketable financial transactions; it cannot also generate revenues for the development of infrastructures. In addition, due to poor urban planning and irregular land use, over $2 billion or 5% is exposed to high natural hazard potentials. In the absence of functioning land market where prices are regulated and documented, these figures must been considered as rough estimations of the exposure of economic assets to natural hazard such as flooding [86]. Information from the PROGEP corroborates the economic damages and losses associated to flooding in Dakar. At the household levels, an estimated 30,000 houses were affected in the Dakar region, most of which are now uninhabitable and often abandoned [82], and nearly 360,000 people representing 44% of the population of Pikine were affected. The impact of flooding related disasters remains a significant challenge to sustainable development of the city of Dakar [83]. These various estimates point out the importance of adequate planning and land use regulation to mitigate the city's economic vulnerability against risks such as flooding.

15.5.2.4 Financing Infrastructure Development and Economic Development Through Smart Land Tenure

At the economic and financial aspects, there are various social and economic advantages including access to the financial and economic market as illustrated by de Soto. De Soto argued that granting titles to the poor would liberate the plots they occupy and transform them into capital. This, in turn, could be used as collateral for loans to jumpstart their businesses, or improve their houses, among other gains that

increase their quality of life. At the community level, regularization of land tenure will help the municipality to legally collect various taxes that can be used to improve basic infrastructures such as connection to water, sewerage facilities, energy sources and waste management facilities. This would also allow people to fully participate in the development of their communities at the policy as well as the implementation level instead of seeing proprieties as dead investments serving only for shelter [87]. Though having a title dead does not necessary lead to secure a bank loan; it may not be sufficient in itself to animate the dead capital interred in land and property, particularly in countries where banks lend only to workers with high wages and a stable job, as it seems happen in some countries covered in de Soto study. However, families with title dead may be likely to invest either to improve the quality of their homes or to increase their size. It is also important to note that land tenure goes hand and hand with urban planning [88]. Without an accurate mapping, legal title dead cannot prevent land disputes as it often occurred in African cities.

While there is argument against the de Soto theory in poor settlements, in Dakar regularization of land tenure will work for many middle and upper income households that have not been able to use their property as collateral due to lack of legal ownership document. Another important group land regularization will benefit is the Senegalese from the diaspora who usually send money to their family and build houses in Senegal. Most of these houses are built in irregular settlements. Among the Senegalese of the diaspora, certain have a high desire to return home, but they have not save enough to do so, and they cannot use their houses as collateral and start a business in Senegal. No choice, even those they are here cannot get a title dead, what about those that just come to visit their family for a month or less. These are not the poor as described in the de Soto book, they have already the value of savings as underlined by the money they sent to their family in a monthly basis. The money received from the diaspora is estimated at $1.9 billion (FCFA 971.4) by the Senegalese Ministry of Finances, much higher than the foreign aid Senegal received during the same year. It represented 12.1% of the national GDP. The Ministry of Finances considered that the diaspora are the first donors of Senegal [89]. However, the money of the diaspora is not invested in the market, it is invested in residential houses and household subsistence. Without legal recognition, these houses cannot be transformed neither into capital nor transacted through the economies of scale and agglomeration that the city of Dakar potentially offers. It may take several years before regularization, particularly when it is bought informally.

Large infrastructure projects require huge investments. However, like any large structures, they depreciate very slowly over decades or even centuries [90]. The central government transfers on which Dakar often rely will not suffice to finance all infrastructures required to take advantage of the economies of scale and agglomeration that Dakar can offer its large population of more than 3 million inhabitants with high density of over 15,000 inhabitants per km^2. Therefore national and local authorities should explore various financing options for infrastructure development. The costs of developing housing, infrastructure, and industrial premises must be

coordinated with land markets and land use regulations in order to fully take advantage of the economies of scale and agglomeration of the city of Dakar. This calls for the formalization of the land tenure, which, in turn, will increase the land values that can be used to contribute to the development of basic infrastructures such connection to water, sanitation, drainage, solid waste management and streets. For instance, in Dakar due to lack of municipal finances most municipal street networks are not paved. Municipalities with formal land system have the large proportion of paved streets compared to others without formal land system [91].

Secure tenure goes beyond the legal character; it attracts investments as illustrated by the level of provision of infrastructure in municipalities considered as legal settlements comment to others considered as informal settlements. These municipalities also enjoy health centres and school facilities. They also attract the financial market because they have a legal urban plan with a sufficiently documented cadastre system. This shows the community character of land tenure that goes beyond the household and embrace infrastructure in the municipality itself. In most irregular settlements, there are few or no paved streets, and the few streets they have do not have light. Lack of documented urban plans affects the financial as well as the land market. It is noted that capacity and resource constraints are the main reason infrastructure in most municipalities have been lagging behind. In absence of formal land system, a settlement is trapped into poverty. With this, there is no doubt that wealth is associated to formal land system. Let make secure tenure work for people and communities. Dakar is expected to reach 5 million inhabitants in 2035. This will propel new demand for infrastructure such as water, sanitation, sewerage, waste management and streets among others. To meet this demand, land transactions must be eased with transparent efficient land law, administration and governance with documented land and property rights; documented guidance of land valuation and prices and; coordinated land use and urban planning. Land tenure goes hand and hand with urban planning. Urban planning supported by accurate demarcation of public and private uses are of importance [88]. Without an accurate mapping, legal title dead cannot prevent land disputes as it often occurred in African cities. In Dakar, it may take several years before regularization, particularly when it is bought informally. Formal land Registration will ease transactions and boost economies of scale and agglomeration.

Considering the weak financial revenues of the city Dakar, a land value of 44US $ must be seen as an opportunity to tap on it. It represents nearly 500 times the annual revenue of the metropolitan area estimated at US$94.8 million). Though there is a steady increase of the budget of Dakar from US$ 4 million to US$ 56 million, the city is still in the incapacity to satisfy the increased demand in most basic services such as water, sanitation, solid waste management, health and education. The budget of the city finances mainly operational against investment expenditures (59% against 41%) [92]. The budgets mainly include local taxes and levies (around 90%) for all the departments. Subsidies from central government remain minimal, less than 2%. But this situation is more due to the nature of taxes levied in each entity rather than to performance of local authorities [92].

15.6 Towards a Smart Metropolitan Regional Development

Most of the components of a Smart Metropolitan Regional Development (SMRD) are composed of several simple sub-components. Put them together to track progress on the overall objective of the SMRD will require the development of composite indices using sophisticated multi-level statistical analysis including Principal Component Analysis. The complexity of a composite index is the fact that it is strongly influenced by several factors including: the normalization, the standardization and the degree of association between variables and the number of variables that compose the index. An index can also be conceptualised differently using different variables. This calls for caution when interpreting a composite index. For instance the Quality of Life is conceptualised and measured in different ways across studies. The Human Development Index includes indicators of health and education, alongside an economic component (Gross Domestic Product or GDP); the Legatum Prosperity Index considers quality of life to be multidimensional, including both wealth and wellbeing; The Economist Intelligence Unit's Quality of Life Index links life satisfaction to health, family life and community life; and the OECD's Well-being Initiative has two dimensions: 'material living conditions' and 'quality of Life' [93].

In our study, a smart metropolitan regional development is viewed as a sustainable, inclusive and prosperous metropolitan regional development that promotes a people-centric approach based on three core components—Smart Metropolitan Region Foundation, Information and Communications Technology (ICT) and Smart Institutions and Laws, which are the pillars of the other dimensions of a smart metropolitan region: Infrastructure Development, Environmental Sustainability, Social Development, Social Inclusion, Disasters Exposure, Resilience, and Peace and Security. **Infrastructure Development** complements the basic infrastructure services under each smart metropolitan foundation and extends to actual investment and advancement of services such as transport, ICT, industrial energy, education, health, etc. **Environment Sustainability** is comprised of elements of energy, transport, building and pollution. **Social Inclusion** includes aspects of participation in decision-makings as well as equal opportunities for growth and prosperity. **Social Development** encompasses elements of education, health, public space, social inclusion and social capital. **Disaster Exposure** incorporates elements of mitigation and adaptation to various disasters such as flooding, droughts, storms and earthquakes. **City Resilience** is composed of elements of city foundation, environment, social capital, and social development. **Peace & security** included the elimination of all forms of discrimination and violence and conflicts, including domestic violence, violence in public places, crime, armed conflicts, terrorism, etc. An insecure metropolitan region limits opportunities for investment and economic growth and cannot be a smart metropolitan region.

The city of Dakar was included in the development of three indices published for the UN-Habitat and conceptualized and further developed by Mboup G. (2012,

2013 and 2014). Those indices include: the City Human Development Index, the City Prosperity Index and the urban form-based City Prosperity Index integrating the Composite Street Connectivity Index. This section will take it further for the development of the Smart Metropolitan Regional Development Index.

15.6.1 Urbanization and Human Development

The human development is made from element of economic development (GDP per capita) and elements of Social Development (Education and Health). All three elements are components of a smart metropolitan regional development.

