PEARL
Peer Experience and Reflective Learning

Research Paper

Exploratory Research on Smart Cities

Theory, Policy and Practice

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Foreword

The idea of a smart city has caught the imagination of the urban sector in India. There is excitement about the application of new technologies and the deployment of development models that can deliver social and economic outcomes that can ensure the sustainability of urban interventions.

The smart cities mission of the Government of India applies the concept of 'area improvement' of existing Indian cities, bringing the best practices related to the new urbanism movement into the purview of development activities that can stimulate the local economy, harness the economic identity of a place and its people and improve the quality of life for all citizens. These are not trivial pursuits. In order to achieve the expected outcomes, the mission will have to build capacity in city managers and functionaries to support integrated and evidence-based planning, and will have to leverage the potentials in smart technologies and applications to bring about game-changing transformations in the way we plan and manage our cities. Significantly, the mission will have to work with local communities and stakeholders across the socio-economic spectrum to build a common vision and to prepare the road-maps that will carry the city towards that vision. E-governance and the use of big data and an open-data environment will ensure the kind of transparency that will restore the trust that is a necessary ingredient of sustainable urban development.

It is necessary that we establish clarity about how the city comprises various systems, networks and environments that lend themselves to transformation for achieving the objectives of the mission. This study aims to assist its readers in establishing that clarity, through a discussion of various theories and parameters that have been seen to govern the development of smart cities around the globe. While the study does not directly address the guidelines of the new mission – it has been prepared before the mission was launched – it anticipates some of the needs of smart cities in India, attempts to explain the rationale behind global examples that address similar needs, and presents the various definitions and scenarios that are likely to be encountered by city managers in India and the urban sector at large.

This study is essentially a survey of literature and theories about smart cities. It is not a compendium of solutions or an illustration of the smart cities mission of the Government of India. As the title suggests, it is essentially a navigation tool that might be useful for those who wish to understand the context in which smart cities in India are being envisaged. The area-based approach of the Ministry of Urban Development, which is directed towards revitalising existing cities through a systematic improvement of entire living environments, is likely to be a unique contribution to the history of smart city development. As such, it is a story that needs to be documented and analysed in a different publication. NIUA intends to follow up this study with an intensive analysis of the aims and outcomes of the mission.

The Cities Alliance has been a timely and most valuable source of support to NIUA at a time when the institute is called upon to assist the Ministry of Urban Development in a larger capacity building program. We are thankful for their collaboration.

The study has been authored by A.N. Nanda Kishore and Zoya Sodhi, with assistance from Pranay Dave, Mohit Kapoor and Sridipta Ghatak for compilation of Smart Cities partnerships in India. Deep Pahwa and Kavita Rawat designed and formatted the report. As the Coordinator of the PEARL (Peer Experience and Reflective Learning) program at NIUA, Dr. Debjani Ghosh has provided the necessary encouragement and support. We trust that their collective efforts will enable an informed engagement with smart cities in India.

JAGAN SHAH

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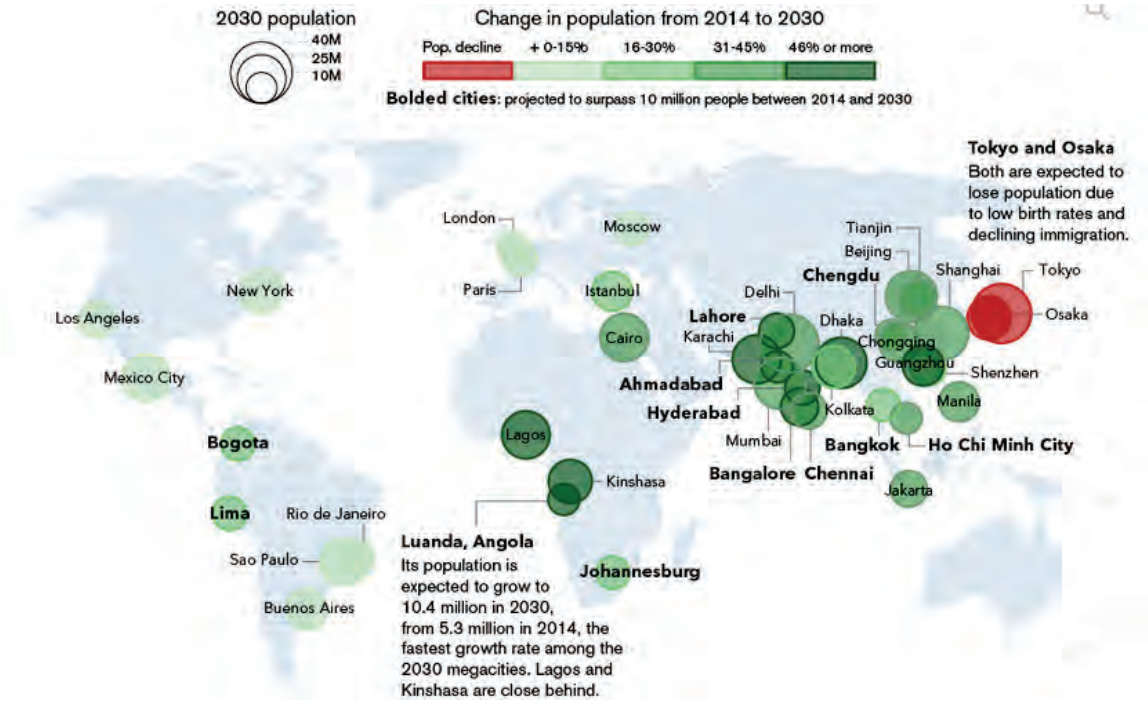
CHAPTER I: SMART CITIES

1.1 Background

According to the United Nations population division (UN 2004), world population was around 1.65 billion at the end of the 19th century and it crossed the 6 billion mark by the end of the 20th century. Major areas wise contribution to world population indicates Asia as the top contributor with 57.4 percent in year 1900 to 60.8 percent in year 1999 followed by Europe. At the beginning of 2014, the world's population was estimated at 7.2 billion, with approximately 82 million added every year thereafter (UN 2014). With the current rate of urbanisation at 32 percent, new Jakarta (with population of 30.53 million) is expected to pop-up every year (Demographia 2015). The population of Africa is expected to be three times the population of Europe by 2050; increasing levels of urban versus rural population are signs of the changing landscape of population distribution across the world (UN 2014).

Figure 1: Cities with a projected 2030 population of more than 10 million



Source: UN World Urbanization Prospects (Tribou 2014)

Historically migration from rural to urban areas and, therefore the process of redefining the boundaries of the rural-urban fringe for expanding city regions played a key role in defining a city's population. In today's world, natural increase is expected to make a larger contribution to urban population growth than internal migration in many regions. This transformation of cities has been a major aspect, if not a driver, of economic development and they present the case of cities as focal points of economic growth. On an average, urban residents have better access to education and health-care as well as other basic services such as clean water, sanitation and transportation than rural populations do. Cities are also the major centres of consumption of resources (UN 2011). Currently, urban areas roughly occupy 3 percent of the planet's surface and, consume 75 percent of the global primary energy; they emit between 50 and 60 percent of the world's total greenhouse gases (Editors 2014; UN 2015).

For urbanisation to continue to offer important opportunities for economic and social development, it needs to be well managed. However, the speed and scale of urbanisation in developing regions challenge the capacity of governments to adequately plan and meet the needs of the growing number of urban dwellers. As cities grow, managing them becomes more complex and their populations become more diverse. Developing countries will need to adjust to this process much faster than developed countries did in the past (UN 2011). This, along with increasing levels of aspiration of the urban communities for a better quality of life and services, has forced city stakeholders to consider change in the management models of resources and infrastructure for cities and respond with innovative practices and scalable solutions (Laartz & Lulf 2014). These are some of the main drivers for Smart Cities development.

1.2 Introduction

'Smart Cities' aim to decrease the challenges that cities face, such as scarcity of energy resources, healthcare, housing, water, and deteriorating infrastructure (roads, schools and transportation).They also suffer from price instability, climate change, and the demand for better economic opportunities and social benefits (Washburn et al. 2010).