In the last 20 years, considerable progress had been made in education as witnessed by the increase in the percentage of young people 15–19 years and 20–24 years old with at least a primary level of education. Estimated at 68% in 1993 and 72% in 1997, the percentage of women and men 15–19 years with at least a primary education is estimated at 90 and 95% in 2015 respectively (Fig. 15.27). These figures show that basic education is quasi universal in Dakar and makes the city of Dakar potentially smart. Education is, indeed, critical to meeting the challenges in the ICT era, as it also connects people to new approaches, solutions and technologies that require basic literacy.

It is important to note that similarly the literacy rate has increased from 59% in 1993 to 80% in 2014 among the young women of 15–19 years and 84% in 2005 to 86% in 2015. However, these literacy rates are 10 points lower than the proportion of people in the same age group with a primary education level, indicating that primary education does not necessary provide literacy capabilities. In Senegal, measures have been taken to improve learning quality with the introduction of pedagogical resources, especially textbooks for the core subjects of reading and mathematics with the provision one textbook to every student in a classroom; this has increased literacy scores by 5–20% [94]. By 2030, literacy will be universal in Dakar as access to education will also be universal. This will impact all sectors of the metropolitan region smartness in many levels in terms of attitudes and behaviour.

In addition to analysing the education level, we have also assessed the net primary school attended among children 6–11 years old in Dakar, which is the normal primary school age. Since 2004, the minimum age to enrol to public primary school is reduced to six years from seven years previously. The net primary school attendance rate calculated among children 6–11 years old used the series of Demographic and Health Surveys conducted in Dakar also show progress in school attendance for both boys and girls. Estimated at 60% in 2000, the net enrolment ratio at the primary education level increased to 78% for both boys and girls, and to 90% and 91% in 2015 for boys and girls respectively.

Analysis of series of DHS in Dakar shows that the percentage of young people with secondary education level has also increased during the last 20 years, from 37 to 62% for women aged 15–19 years old and from 57 to 71% for men aged 15–19 years old between 2000 and 2015; this is a notable change (Fig. 15.28).

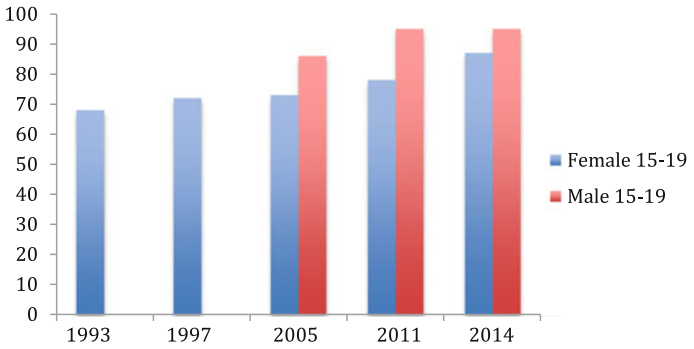

Fig. 15.27 Percentage of men and women aged 15–19 years old with at least a primary education level, Dakar

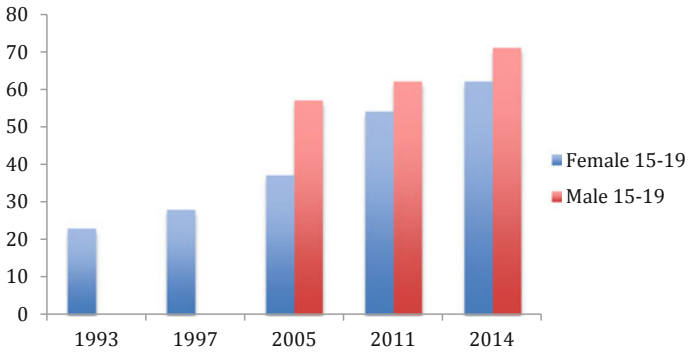

Fig. 15.28 Percentage of men and women aged 15–19 years old with at least a secondary education level, Dakar

The increase in secondary education in Dakar can be associated with two main aspects. First is the expansion of secondary education facilities in remote and poor areas taken by the government in the early 2000 allowing children to move from primary to secondary level within the same geographical area. Schooling in their neighbourhood has also mental and social advantages on children, giving them the opportunity to grow along with their parents. Second is the extension of free and compulsory education to include lower secondary, which has been possible due the political commitment of Senegal as in the MDGs and in the Dakar Framework. Senegal is, indeed, among the few African countries that devote more than 1% of GDP (1.4%) to higher education.

A healthy population is critical to realizing economic growth through increased productivity [95]. Healthy workers are more productive, bringing greater income to families and higher levels of economic growth for nations. The Demographic and Health Surveys (DHS) held in Senegal show a constant progress in access to health services in Dakar during the past 25 years. In the 1990s, access to health services was very limited and infant and child mortality rates were consequently high. With a steady improvement in health coverage, enhanced with the Millennium Development Goals (MDGs) with its Goal 4, 5 and 6, the improvement was accelerated during the 15 years of the MDGs. There is no doubt that improvement in health is significantly contributing to the Dakar smartness. Children born in Dakar have more access to health services such as antenatal (by their mothers), delivery cares and immunization than those born in other cities, town and villages of Senegal. In Dakar, access to antenatal cares is almost universal and 90% of delivery occurs in health centres compared to less than 50% in other places of Senegal (49% at national level). Over 10% of delivery in Dakar is assisted by physicians or other health care specialists compared to only 1% at the national level. Most of children in Dakar have also received all required vaccines such as BCG, polio, measles and DTP. When we consider all four types of vaccinations, the percentage children with all vaccinations is 59% compared to 42% at the national level. In Dakar coverage of child immunization is high both in non-slum and slum areas, a situation that shows that living in Dakar provide remarkably the opportunities of access to better health care. Thus, access to health care services in Dakar regardless of the economic status of families, is much better than elsewhere in Senegal.

Significant decline of infant and child mortality rates make living in Dakar smart In the context where access to health services has significantly improved, mortality has also significantly decreased, particularly among children under five years old. Infant and child mortality rates have been more than halved during the past 15 years. In particular, infant mortality has significantly decreased from 59 per 1000 in 2000 to 28 per 1000 in 2015, the child mortality from 35 per 1000 to 13 per 1000 during the same period. The under-five mortality rate, on the other hand, has decreased from 87 per 1000 to 41 per 1000. The decline of mortality rates has also been observed in other parts of Senegal, but to a lesser extent, making the figures of Dakar much better than the national figures. In 2014, the under-five mortality rate, estimated at 41 per 1000 is more than two times lower than the the rates estimated for five regions in Senegal (Diourbel, Sedhiou, Tambacounda, Kedougou and Kolda) (Fig. 15.29). Life expectancy in Dakar is estimated at 69.6 years with an advantage of 2.5 years for female compared to male, 70.9 years and 68.4 years respectively. Overall, people living in Dakar live five years longer than those of others regions; the national life expectancy is estimated at 64.8 years. It is important to note that Senegal has experienced a remarkable improvement on health with the life expectancy of 10 years higher than the level 15 years ago. In 2000, the life expectancy was estimated at 56 years.

Significant progress has also been made in the fight against malaria, which had been the first cause of deaths in Senegal. In the past fifteen years, there has been a

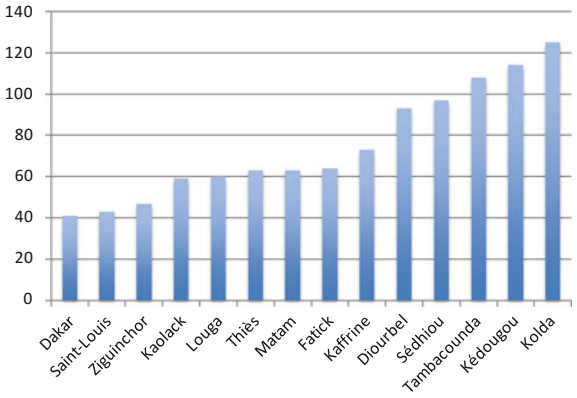

Fig. 15.29 Under-five mortality rates (per 1000) by region. *Source* ANSD, Senegaesel Demographic and Health Survey, 2014

significant decrease in malaria-related deaths from 40% in 2000 to less than 5% in 2015 contributing to the remarkable decline of mortality as observed in the same period. The prevalence of fever, among the symptoms of malaria, has also drastically decreased, estimated at over 40% to less than 20% in 2015 during the same period as indicated by Demographic and Health Surveys in Dakar. A hemoglobin level less than 8.0 g/dl is an indication of severe anaemia. In Dakar, that level is estimated at 3.2%. In Senegal, the National Programme to fight against Malaria (NMCP) has included in its strategic planning the promotion of the use of Insecticide Treated Nets (ITNs) as a major axis of intervention for reducing morbidity and mortality due to malaria. To achieve this objective, the NMCP and its partners have implemented procurement and distribution activities "Impregnated mosquito nets Insecticide to Long Term Action". This distribution is performed during routine activities through health facilities and community-based organizations. Since 2003, with the spread of chloroquine resistance, Senegal adopted sulfadoxine—pyrimethamine combination plus amodiaquine for the treatment of uncomplicated malaria. Then in 2006 according to WHO recommendations for the management of confirmed cases of uncomplicated malaria, Senegal adopted a Therapeutic Artemisinin-based combination.