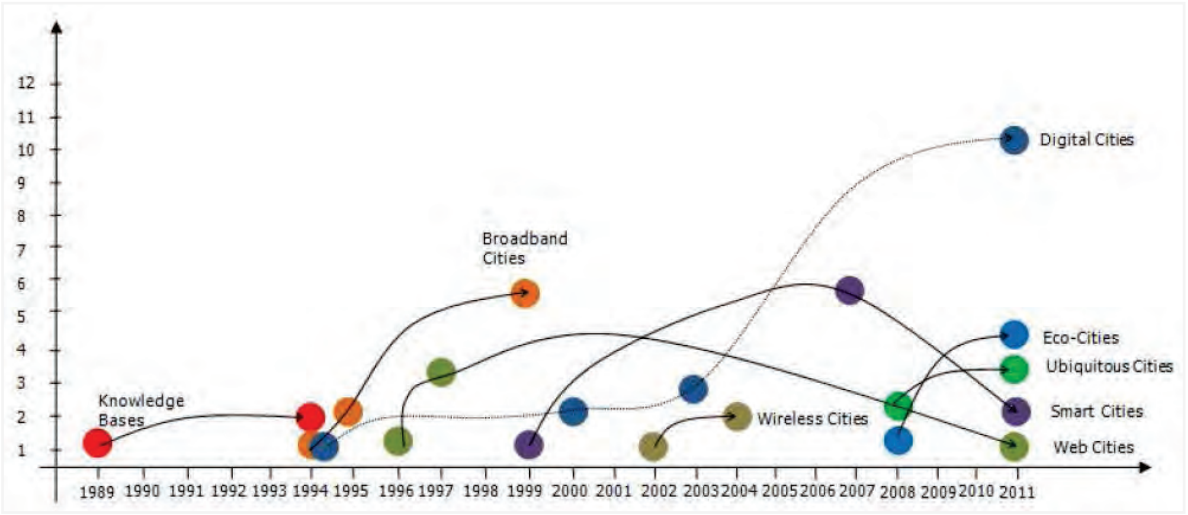
Recent advancements in Information and Communication Technologies (ICT), aligned with technology cost reduction, such as cheap mobile apps, free social media, cloud computing, and cost-effective ways to handle high volume data, provides cities with better opportunities and tools to understand, communicate, and predict urban functions (Susanne Dirks and Mary Keeling 2009; Berst et al. 2013).

In this context, Smart Cities and Smart City projects are being seen as a holistic approach to city planning (Roberto Requena et.al., 2014). Shah (2015) on the Government of India's 100 Smart Cities Programme says it is about making cities better and he emphasises the need to leapfrog towards bringing cities to a level where they deliver a quality of life that people are demanding, youth are expecting and which is everybody's right. Himmel et al. (2014) conclude with the need for understanding today's urban challenges by the youth — who constitute 25 percent of today's world population and 28 percent (UNFPA 2015) in the case of India — and actively participating in civic engagement.

1.3 Evolution of smart cities

In Anthopoulos & Fitsilis (2013) a roadmap for Smart Cities was presented. Based on this research it is evident that Smart Cities have emerged over the last 20 years from their initial web forms to their modern ubiquitous and eco-friendly status and are considered favourable e-Government environments. The timeline presented below indicates the existence of various alternative approaches to the Smart City. The roadmap in this case was depicted via technology road mapping methods to understand recent trends in the evolution of Smart Cities and to justify alternate approaches. This roadmap was structured according to the e-service sets that Smart Cities offer and could be a useful tool for urban local bodies (ULBs). From this analysis of various approaches to Smart Cities, it is understood that technological factors are key determinants to the viability of Smart Cities. It has also raises the issue of viability indices in measuring the sustainability of Smart Cities.

Figure 2: Evolution of Smart City Approaches



Source: (Anthopoulos & Fitsilis 2013)

1.4 Smart Cities Definition Analysis

Exploratory research focuses on multi-dimensional keyword analysis for definitions of Smart City (Caragliu et al. 2009; Kogan 2014; Cavada et al. 2014); a conceptual framework (Mosannenzadeh & Vettorato 2014); definition of a sustainable Smart City (Sekhar N. Kondepudi 2014) highlighting the importance of existing literature and empirical evidence in redefining the context specific framework for Smart Cities.

The keyword analysis also facilitates the process of defining Smart Cities, while providing a framework to define each sub-system. City governments while planning for transforming their existing cities into Smart Cities or planning for new can ones can apply this framework in order to recognise their goals, components, and key stakeholders. One such case of a conceptual framework by (Mosannenzadeh & Vettorato (2014) will set the context for the subsequent sections of this study. The key guiding principle of this framework is Kipling's method of 5W1H (Why, What, Who, How, When and Where), which is considered the most basic approach in information gathering and understanding of literature (Zaidi et al. 2006) relating to the Smart Cities movement.

1.4.1 Why Smart Cities?

The keyword analysis of Smart Cities' main goals and drivers is divided based on literature in three main domains (academic, governmental, industry). It shows that academic literature has a holistic approach and covers a wide range of issues. It is mostly concentrated on improvement in three main aspects: governance, community/social development, and Environment. From the industrial point of view, Smart Cities emerge mainly due to the interaction between competition and sustainable urban development. In addition, efficiency and sustainable environment are amongst Smart Cities' main objectives. Finally, governmental literature is more concerned with overall challenges including quality of life, economic growth, environment, energy, sustainability, health and safety, and mobility. The top five in the combined list included economic growth; sustainable environment; sustainability; quality of life; and improved governance.