Dakar is still engine of Senegal Economy as illustrated in Fig. 15.30 with the Dakar HDI much higher than national HDI; it has better economy outcomes as well as better health and education status. It occupies a pivotal place in the trade sector both nationally and internationally. Important progress has been made on education, which is critical to meeting the challenges of smart metropolitan regional development, as it connects people to new approaches, solutions and technologies that enable them to identify, clarify and tackle local and global problems. Similarly, important progress has been made on health, which is critical to realizing economic growth through increased productivity. Healthy workers are more productive, bringing greater income to families and higher levels of economic growth for nations, and then enhance smart economy.

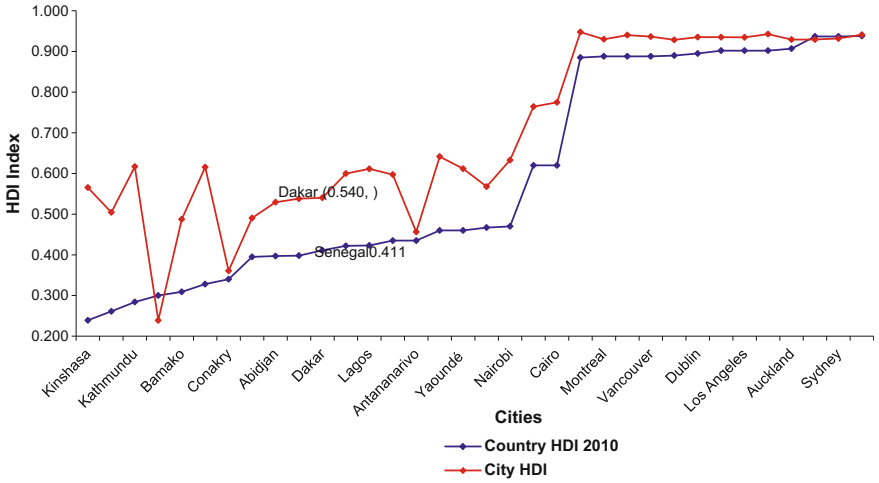

Fig. 15.30 City Human Development Index (HDI) and Country HDI, 2014. *Source* Mboup, G., 2016. Smart Social Development Key for Smart Economy. In Vinod K. et al., 2016. Smart Economy in Smart Cities, Springer

However, these advantages may also be linked to political choices that concentrate various economic infrastructures in Dakar such as: ports, international airports, the international trade and commercial centres, etc. They have also concentration of civil servants, private sectors such as banking and industrial enterprises. All this allows Dakar to contribute more than half of the national economies. However, Dakar has not been able to pay back and boost the rural economies and other Senegalese cities. Now the question is how to turn the linkages between urban and rural in the way that rural can reap the benefit of urban economies of scale and agglomeration of Dakar. This is where, ICT as a connector may play a crucial role in the inter-cooperation between rural and urban making circulation of goods and services cheaper and faster.

Though cities like Dakar are engine of economy growth, they need to be driven smoothly in an efficient administrative and governance environment. Thinking that having a large city and a high density is sufficient to produce economies and scale and agglomeration, is a simplistic view because there are many other factors that need to be present for urbanization to produce wealth and prosperity in general. In Dakar like in many African cities those ingredients are lacking leading to various negative externalities. Finally instead of enhancing economies of scale and agglomerations, Dakar as many African cities encourage diseconomies. Youth non-employment is high, and young people from impoverished urban areas can only find jobs in the informal sector with no social security coverage, paid parental leave, retirement, and unemployment benefits. The high rate of non-employment of young people in Dakar is a reason for concern; the lack of decent, sustainable jobs promotes a sense of displacement in the general youth population and often leads to crime, under-development, and a cycle of poverty. Frustrations accompanying

long-term unemployment among groups of urban young men may feed political and ideological unrest and provoke violence.

15.6.2 Urbanization and Environmental Sustainability

Proliferation of informal sectors has led to the anarchic development of economic activities, industries and residential settlements. Growing industries located in or near the city, are key resource users as well as sources of pollution, waste, and greenhouse gases emissions. In addition to the fact that most unplanned settlements are located in flood prone areas, and wastes are poorly managed, climate change makes the situation worse [96]. Climate change contributes to sea level rise as recently noted in several coastal cities such as Dakar. Rise of the sea level accelerates coastal erosion and causes the loss of farming and habitable land. In Dakar, every year, the sea level rises by 4 mm causing a loss of 1 m of coastal land and an increase in flood vulnerability [97]. GHG emissions in the region of Dakar is also of concern with an annual estimate of 15,786,000 tons of CO_2, and 5.03 tons per capita. The main sources of GHG are industrial energy (30%), transportation (16%) and household (15%), and processing industries (12%) [98]. Indoor air pollution is a quiet and neglected killer, with lack of global awareness being one of the primary obstacles to the widespread implementation of existing, proven interventions [99]. Women usually have the added responsibility of caring for children who are then also exposed to high levels of indoor air pollution on a daily basis [100] (Fig. 15.31).

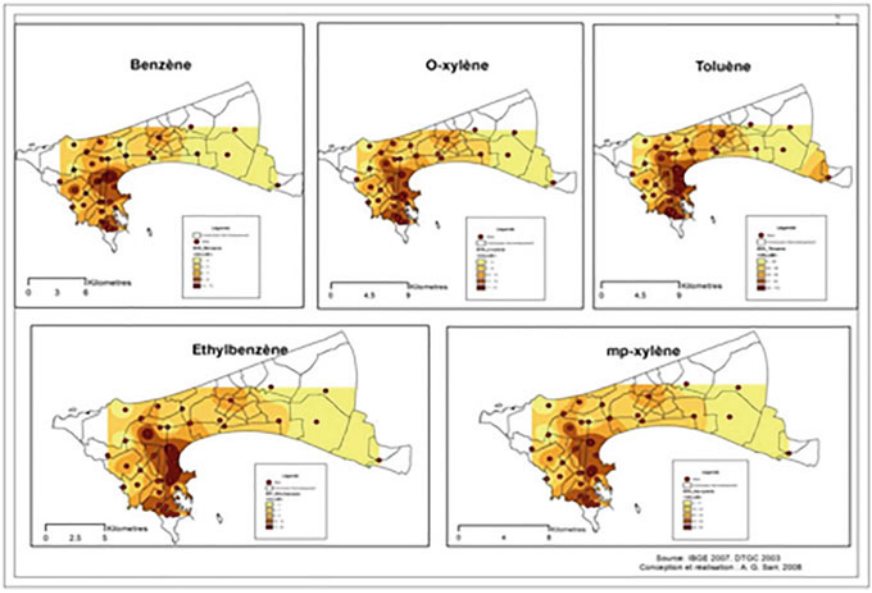

Fig. 15.31 Dispersion of pollutants in Dakar in June 2007. *Source* Gaye et al., 2009

The government of Senegal has developed an Integrated Urban Storm water Management and Climate Change Adaptation Program for peri-urban Dakar that aims at developing a national strategy on integrated urban storm water management and climate change adaptation based on the full set of investment plans and technical studies emerging from the Drainage Master Plan as well as from the Sanitation Master plan and diagnostic studies and consultations in selected cities. In addition to that, the three years Senegal's Sustainable Cities Initiative Project initiated in 2017 aims to integrate climate risks in urban planning, design and management [101].

15.6.3 Urbanization and City Prosperity

The City Prosperity Index (CPI) published by UN-Habitat in 2012 under the coordination of Mboup G includes various indices and indicators that are relevant to urban areas, and important for prosperity-oriented public policy-making. The first version of CPI published in 2012 was based on five dimensions: Productivity, Quality of Life, Infrastructure Development, Environmental Sustainability, and Equity and Social Inclusion [102]. In 2013, the CPI was revised to include the urban form dimension measured by street connectivity [103].

Dakar was classified among the Cities with weak sustainability, inclusion, resilience and prosperity index (with an index between 0.500 and 0.599). In this group, much remains to be done in terms of quality of life, infrastructure and environment. Production of goods and services is still too low, a reflection of underdevelopment. The Economic Development of Dakar is estimated at 0.347. Historic structural problems, chronic inequality of opportunities, widespread poverty, inadequate capital investment in public goods, and lack of pro-poor social programmes are critical factors behind such low degrees of prosperity. The city product of African cities in this bracket is low, as are the ratings for quality of life and infrastructure. Most of these cities perform better on the environment indicator [low emissions of fine particles (PM10)] (Fig. 15.32).

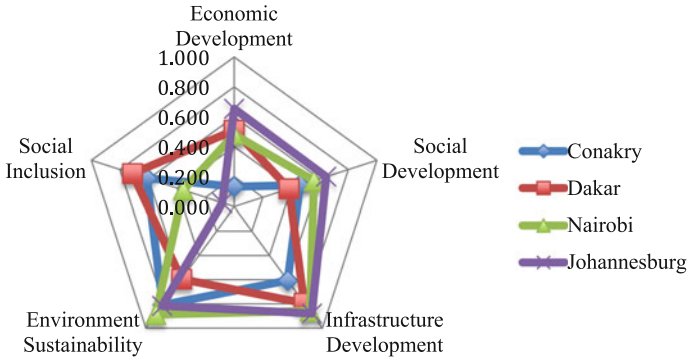

Fig. 15.32 Towards prosperity

15.6.4 Towards a Smart Metropolitan Regional Development

Among the components of the Smart Metropolitan regional Development, five have been part of the City Prosperity Index (CPI): Productivity, Infrastructure development, Environmental Sustainability, Quality of Life and Social Inclusion. The SMRD index introduces other components relevant for sustainable urban development: Disaster Risk Reduction and Resilience, Peace and Security, Institutions and Laws; It also expands productivity to Economic Development, Quality of Life to Social Development, and make the distinction between Infrastructure Development and Basic Infrastructure. It also introduced the concept of city foundation built upon three dimensions: urban planning, land policies and basic infrastructure. It also introduces ICT at the centre of the SMRD along with the City Foundation and Institutions and Law. Considering that the CFI and the CPI was already measured in previous sections, the measurement of the SMRD is incremental and built upon those indices with the inclusion of Peace & Security as well as Disaster Risk Reduction and Resilience (Fig. 15.33).