1.4.2 What are the components of a Smart City?

The components of a Smart City are its most important urban domains. These are the main targets for stakeholders to invest in. Giffinger et al. (2007) lists Smart Cities' different domains as economy, people, environment, governance, mobility, and buildings. Susanne Dirks and Mary Keeling (2009) have a more

practice-oriented division. They define the Smart Cities' main components (systems) as people, business, transport, communication, water, and energy. Berst et al. (2013) consider a different set of domains — built environment, energy, telecommunication, transportation, water and waste water, public health services, public safety, and payments.

Academic literature have a more holistic but general view about the main Smart Cities' components, while industrial and governmental literature has a more practical and short-term approach. The latter mainly concentrates on urban sectors that can be directly affected by urban authorities, such as transportation, energy, and buildings.

Combining the keywords for all three domains results in several common components: services, transportation, people, governance, energy, and buildings. There are other important keywords not so common to all, such as health, safety, mobility, environment, education, economy, infrastructure, and water. However, further analysis is required to sub-divide the main components of Smart Cities. For example, transportation is a sub-sector of mobility, and energy could be a sub-sector of the natural environment. These inter-relationships can lead us to choose the following areas as the main components of Smart Cities: Government, Mobility, Services, Community, Economy, Natural Environment, and Built Environment.

1.4.3 Who are the key stakeholders in a Smart City?

The engagement of stakeholders is key to the creation of Smart Cities. Although the perspective of each of the three domains is different they are complementary to each other. Leydesdorff & Deakin (2011) introduce the university, industry and government as the three main actors of Smart Cities whose functions are subsequently organised into knowledge production, economic wealth creation, and reflexive control. Lombardi et al. (2012) revised triple-helix (concept of university-industry-government relationships) by introducing civil society as the fourth main actor. C Aoun (2013) states that Smart Cities involve business and local stakeholders, with city leadership. It introduces governments, private investors, industry suppliers, NGOs and associations, utilities, and planners and developers as different stakeholders who should collaborate to achieve Smart Cities.

CONCERTO a research project in European commission, suggests that in order to create Smart Cities, policy makers should bring all stakeholders together, including investors, local authorities, material suppliers, designers, urban planners, developers, energy utilities, contractors, engineers, tenants, and owners (Bahr 2013).

The keyword analysis of different notions of main stakeholders shows that academic literature presents a holistic and general point of view with four main groups: people, companies/industries, government, and university, while industrial literature has a more detailed and practical approach by adding NGOs, investors, planners and developers, contractors, etc. Governmental institutions suggest a more practical point of view. Alessi & Saritas (2013) for example, considers mayors/politicians, city administration, utilities, energy service companies, network operators, developers, architects, planners, communities, construction companies, industries, component manufacturers, renewable energy industry, ICT companies, financial institutions, R&D institutes and universities.

Based on all these analyses it is finally understood that four main groups of stakeholders are involved in the creation of Smart Cities: People, Government, Industry and Universities. In addition, some lateral groups of planners, developers, financing organisations and NGOs are also involved. Each of these groups consists of many stakeholders. For example, government includes local /regional policy makers and authorities, municipal and other authorities.

1.4.4 How to create a Smart City?

Creation of Smart Cities is the most important part of conceptualising the framework. All literature presents the role of ICT (Lee et al. 2013; Odendaal 2003) unanimously in this endeavour, with the emphasis on technology as an enabling component (Hollands 2008) of the framework in governmental, social, economic, and environmental areas (Komninos et al. 2011; Pol et al. 2012; Giffinger et al. 2007). Industrial literature has a more instrument-based approach (Susanne Dirks and Mary Keeling 2009) and governmental institutions emphasise pro-activity and the necessity of creating metrics in order to measure the function of urban systems (Kanter & Litow 2009).

The suggestive framework for creation of a Smart City includes ICT combined with other strategies like investment in social capital, collaboration of different stakeholders, and integration of different components of the city (Mosannenzadeh & Vettorato 2014). This requires gathering data (Batty 2013) and knowledge in all domains and of all stakeholders, and communicating this data through a comprehensive and interconnected urban network in order to have an integrated-collaborative urban development (Tranos et al. 2012; Neal n.d.).

1.4.5 When and Where to create Smart City?

The most common time reference is the 'future' (Hall et al. 2000; Canton 2011; Komninos et al. 2011), which means there is no time limit for creation of Smart Cities. This could be due to their continuous nature of evolution (Aoun 2013).