In addition to the urban challenges analysed in previous sections, the population of Dakar metropolitan region has been constantly exposed to disasters, particularly to flooding during raining seasons. Apart from habitat degradation, floods have caused considerable economic, social and environmental losses in Dakar. In 2009, the Post-Disaster Needs Assessment (PDNA) estimated damage and losses to total US$89 million nationwide, of which US$71 million was for damage and losses in the Dakar region alone, with the most significant damage being on housing (61%), transport (11%) and health (10%)[1]. Contrary, Senegal was classified among the

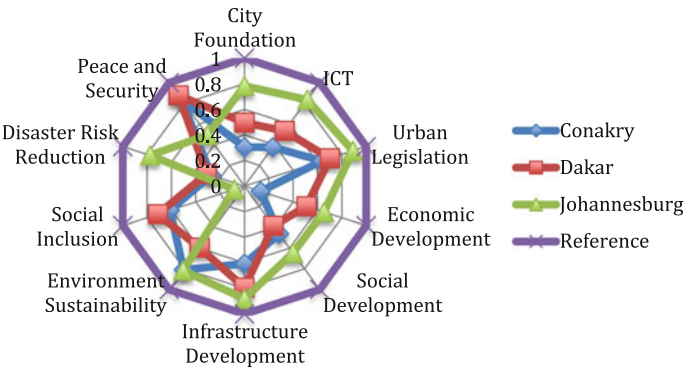

Fig. 15.33 Smart Metropolitan Regional Development Index (SMRDI). *Source* Provisional results from Mboup G. (ed.), 2018 Forthcoming Publication "Smart Economy in Smart African Cities", Springer

[1]Republic Senegal, 2010: 44-53, quoted by IAGU, 2011.

highly peaceful countries based on the Global Peace Index (GPI) ranking in 2015. The GPI scores are the aggregates of 23 qualitative and quantitative indicators across three thematic domains: the level of Societal Safety and Security; the extent of Ongoing Domestic and International Conflict; and the degree of Militarisation. Out of 163 countries, Senegal was ranked at the same level as the United Arab Emirates with a score of 1.805 compared to the lowest score, which is estimated at 1.148 for Iceland and the highest score, which is estimated at 3.645 for Syria. In Africa, only four countries—Senegal, Mauritius, Botswana and Namibia—are among the top 50 peaceful countries globally. For Guinea and South Africa, the GPI score is estimated at 2.214 and 2.376 respectively[2]. However, a high score in the GPI is not sufficient to boost the smartness of the Dakar metropolitan region, which has been suffering from multiple social, economic and environmental deprivations. With a weak City Foundation, a low Human Development Index as well as a weak City Prosperity Index, It is obvious that the Dakar Smart Metropolitan Region Index will also be weak as it is strongly determined by the three indices. Though this a preliminary assessment of the SMRDI since data are not able for some sub-indices, rapid assessment of available data point to the fact Dakar SMRDI is low due do to historic structural failure on urban development, chronic inequality of opportunities, widespread poverty, inadequate capital investment in public goods, etc.

15.7 Spatial and Economic Design Strategies for a Smart Dakar Metropolitan Regional Development

Recognizing the unbalanced Dakar metropolitan regional development, in one hand, and the multiple problems associated to lack of basic services, on another hand the Senegalese government has taken bold actions to transform the urban landscape of the metropolitan region from a monocentric to a polycentric metropolitan region with the creation of urban centres to decongest the Dakar urban agglomeration. This new spatial re-organization is also accompanied with economic transformation through the ambitious economic development, the Plan Senegal Emergent. This is through key main complementary programmes, reforms and plans: (1) the Plan Senegal Emergent; (2) Act III of Decentralization; (3) Metropolitan Planning; (4) Dakar Urban Master Plan 2035 and; (5) Digital Senegal Strategy 2016–2025. These urban policies and programmes aim to spatially and economically transform the Dakar Metropolitan Region to be smart,

[2]https://reliefweb.int/sites/reliefweb.int/files/resources/Global%20Peace%20Index%20Results%20Map_0.pdf. Download: 8 March 2018.

sustainable, inclusive, resilient and prosperous. They aim to transform the monocentric system to a polycentric system where every urban centre equally contributes to the development of the metropolitan region.

This section is a prospective analysis of different ways economic and spatial transformations from these different programmes, reforms and plans will contribute to the smartness of the Dakar Metropolitan Regional Development. Most national and urban policies and programmes aim to spatially and economically transform the Dakar Metropolitan Region to be smart, sustainable, inclusive, resilient and prosperous. First we will analyse different spatial design strategies in the ACT III of Decentralization, the PSE, the National Territorial Plan, Master Plans, and other plans. Second we will analyse the economic transformation expected in these programmes, reforms and plans.

15.7.1 Decentralization of the Dakar Metropolitan Region

Under the Act III of Decentralization adopted in December 2013, each department of the Dakar Metropolitan Region has been sub-divided into municipalities. Overall, the metropolitan region counts 49 municipalities. Each municipality is headed by a mayor, who is responsible to, among other things, preserve, maintain and administer the properties and assets of the municipality, coordinate municipal waste management and hygiene, protection and conservation of historic sites and monuments, promotion of national and local cultures, preparation and implementation of various kinds of plans (including master plans and detailed urban plans), and management of health and education programmes. The Act further gives guidelines on municipal finance, which is key in the implementation of urban programmes. This is a clear demarcation of the original urban development management where administrative and financial management of municipalities was performed at the central level; it opens the road to polycentric specialized urban centres.

15.7.2 Plan Senegal Emergent (PSE): Holistic Approach of Economic Development

The PSE was conceived based on the Social and Economic Development National Strategy for the period 2013–2017 with the objective of: (a) 7% of economic growth by 2018 compared to a level of 4.6% in 2013; (b) Emerging Country Status by 2035. The Plan Senegal Emergent (PSE) provides further guidance on the Dakar Metropolitan Regional Development, strategically based on three axes: (1) structural economic growth and transformation; (2) human capital, social protection and sustainable development; and (3) governance, institutions, peace and security.

At the sectorial level, the PSE is glued around six main sectors: energy, infrastructure, business environment, telecommunication, human capital and finance. Flagship projects under the PSE include developing Dakar as a regional logistics hub for the production and distribution of industrial products and services in West Africa; development of multi-services and touristic hubs; development of Dakar as a referential regional campus with five world-class international schools; creation of business parks hosting international companies and institutions; and making Dakar an international medical city. The plan anticipates that these flagship projects will result in strong convergences and synergies within the region and improve the attractiveness and competitiveness of Dakar, and Senegal at large. Making Dakar a regional hub is similar to the thesis of global cities as discussed by Saskia Sassan since the 1990s. Four functions characterise metropolitan regions in the context of globalization: (1) innovation and competition; (2) decision-making and control; (3) gateway; and (4) symbol or branding [104] (Fig. 15.34).

15.7.3 Spatial Design Strategies for a Smart Dakar Metropolitan Regional

Along the transformation of the Dakar metropolitan regional development, national authorities have put in places planning guidelines through the Urban Master Plan of Dakar (Plan Directeur d'Urbanisme—PDU) 2035 and National Plan for Territorial Development "PNAT". The PDU 2035 aims at urban development of the region of Dakar and its surroundings by 2035. Its main objectives are: Sustainable Urban Development; Compact cities connected with a transport network; Robust and Resilient city and; Vibrant city with active interaction between information, goods

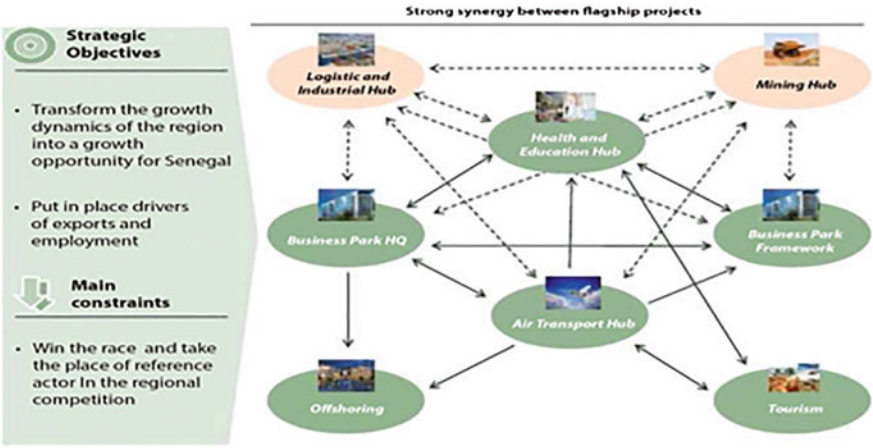

Fig. 15.34 PSE Flagships Projects. *Source* Republic of Senegal, Plan Senegal Emergent, 2014

and people. The PNAT proposes five development urban areas: Multifunctional urban areas; Areas for economic activities; Areas for agriculture activities; Areas for touristic activities; and Areas for conservation. The PNAT also identifies areas with high risk for habitation and any other activity. In these areas, modification of the land including by residential structure, or any cadastral operations is prohibited. This plan promotes green areas and other protected areas for environmental purposes or spaces with light recreational facilities, which, when well integrated enhance the character or the ecological value of the area. Specific focus areas of the PNAT also aim at: controlling the internal urban growth; reducing the proliferation of slums; promoting a balanced urban development; and meeting the housing demand.