Since getting smart implies a continuous improvement of the urban situation (Aoun 2013) , each city can be 'smarter' (Electric n.d.). Obviously, many factors can accelerate or hinder this 'continuous improvement'. For example, existing policy frameworks, recent practices in integration of technology in urban infrastructure (Neal n.d.) , and high level of technology advancement in a city can lead to better success in 'smart' development. However, there is no absolute limitation to the implementation of Smart Cities.

1.4.6 Summary

The following are some of the Smart City definitions with focus on some specific aspects which will set the context for the subsequent sections of the report.

An extensive definitions analysis by the ITU-T Focus Group on Smart Sustainable Cities to understand the 'smart' sustainable cities definition included 116 existing definitions of 'smart' sustainable cities, resulting in establishing eight categories and 30 indicators (Sekhar N. Kondepudi 2014) . This facilitated the ITU-T FG-SSC to derive the following standardised definition:

"*A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects*."

Emphasising the cities governance aspect, Ghani (2012) says *the concept of* says *the concept of "Smart Cities*" *is "really about good governance. It's about giving basic services to our citizens. It's about livability. It's about how we are using our resources. It is how a city functions on a day-to-day basis. I think smartness is about doing more with less."*

The importance of reforms is stated by Correa (2014) "*The promise of the new government to build 100 Smart Cities will require not only new technology but also drastic reforms in the political and institutional environment in which our cities function, with a focus on connectivity, integrated land use and transport planning, and environmental sustainability*."

Referring to urbanisation and trends suggesting India as an urban majority country by 2040 Sanyal (2014) says, *"India's 100 Smart Cities plan should be seen as an attempt to create urban infrastructure in anticipation of the deluge."*

Ashwin Mahesh says *"A Smart City is one in which citizens are co-managers of the city along with public officials"* thus highlighting the importance of citizen engagement (NIUA 2015).

Tim Campbell advocates that *"Smart Cities need to go beyond technological innovations for improved service delivery"* (NIUA 2015) and as part of his blog (Campbell 2014) defines the smartness of cities in three flavours: *"1) cities are learning to learn, 2) cities are learning how to use ICT to make city systems more efficient, equitable and resilient, 3) cities are gaining new awareness about the important role they can play on global issues like climate change."*

According to the Manchester Digital Development Agency (MDDA n.d.) , *"a 'Smart City' means 'smart citizens' – where citizens have all the information they need to make informed choices about their lifestyle, work and travel options."*

CHAPTER II: Theory of Smart Cities

2.1 Introduction

The definitions put forward in the earlier section draw attention to governance and in some cases participatory governance as a tool to manage the growth of the Smart Cities, thereby enhancing the quality of life and optimum management of natural resources. Quite a few Smart City theories and models, including models which are an amalgamation of simple frameworks and hybrid in design and new ideas, are emerging. This section sheds light on the grouping of these models based on their theoretical framework using various research methodologies.

2.2 Theory of Strategic Priority Areas

A Smart City framework is based on priority areas which are specific to the city's context. Any model can focus on one or more of these priority areas depending upon the agenda of the programme under which it is proposed or initiated. Broadly, the priority areas can be categorised into Political, Economic, Technology, and Environment based on an abridged version of PESTLE analysis which is widely used as a tool to understand the new project business landscape by industries, specifically marketing industries. Although there are other focus areas (Allwinkle & Cruickshank 2011) , the categories mentioned are most common and comprehensive. The approach adopted in this case is theoretical in nature using some empirical case studies in order to understand and analyse the models that are referred to in current literature.

2.2.1 Political

Smart City model frameworks which are based on this priority area are more inclined towards participatory democracy, building social capital and focusing on ways and means of social interaction between communities and city administrators. Participation of communities will largely depend on democratisation of information and re-establishing traditional information flows. Open-source platforms across the globe have set the agenda to re-establish the link between citizens and the planning process. Heller (2013) argues that getting a right balance of market, the state and civil society will facilitate inclusive and democratic forms of development. It is substantiated with analysis of the role of transnational activism and how social movements and civil society have shaped different developmental trajectories in Brazil, India and South Africa.

It is believed that technology and democracy can create revolutionary solutions from the bottom up (English 2014). As mentioned in Caragliu et al. (2011) Smart City models are increasingly addressing political aspects. This priority area model builds on the principle that communities that are empowered with evidence based knowledge, which is considered as the guide to the development of social policies and practices (Mullen 2014) , will work toward creating Smart Cities.

These models emphasise the tools which empower citizens with knowledge, and the process of engaging citizens in Smart City planning, as well as the platform for these citizens to share their ideas and achieve the goals of Smart Cities. Tools, process and platforms can be technology driven but the design of these systems needs to be citizen centric to motivate the common public in order to access them with minimum or no difficulty.