The Department of Urbanism and Architecture (DUA) provides tools, instruments and guidelines on how to design, plan and manage cities. They have also introduced a Master Plan of Dakar in 2000 (Plan Directeur d'Urbanisme (PDU) 2025), another Master Plan of Dakar in 2014 (Plan Urbain de Dakar 2035) in 2014. The PDU is a reference document that aims to plan and program the development of an agglomeration in short and medium terms (10–20 years), taking into account the global objectives of the regional development. It specifies the socio-economic and demographic perspectives of the region and the agglomeration and determines the means and strategies to be implemented in order to reach a harmonious and sustainable development. From 1946 to 2015, there have been several urban Master Plans developed in 1946, 1961, 1967, 2000 and 2014 (revision of the PDU 2025).

However, technical and regulatory instruments, which could ease the implementation of master plans at the local level are complex and require enormous steps and times for their approval. Initiated in 2000, the PDU 2025 was approved only nine years later. The Master Plan Dakar 2025 has been ineffective in particular because of insufficient consideration of local realities, of the lack of involvement of local communities and populations in its preparation and its inability to properly treat disaster risk such as flooding. The Urban Mobility Plan in the PDU 2025 has been developed to address the critical problems of mobility in the Dakar Metropolitan Area and to reorganize the transport by promoting public transportation in Dakar, but it has not been taken into account in the construction of the major roadwork components in Dakar, which are implemented and managed by other specialized agencies. This shows a lack of coordination between the central government which is in charge in preparing and approving master plans, and the local authorities and other agencies which have the responsibilities to implement these plans at the local level.

Learning from the PDU 2025, **The Urban Master Plan of Dakar (Plan Directeur d'Urbanisme) 2035** is in this context the revision of the **Urban Master Plan of Dakar 2025**, it was initiated by the Ministry of Urban Renewal, Housing and Living Environment with support from the Japan International Cooperation Agency (JICA) in 2014. The PDU 2035 aims at urban development of the region of Dakar and its surroundings by 2035 [68]. Its main objectives are: Sustainable Urban Development; Compact cities connected with a transport network; Robust and

Resilient city and; Vibrant city with active interaction between information, goods and people.

There are other sectorial plans, which have been also hardly implemented. The Master Plan for Urban Planning and Preservation of the Niayes and the Green Zones of Dakar (PDAS) has not played its role yet, in terms of overall urban planning. The PDAS is a specific plan for the Niayes (depressions zones) and Green Zones at the level of the Dakar Metropolitan Area, and has been validated since 2004. The Regional Land-Use Planning framework (SRAT) provides comprehensive guidelines, which are not compulsorily taken into account in the field. In fact, the SRAT is validated but the implementation does not really respect the prescriptions included in it. Finally, the actions planned in the Regional Integrated Development Plan (PRDI) finalized since 2004 are not implemented yet.

15.7.4 Creation of Digitally, Economically and Socially Served Urban Centres: From Monocentric to Polycentric Dakar Metropolitan Regional Development

While developing urban policies and projects to tackle flooding and traffic congestion in the agglomeration of Dakar, national authorities have taken bold urban policies with the creation of six polycentric urban centres in the outskirts. The creation of these urban centres will decongest Dakar and will mark the transition of big cities to digitally connected towns (of less than 1 million people). Fighting the problem of the big city from outside with the formation of small cities. This represents a new form of urbanization, the digital urbanization where digitally connected towns offer urban advantages traditionally only found in big cities with high densities, such as economies of scale, agglomeration of economies, diffusion of ideas, innovation, and participation to political affairs.

In order to decongest Dakar, three categories of urban centres are being planned to take place in the Department of Rufisque, situated in the East of the Metropolitan Region:

- *Urban centres of the* "*Massif*" structured around national sport centres and an international exposition centre;
- *Coastal urban centres* structured around coastal touristic areas and;
- *Eco urban centres at the* "*Lac Rose*" characterized by the presence of microorganisms and mineral elements.

The creation of these urban centres is a combination of economic and spatial design strategies. As underscored in Chap. 1 of this book "Designing economic and spatial strategies for Smart Metropolitan Regional Development shall be conducted by the spatially identifiable economic community at micro levels from time to time to suit the ever-changing scenarios of the economic environment. However

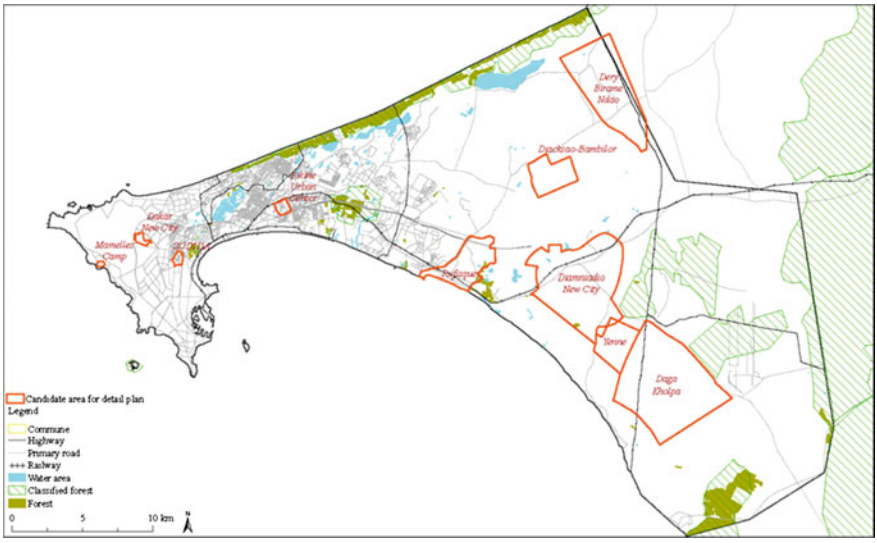

Fig. 15.35 Map of Dakar Metropolitan Region with the creation of the six urban centres. *Source* Mboup G., 2016. In Smart Economy in Smart Cities (ed. V. Kumar et al.), Springer

economic strategies may have a shorter lifespan than spatial strategies but both should fit in. Spatial strategies should be based on economic strategies each complementing the other. When this micro level communities cumulates to have a mega-community, they can make use of the vehicle of economic E-Democracy to formulate ever changing and dynamic strategies" [105].

Overall six urban centres are planned to take place in the first phase of the programme. These urban centres are created to support economies of scale and agglomeration. Among these urban centres, features the Urban Pole of Diamniadio, which is already under implementation as part of the Plan Senegal Emergent (PSE), representing the first sustainable city model with the integration of climate risk resilience. For instance, the Special Economic Zone of Diamniadio will constitute a multifunctional platform for most of the income-generating activities (industry, crafts, clothing, equipment, infrastructure, etc.). It is part of the national policy to encourage companies to relocate and diversify their activities outside the department of Dakar and attract new investors, notably with: the creation of manufacturing units with high added values; Assembly and processing industries; Construction of several logistics platforms (transit, storage) to streamline internal and regional transport flows; Creation of two zones dedicated to export services, integrated and connected (Fig. 15.35).

It is in the ICT revolution momentum that the government of Senegal has initiated the creation of urban centres in the outskirts of Dakar in order to decongest the city [106]. The government is, indeed, putting in place an ambitious project of a technology park in Urban Pole of Diamniadio, called "Diamniadio Technology Park". The park is based on the **Silicon Valley model and intends to promote**

data revolution and higher education centres. The Urban Pole of Diamniadio is also among the pilot cities of the National Sustainable Cities Initiative (SCI) as part of the Sustainable Cities Programme launched by the Global Environmental Facility (GEF) in 2016. It consists of "Planning and Managing the urban pole to decongest Dakar and to be a sustainable city model connected to Dakar and the rest of the country through walking, non-motorized, ICT means".

In the Urban Pole of Diamniadio, it is also planned to create an integrated campus of reference by 2018 with the creation of at least five world class professional schools; Business Park by 2017; Establishment of "Dakar Medical City"; Integrated tourist areas; Regional airline hub (medical, tourism, regional headquarters of companies and international institutions, education-training). The urban pole of Diamniadio is in a crossroads that connects Dakar to the rest of Senegal thanks to the RN1, the RN2, the Niayes road and the Diamniadio-AIBD highway. In addition the Diamniadio pole enjoys an opening on the sea through Bargny. The Diamniadio Special Economic Zone will be a multifunctional platform for most of the income-generating activities (industry, crafts, clothing, equipment, infrastructure, etc.). It is part of the desire of the government to encourage companies to relocate and diversify their activities outside the capital and attract new investors, in particular with: the creation of a high added value manufacturing centre; assembly and processing industries; rehabilitation of the Dakar-Bamako railway line to boost the corridor; construction of several logistics platforms (transit, storage) to streamline internal and regional transport flows; creation of two (02) zones dedicated to export services, ready to use, integrated, connected; Dakar an integrated reference campus by 2018 with the creation of at least five internationally renowned schools; Business Park by 2017 and to host by 2018, 50 seats and 2000 to 3000 high-income households receiving services (luxury housing, social services, cultural and leisure activities); implantation of "Dakar Medical City"; integrated tourist areas; regional air hub (medical, tourism, regional headquarters of companies and international institutions, education-training); AIBD's capacity to reach 6 million passengers by 2020 and 10 million by 2035.

The creation of the Diamniadio Urban Pole and other urban centres is a paradigm shift to decongest the Dakar urban agglomeration. In order to do not repeat the errors observed in the Dakar agglomeration, where Pikine and Guédiawaye are suburbs of Dakar, the Diamniadio Urban Pole is created to be a place of production, distribution and consumption of goods and services, for its population and for the rest of the country. From the perspective of urban planning, the Diamniadio urban pole is designed to promote: (1) an adequate percentage of space allocated to streets for all modes of transport; (2) efficiently designed streets that allow traffic without congestion; (3) road design that allows for shorter trip configurations with multiple choices; and (4) Mixed land use models that allow shorter travel distances.

In addition to the creation of urban pole to de-densification of Dakar city core, the Senegalese is also taking other actions outside the Dakar metropolitan region to reduce the demographic and economic power of the Dakar agglomeration. The Senegal government is also introducing the development of urban poles in the rest of the country as illustrated in Fig. 15.36.

Fig. 15.36 Spatial distribution of urban poles in Senegal. *Source* Republic of Senegal, 2014. Review of Senegalese Urbanization

15.7.5 Emerging Trends: Linking the Dakar Metropolitan Region to Other Regions—The Corridor Dakar-Thies-Mbour and Beyond

Another urban development is the emergence of urban corridors, which represent a type of spatial organization with specific economic and transportation objectives. In Senegal, the government is also encouraging growth, convergence and spatial spread of geographically linked metropolitan areas and other agglomerations. These are emerging trends linking Dakar-Thies-Mbour, turning into spatial units that are territorially and functionally bound by economic, political, socio-cultural, and ecological systems. It is expected that the Dakar master plan include Thies and Mbour. Linking Senegal to Mali, Mauritania, Cape Verde, Guinea, and Guinea Bissau and beyond. This is inline with Africa intra-regional cooperation as outlined in Africa Agenda 2063. However, More holistic approach of corridor policies is needed to include economic development of areas in the corridor zone of influence and support continental cooperation (Fig. 15.37).

However, all these forms of urban growth require planning and management of the space, and efficient mobility means. Though their economic output may be enormous, their management requires considerable investment on infrastructure,

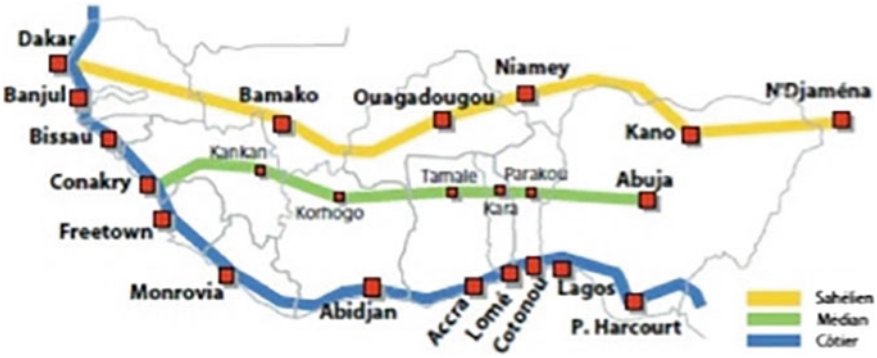

Fig. 15.37 Inter-regional urban corridors. *Source* Republic of Senegal, 2014. Review of Senegalese Urbanization

particularly to ease mobility and communication in order to constitute a large economic output, combining large markets, skilled labour and innovation [107].

15.7.6 Connecting Economically and Spatially Distinct Urban Centres in the Dakar Metropolitan Region

The Dakar metropolitan regional development with a population of more than 3 million comes with its constraints or requirements in terms of infrastructures such as road networks and transportation systems which are key for linking services such as workplaces, health centres, schools, markets, etc. Efficient mobility is required to allow localities of the metropolitan region to specialize in the production of goods and services for which they have comparative advantages and ease inter-localities cooperation. This will allow large-scale production of goods and services that can be distributed within the metropolitan region and beyond with time, cost and reliability opportunities.

The government of Senegal has quickly realized that development of the Dakar metropolitan region will be achieved only through the development of efficient mobility means. In the PSE, it is indeed, planned: the construction of road infrastructures (1170 km of paved roads, at least 4000 km of rural roads, 7 bridges, and modernization of bus stations); the construction of maritime infrastructures (restoration of inland ports of new infrastructures and port platforms); the construction of railway infrastructures (rehabilitation of 573 km of railway line, construction of a new standard gauge line) and airport facilities (rehabilitation of regional aerodromes), a tramway is also under development. The newly created international airport, located in the Urban Pole of Diamniado, is expected to have a capacity of 6 million passengers by 2020 and 10 million by 2035 (Fig. 15.38).

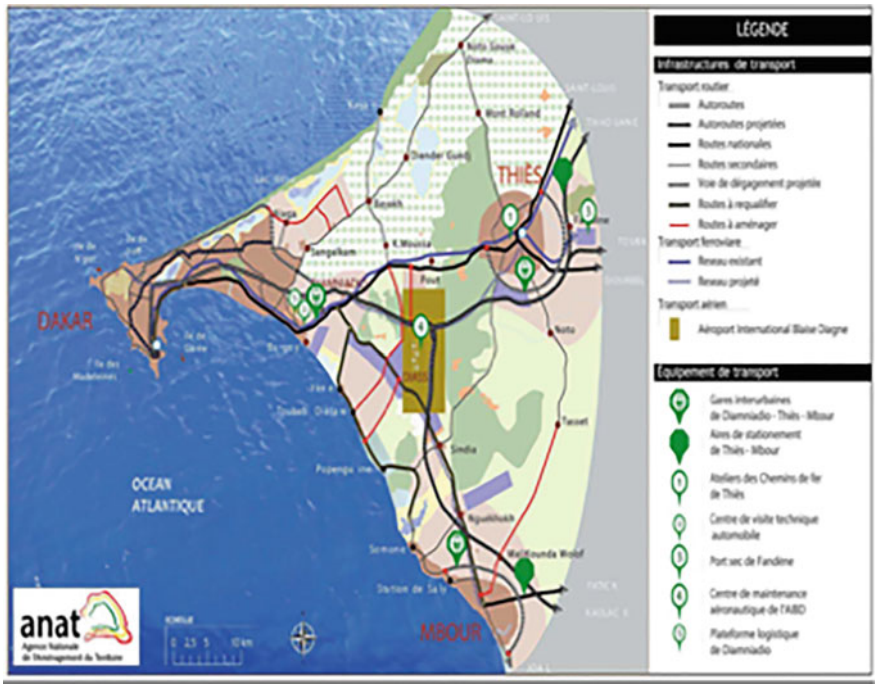

Fig. 15.38 Planning and management of transport Infrastructures in the Dakar metropolitan region (road, ail, air and Water). *Source* Republic of Senegal, 2014. Plan National d'Amenagement du Territoire

In addition to development of transport infrastructures, it is important that these newly urban centres be planed to be dense, compact, mixed land with sufficient connected streets and public spaces.

Mixed land use and polycentric urban centres for efficient urban mobility is central to the creation of the urban centres

At the beginning of the city development, services and residences are kept together as all start-up of settlements of small size; the question is to make a city planning where the population growth will be coordinated with services geographically balanced, avoiding the start-up to become the city centre of the future city, and the expansion being the periphery. There is nothing new of having people and services together, the challenges are how to keep them growing in a coordinated manner where the mixed land use is preserved [75]. It is noted that along urbanization, the city centre and the periphery become distant, and if urban growth is not well coordinated, this will end up with the formation of residential areas without services distinct from the city centre without residences as the current situation in Dakar metropolitan region. When planning city growth, it is important to integrate the mixed land use approach that has proven efficient with high economic, social and environmental returns. Mixed land use settlements have various social and

economic benefits by improving accessibility to services and urban amenities for a broader segment of the population, and increasing housing options for diverse household groups. In the process of the growth of the Dakar metropolitan approach, it is important to consider the enforcement of urban planning and particularly for transport infrastructures (land in reserve and to keep inbuilt for future transport infrastructure) [108]. By combining spatial planning and transport policies, local governments would reduce people's need to travel; improve travel conditions with affordable and efficient public transport options; and manage supply and demand traffic to curb congestion, which is a major barrier to productivity and a headache for residents.