The citizen engagement process in the case of Bengaluru, India in city planning (Tender Sure, lake improvement projects across city), designing of physical built environment (redevelopment of market areas), and public systems (bus systems, public spaces) are classic examples of focusing on the political arena and on industry and technology.

2.2.2 Economics

Installation of new infrastructure and augmentation of existing physical and social infrastructure, its operation and maintenance in cities includes high capital investments and recurring costs. Urban growth management techniques are part of the planning approaches to this challenge (Patricia 2012) and address the economic aspects of the city making them business/industry friendly with not just any infrastructure but intelligent infrastructure. This is the Smart City model approach (Clark 2014; Thite 2011).

Since the time trading began, cities have been seen as the hub of economic activities or as financial centres (Moir & Clark 2014). Research shows (Olubukunola et al. 2014) that only local governments can generate revenue internally and leverage the external resources available to fulfil most of the requirements of the citizenry.

In today's world cities are the preferred destination for global investors, and are in competition with each other locally, regionally and globally. A study of business climates by (Moir & Clark 2014) for six European cities at three different levels — national, regional and local — indicates that the top ranking nation need not be the one which has the most business friendly cities. Although policy environment at state and national levels sets the agenda for industry investments, a lot depends upon the branding of a city. Cities using tools like the livability ranking index and credit rating to attract investments in their projects but factors like availability of qualified workforce, real estate and human resources costs, and most importantly, business infrastructure are the deciding components.

Globally, cities are being branded on their uniqueness and assets. For example, the capital city of the Republic of Korea has been branded as 'Design Seoul', showcasing how the concept of design plays a role in policy formation in the city of Seoul, namely — urban design, service design and system design — by integrating technologies, art, architecture, and business in creating a global Smart City (SMG 2009). Advanced and rapidly developing countries have examples of Smart City models which focus on industry as their base.

Efficiency is one of the key aspects for the economic priority area of the Smart City model framework. Cities need to develop an institutional mechanism framework for coordination and collaboration between various agencies involved in city governments. The collaboration model can be between technology focused cities and business focused cities.

Operating efficiency has been one of the challenges for Smart City model frameworks based on economic priority areas, while promoting at the same time a culturally rich and diverse city life (Kuk & Janssen 2011). City administrators and managers in the process of increasing efficiency and thereby revenue in city systems across the sectors may neglect or comprise on the networks of relationships among the people and communities they live in (Caragliu et al. 2009). Active civic engagement means investing time to motivate the communities and empower them with knowledge about how to be involved in the process of city development. A classical example of neglecting citizenry in the augmentation of city services and thereby enhancing efficiency is Detroit. Differences of opinion or different value systems among different communities of people can be taken as an advantage in spite of time delays as this is believed to bring in the long term collaboration among these communities and in the long run it facilitates the city's development towards creating a more productive and efficient society (Potter et al. 2011). Social equity, with business as the focus group, is one of the key factors in

addressing the Smart City's goal of achieving efficiency, as the varying levels of unemployment among poor residents is a challenge to the operational efficiency of Smart Cities (Silva 2015).

2.2.3 Technological

Some frameworks suggest technology aided innovations as the key to the phenomenon of Smart Cities and citizen engagement in active management of these cities. Tools like internet revolution which includes access to internet in public places, information kiosks, digital information centres, citizen services centres, etc., have played the role of catalyst. Availability of information through various web-based platforms that solicit each citizen's perspectives and feedback promote various forms of virtual civic engagement in city management (Allwinkle & Cruickshank 2011; Hollands 2008).

One of the city's functions that can definitely take leverage of the advancements in technology is transportation. In this world of auto-dependent cities, several Smart City models deal with technological innovations to redefine and advance transportation. Academic institutions and the automobile industry have been involved in research studies to develop a smart highway system in order to address traffic jams and auto-related accidents (Cepolina & Farina 2012). Other advancements result from multi-disciplinary collaboration between car makers, city officials, and urban planners. As mentioned in the case of Vienna by Charbel Aoun (2013), the challenge for mobility in Vienna is to shift commuter travel on to more sustainable modes. However, the capacity of the mass transit network is already under pressure, so Vienna needs new innovative collaborative solutions to address this challenge. One such collaboration is to develop a smart system through coordinating vehicular technologies, traffic signals, and sensors embedded in street pavement, to reduce fatalities at street intersections that are prone to accidents (Ianuale et al. 2015). Moreover, given the fact that the elderly population is one of contemporary society's fastest growing groups (Pavel et al. 2009), it might be necessary for scientists and engineers to investigate how technologies can make our cities and transportation systems work in a smart way to create a physical environment that promotes the health, safety, and welfare of elderly people (Johnson et al. 1994; Commission 1998; Box et al. 2010).