15.7.7 Modelling Multiple Connectivity Choices: Example of the Diamniadio Urban Pole

Today, the opportunities for ICT to support the overall transport challenges and opportunities are enormous. Newly cheap ICT can unlock possibilities for greater transport efficiency. Cities may be able to use real-time data to design and implement policies that increase transit accessibility, decrease travel time, substitute for expensive road construction, and reduce congestion and pollution. The ICT revolution with the rapid development and use of Internet, digital mobile communication, and "big data" analysis enable to develop less costly and more powerful "intelligent transport systems" (ITS) [109]. Big data with its wealth of information from various sources as smart phones, GPS and sensors offer unique opportunities for complex transport modelling.

Allocation, design and development of transport infrastructure and services can more and more subject to rigorous planning. Transport planning has to reflect the fundamental changes in cities and contemporary issues and problems. Transport planning is to make effective decision concerning the allocation of transport resources, including the management and regulation of existing transportation activities. Just as urban planning requires the inputs of many stakeholders and specialists, transport planning is beginning to utilize multi-disciplinary teams in order to broaden the scope of the planning process. This is now possible due to the fact that ITS allow an open platform of transport data accessible to all stakeholders and partners. It can also boost active participation of citizens in sharing their needs and concerns in terms of mobility [110, 111].

Under the Senegal Sustainable Cities Initiatives, in addition to developing transport infrastructure, the government of Senegal has introduced the model of multiple connectivity choices as presented in Fig. 15.39.

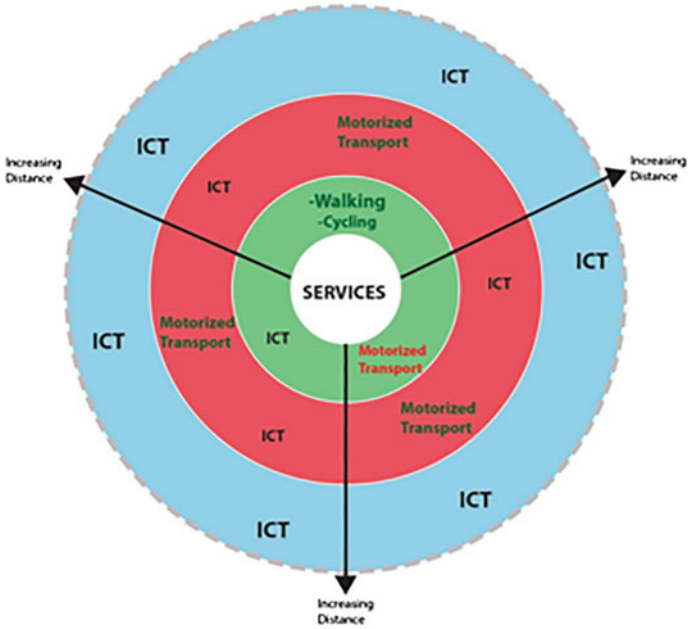

Fig. 15.39 Multiple choices of access to services. *Source* Mboup, G., 2016

Interpretation of the multiple choices of access to services: (1) the green panel illustrates a situation of mixed land used or alike where services are walking distance from residence (threshold to be determined). Here we can walk, drive and use ICT, but walking along with the use of ICT to access services is sufficient and then highly recommended; (2) the red panel illustrates the situation where services are far away from residence, in a distance making it impossible for people to effectively walk to reach most services, but are in a reasonable distance (threshold to be determined) where people can use motorized means of transport with the benefits that can offer an ITS; They can also use ICT to perform work outside their workplace or to access other services. This situation includes telecommuting as well as all other forms of ITS such as RTPI and; (3) the third scenario with the blue panel illustrates a situation where the services are very far (threshold to be determined) from residence making it difficult for people to use motorized means of transport every day to services, here the convenient option is the use of ICT to effectively reach services. This third scenario represents a complete substitution of movement of people by the use of ICT to perform work outside workplaces, such as in an offshore call centre and to access services far away from their producer and distributer location such e-banking, e-commerce, etc. This is usually the case where people reside outside the city where a company they are working with is located. ICTs have, indeed, made virtual access to services such as

employment, education and business opportunities possible, hugely changing the dynamics on physical distance limitations. In all situations, the use of ICT will ease access to services and take city towards smartness. ICT indeed offers a promising sustainable solution to access to different social and economic sectors, to perform duties or receive services. This will allow economies of scale and agglomeration, even for small firms and small settlements.
Source: Mboup, G., 2016. Creating Digital, Smart Cities for Smart Economies: From Big Cities to Digital Urban Centres. In Smart Economy in Smart Cities, Springer, September 2016

15.7.8 Means of Implementing Economic and Spatial Design Strategies

15.7.8.1 Barriers to Implementing Economic and Spatial Design Strategies

It is not the first time the government of Senegal conceives holistic urban development programmes and projects. But few had been implemented due to various barriers among them: Lack of cooperation and involvement of the population in the preparation of urban programmes and projects; Competition between urban issues and other social, economic and political issues; Regulatory, policy and institutional mechanisms; Lack of Awareness and capacity; Insufficient Financial Resources; etc.

Lack of cooperation and involvement of the population in the preparation of programmes or projects Though the need for economic and spatial design strategies is well grounded, there are various barriers to tackle in the process of findings to the problems and its root causes. Re-organization two centuries of unplanned settlements with little or no consideration of sustainability, inclusion and resilience require transformative actions such as re-planning the unplanned. In the Dakar metropolitan region, due to poor urban planning and management, land tenure in most human settlements is neither well governed nor well administered. Poor land governance is surrounded by poor land administration characterized by a poor determination, recording and dissemination of information about tenure. Without legal proof of ownership, people feel exposed to eviction and are less willing to cooperate when government authorities plan to re-organize the spatial occupation of their settlements. This constitutes an important barrier providing solution to urban development issues. Even in situation where the population is willing to cooperate, they are not involved in the urban planning and management processes. Therefore they do not feel concerned by roles and regulations in terms of spatial occupation and buildings codes established by national and local authorities.

It took over nine years before the Urban master plan of Dakar initiated in 2000 be approved. As of today, only 29 municipalities out of more than 400 municipalities have an urban master completed. This shows the complexity of urban planning and management in Senegalese municipalities.

Competition between urban issues and other social, economic and political issues National and local policy-makers seek visible and tangible outcomes for expenditure, where they can point to something concrete (literally and figuratively) that they have achieved for their constituents. In this situation, economic and spatial design strategies are often in neither in the negotiation table nor in the planning stage. Even, where they are in consideration, due to their medium or long-term nature, policy-makers will opt for other actions more visible in short term than them.

Regulatory, policy and institutional barriers The cumbersome regulatory approval process constrains the preparation of detailed economic and spatial design strategies. The intermediate causes to this cumbersome approval process include: Lack of clarity of roles and responsibilities of various administrative structures; weak coordination between the central government and municipalities in charge of preparing their own detailed economic and spatial design strategies according to the Act III of Decentralization.

Awareness and capacity barriers In most of the Dakar municipalities, local authorities and communities suffer from lack of awareness regarding sustainable urban development issues in general. In addition to that they do not have the required skills and competencies to properly integrate smartness in the planning and management of their cities. This constitutes important barriers to consider in the economic and spatial design strategies. Awareness and capacity building of local authorities and communities is key for the success of any urban project at the local level.

Financial barriers Local authorities do not have sufficient resources to plan and manage their cities. Economic and spatial design strategies are not well positioned in the competition of several other interests when it comes to development of cities. In addition to that, there are: difficulties in accessing various financial sources due to lack of appropriate financing mechanisms to assist municipalities. The availability of finance is essential for efficient implementation of urban development programmes. “Marginal role and weak capacities of municipal authorities: municipalities are marginalized and lack the required capacities and resources to plan and manage the more and more complex situations. The role of African local governments in urban development is indeed highly constrained. Many countries have sought to decentralize service delivery to local governments, but without a commensurate transfer/increase in revenue sources/financing. Moreover, most towns and cities in Africa have limited professional capacity for managing urban development. Municipalities lack legal and administrative frameworks for efficient service delivery and management of urban planning, land tenure and finance” (ECA 2014).

The absence of finance can constrain the ability of relevant authorities to implement, for instance, sustainable high-capacity public transport options. The implementation and management of metros, light rail or BRT systems require large amounts of funding. As an illustration from the UN-Habitat's Global Human Settlements Report 2013, "to live decently at the standard appropriate for middle-income countries, their average per capita income will need to be at least $5000, so the income of such a city would be around $25bn. To put this in context, the typical African country currently has a sovereign bond market worth around $2bn, and annual aid inflows are around $1bn. No African government, and no individual company, could afford to finance the cost of building an entire city. The future financing of Africa's urban structures will rely primarily upon tapping into financial markets, domestic and international, and tapping into them on such a scale is not a trivial matter….". During their conception, it is important to take into consideration key elements determinant to their cost, demand, supply, affordability, etc. Due to the huge investments that public transport such as metro, light right and BRT required and considering the limited revenues of cities, it is important to assess carefully the funding for capital investments that requires the participation of local, regional and national governments as well as the private sector. Other partners can also be of interest such as international funding from climate change financial mechanisms. It is also important to tap to non-traditional funding such land [112]. In addition to transfers from different levels of government, local authorities require innovative funding mechanisms to support implementation and operation of public transport systems beyond the fare box revenues [61].