An example of a Smart City initiative in which technology has an overarching impact on other priority areas such as the economics as part of the its outcomes is the case of the call for innovative technologies to improve wayfinding and navigation by the Institute for Sustainability and the Mayor of London's Office. In this case it is seen as a tool for economic growth in areas undergoing redevelopment (Institute for Sustainability 2015). Signage systems, environmental graphics, augmented reality (AR) technologies, smart phone technologies, and the Internet, can help residents and visitors navigate and experience the physical environment of cities in a more intelligent, convenient, and enjoyable manner.

Another area where technology can play an important role is to manage the city's regions with various government agencies working together more effectively, not just locally but regionally. Technology can reduce overlapping tasks and bureaucracies and promote the concept of co-creation. They can streamline review and approval processes, and they can promote more effective community outreach and communication. Moreover, technology can help municipal employees generate fresh and innovative ideas on matters that concern citizens; technology can encourage citizens to be more engaged in city management, or to volunteer for civic activities. All of these benefits can help promote a Smart City by making citizens more informed, active, and responsive. Smart City models of Asia especially Singapore, Japan, Korea, China and Taiwan, etc., have considered technology as the top priority area as part of the roll-out strategies.

Digital divide is one of the key challenges for this priority area and technological innovations alone cannot reverse the phenomenon (Chourabi et al. 2011). To scale up the solutions the factors like

affordability, lack of technical skills and behavioral factors why communities are on other side of digital divide needs to be addressed (Bolt & Crawford 2000; Ponting & McAdam 2013; Fung et al. 2015). Another challenge is how to promote an ideal integration of virtual and actual engagement that encourages citizens to visit their city to enjoy its physical beauty and interact with other people, not just virtually, and but also physically in public places (Sikiaridi & Vogelaar 2000; Mitchell et al. 2004; Wang & Huang 2014).

2.2.4 Environmental

Two key concerns for the future survival of cities and regions are climate change and energy resources. Smart City models with environment as the priority area need to explore innovative solutions in making use of limited resources in order to ensure that future cities are sustainable. In Phdungsilp (2011) citing the case of Göteborg (2050), the participatory process of developing action plans for achieving urban sustainability are presented with back casting as the tool for understanding the relationship between current scenarios and long-term future scenarios. Kourtit et al. (2012) highlights the importance of mobilising all the resources and emphasises creativity and knowledge as the key factors in maximising innovation potential of a Smart City.

Advocates of this priority area of emphasise land as an important resource in managing present growth and planning for a sustainable future. American Planning Association (2012) has developed smart codes which are model planning and zoning regulations with various options for statutory reform, instead of the one-size-fits all model. It elaborates on the model of smart growth as that which supports choice and opportunity by promoting efficient and sustainable land development, incorporating redevelopment patterns that optimise prior infrastructure investments, and consumes less land that is otherwise available for agriculture, open space, natural systems, and rural lifestyles. Land preservation is seen as one of the key ingredients in planning for smart growth models suggested by APA (Daniels 2005). Placemaking is one of the tool for addressing the public safety, health and physiological aspects of this focus group and is evident from the cases of Philadelphia, Soldotna and Orlando as mentioned in Ryan (2014). The city of Pickering, Ontario, Canada's approach to sustainable placemaking is based on ten principles which lay emphasis on mapping the assets of a community, horizontal and vertical collaboration of stakeholders, minimising the ecological footprint, people centric design of public spaces and public infrastructure (Khiyavi 2014). Key elements of the smart growth model are transit oriented development, mixed-use developments and walkable communities.

Even though smart growth and new urbanism are synonymous there are some principal differences like the origin of these concepts. Smart growth was an initiative of public policy experts and environmentalists whereas new urbanism was driven by physical planners and architects. The new urbanism approach towards sustainable urban environment is to reintroduce a traditional neighbourhood development model based on planning theories of the early 1900s. The approach focuses on physical form and argues for its importancein urban ecological, social and economic change. Based on the approach and principles adopted it can be concluded that both the smart growth model and new urbanism promote compact city development and redevelopment of inner city regions in comparison to suburban development, thus moving towards a sustainable Smart City and region. Cities in North America and Western Europe are some of the examples of cities based on environment as the priority area for their Smart City models (Calthorpe 1993; Knaap 2005; Silver 2006; Sokol 2012).