15.7.8.2 Tapping in the Synergies Across Global, Regional and National Agendas and Programmes for Resources Mobilization

Financing the Plan Senegal Emergent and other programmes

In February 2014, the PSE Consultative Committee has estimated a budget of about US$ 6–7 billion to boost the Senegalese economy. It is expected that half of the financing of the Plan Senegal Emergent (about US$ 3.8 Billion) will be from international donors, another 25% from international investors, and another 25% from the government. These figures indicate clearly how the PSE depend heavily on external risks in time of resource scarcity globally. This represents a high risk for a timely implementation of the PSE.

Financing urban poles are also based on partnership with public and private entrepreneurs. Considering the holistic approach in creating these urban poles as presented above, various partners will work together in their implementation.

Since Senegal is among the least developed countries (LDCs) most of its programmes are donor-funded programmes. Therefore it is important to present these programmes and assess how they are linked to national programmes. Being part of the international community, the Senegal Government has also committed to

implementing global and regional development agreements. Prominent among which, in the last couple of years, are those relating to the Post-2015 Development Agenda: Sustainable Development Goals adopted in September 2015; the Paris Agreement on Climate Change adopted in December 2015; The Sendai Framework on Disaster and Risk Reduction adopted in March 2015; the Addis Ababa Declaration on Population and Development earlier adopted in July 2015; as well as the latest one—the New Urban Agenda adopted in October 2016. At the regional level, Africa Agenda 2063 serves as the main interface for operationalizing and monitoring the implementation of all these global agreements in the continent.

All these agendas have a common goal, sustainable development through various inter-related channels and avenues, with the SDGs, New Urban Agenda and Africa Agenda 63 being more holistic and embrace multiple sectors compared to other agendas which are more sectorial and thematic, such Sendai Framework for Disaster Risk Reduction, Paris Declaration for Climate Change, and Addis Ababa Declaration for Population Development. The SDGs is outcome-oriented while the NUA is implementation oriented to enable processes to reach some SDGs goals, particularly the SDGs Goal 11. The Africa Agenda 63 defines the transformative actions or outcome required to transform the region to middle income region "The Africa We want". In Senegal all these agendas operate through the Plan Senegal Emergent (PSE) that defines a holistic approach for the country to transform itself and fulfil the regional aspiration of Agenda 63 towards a middle-income country. In all these programmes, the role of ICT is underscored.

Synergies across Global, Regional and National Agendas and Programmes
Africa Agenda 63 SDGs, Sendai Framework, Paris Agreement, Addis Ababa Declaration, New Urban Agenda (Fig. 15.40).

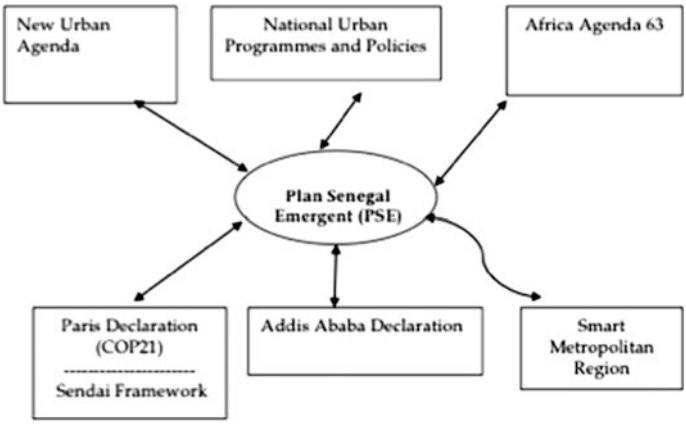

Fig. 15.40 Synergies across Global, Regional and National Agendas and Programmes. *Source* prepared by the author from different agendas

15.8 Conclusion

Development of large metropolitan regions like Dakar constitutes economic and social opportunities as well as challenges depending on how the urban growth was planned and managed. It provides opportunities for economies of scale and agglomeration as well as for diffusion of ideas and innovations, but it will also call for large investments in infrastructures to respond to the increased demand for water, sanitation, solid management, energy and mobility, etc. It will particularly come with increased demand on mobility that must be satisfied with an efficient public transit accompanied with increased spaces for pedestrians and cyclists in order to safeguard the environment while creating economic growth. The metropolitan of Dakar yet occupies a pivotal place in the national trade sector both nationally and internationally. Its autonomous ports (for coastal cities), international airports, international trade centres, touristic sites and commercial centres are assets for economic growth. The majority of economic units in Dakar are in the commercial sector (52%). The metropolitan of Dakar contributes up to 55% of the national Gross Domestic Product (GDP). Up to nine out of ten national civil servants, and from 50 to 90% employees in national's trade, transport, banking and industrial enterprises are in cities. However, most of these urban advantages are concentrated in the city of Dakar. Though the Dakar Metropolitan Region had been administratively divided in four departments, in reality the other three departments act as suburbs of the department of Dakar, where the main commercial and administrative businesses are concentrated. The other three departments remain haunted by the early spatial and social division; they are not well planned, and they lack sufficient land allocated to streets, other public spaces, basic infrastructure and security of tenure.

However, Dakar has not been able to satisfy the employment demand, particularly from young people. In addition to that, due to a deficient urban mobility, Dakar has also not been able to create conditions for specialization. While urban agglomeration allows for job specialization, efficient market transactions and knowledge diffusion, if concentrated growth is not well planned—such as the integration of urban growth with efficient public transit investments, the resulting economic benefits tend to erode. This is the case in Dakar as in many African cities with poor connectivity leading to disconnected settlements.

Recognizing the unbalanced Dakar metropolitan regional development, in one hand, and the multiple problems associated to lack of basic services, on another hand, the Senegalese government has taken bold actions to transform the urban landscape of the metropolitan region from a monocentric to a polycentric metropolitan region with the creation of urban centres to decongest the Dakar urban agglomeration. This new spatial re-organization is also accompanied with economic transformation through the ambitious economic development programme, the Plan Senegal Emergent. It is through key main complementary programmes, reforms and plans: (1) the Plan Senegal Emergent; (2) Act III of Decentralization; (3) Metropolitan Planning; (4) Dakar Urban Master Plan 2035 and; (5) Digital

Senegal Strategy 2016–2025. These urban policies and programmes aim to spatially and economically transform the Dakar Metropolitan Region to be smart, sustainable, inclusive, resilient and prosperous. They aim to transform the monocentric system to a polycentric system where every urban centre equally contributes to the development of the metropolitan region.

Another urban development is the emergence of urban corridors, which present a type of spatial organization with specific economic and transportation objectives. In Senegal, the government is also encouraging growth, convergence and spatial spread of geographically linked metropolitan areas and other agglomerations. These are emerging trends linking Dakar-Thies-Mbour, turning into spatial units that are territorially and functionally bound by economic, political, socio-cultural, and ecological systems. It is expected that the Dakar master plan include Thies and Mbour. Though their economic output may be enormous, their management requires considerable investment on infrastructure, particularly to ease mobility and communication in order to constitute a large economic output, combining large markets, skilled labour and innovation.

Along the transformation of the Dakar metropolitan regional development, national authorities have put in places planning guidelines through the Urban Master Plan of Dakar (Plan Directeur d'Urbanisme—PDU) 2035 and National Plan for Territorial Development "PNAT". The PDU 2035 aims at urban development of the region of Dakar and its surroundings by 2035. Its main objectives are: Sustainable Urban Development; Compact cities connected with a transport network; Robust and Resilient city and; Vibrant city with active interaction between information, goods and people. The PNAT proposes five development urban areas: Multifunctional urban areas; Areas for economic activities; Areas for agriculture activities; Areas for touristic activities; and Areas for conservation. The PNAT also identifies areas with high risk for habitation and any other activity. In these areas, modification of the land including by residential structure, or any cadastral operations is prohibited. This plan promotes green areas and other protected areas for environmental purposes or spaces with light recreational facilities, which, when well integrated enhance the character or the ecological value of the area. Specific focus areas of the PNAT also aim at: controlling the internal urban growth; reducing the proliferation of slums; promoting a balanced urban development; and meeting the housing demand.

It is in the ICT revolution momentum that the government of Senegal has initiated the creation of urban centres in the outskirts of Dakar in order to decongest the city [113]. The government is, indeed, putting in place an ambitious project of a technology park in the Urban Pole of Diamniadio, called "Diamniadio Technology Park". The park is based on the Silicon Valley model and intends to promote data revolution and higher education centres. The Urban Pole of Diamniadio is also among the pilot cities of the National Sustainable Cities Initiative (SCI) as part of the Sustainable Cities Programme launched by the Global Environmental Facility (GEF) in 2016. It consists of "Planning and Managing the urban pole to decongest Dakar and to be a sustainable city model connected to Dakar and the rest of the country through walking, non-motorized, ICT and motorized means". Under the

Sustainable Cities Initiatives, in addition to developing transport infrastructure, the government of Senegal has also introduced the model of multiple connectivity choices (non-motorized, motorized means of mobility and ICT).

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