Challenges for Smart City model frameworks based on this priority area will be to balance between the built environment and natural environment in a city or region. Smart and innovative practices on how to integrate city planning functional frameworks with learning from two movements in the theory and practice of planning in the early 1900s will be crucial.

2.2.5 Summary

The priority areas presented in this analysis are broad and can be sub-categorised depending upon the scale of the Smart City model framework. Priority areas for the Smart City model framework need to be identified based on the public participatory platform as in the case of Hamburg (Weninger et al. 2010) and should take into account global challenges at the planning stage in order to be robust and scalable.

The two key aspects common across strategic areas in this analysis are engagement of communities and collaboration between various city stakeholders. These processes should be initiated when envisioning the model for a city in a) defining the priority areas; b) in the process of implementation; c) when identifying and assigning the role of interest groups in implementation.

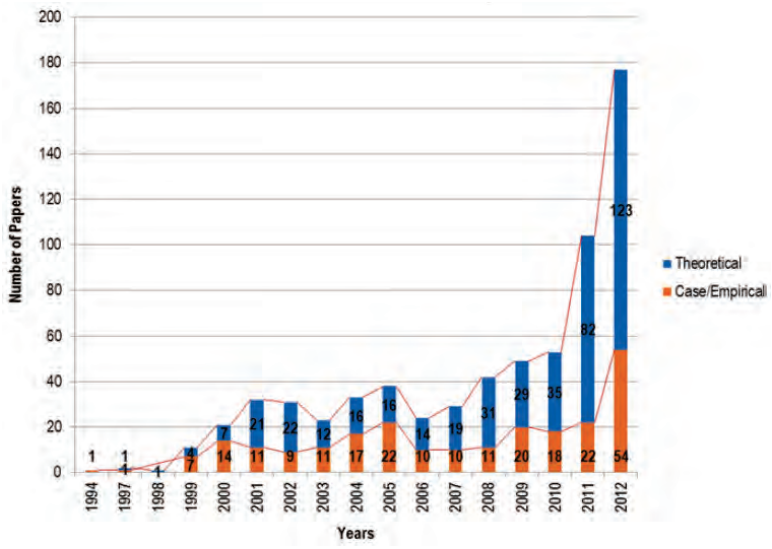
2.3 Theory Of Organizing Knowledge

As mentioned in Facloner (2012), taxonomy enables cities to benchmark content based on the hierarchy of physical city components, and facilitates a Smart City Framework to view how cities function. Based on Cooper (1988) taxonomy of literature review, the study by Cocchia (2014) was to understand the relationship between the Smart City and digital city. It included an understanding of the synthesis of a representative subset of papers and followed five specific taxonomy analyses, namely time, terminology, definitions, typology, and geographic analysis. This study draws the common element (Kogan 2014) between the Smart City approach and alternative approach of a digital city and relates to section (1.3 Evolution of smart cities) in which alternative approaches are discussed. The outcome of typology and geographic analyses reveals two key aspects in understanding the approach adopted and location of the cases studies, respectively, and is presented as part of this section.

2.3.1 Typology analysis

This approach refers to the nature of the studies, which is theoretical and top-down or empirical and bottom-up. The example, in the case of Cocchia (2014) included nearly 64 percent theoretical studies and 36 percent empirical cases. The case of theoretical versus empirical studies is presented below with the number of instances year wise for almost the last two decades.

Figure 3: Typology analysis - Theoretical versus Empirical studies



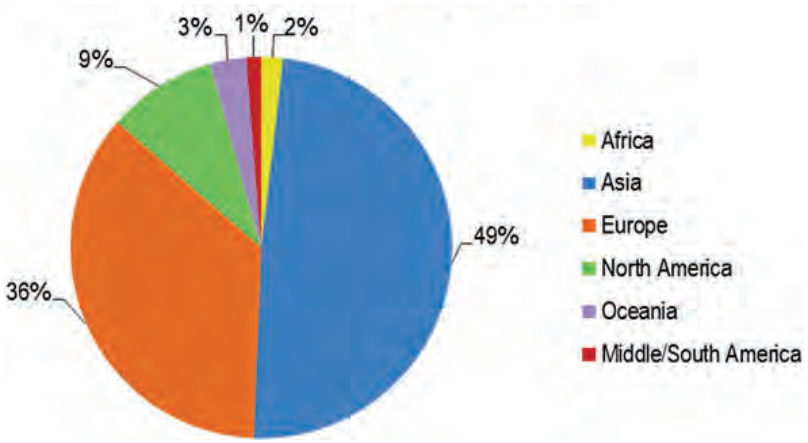
Source: (Cocchia 2014)

In the case of Amsterdam Smart and Digital City the typology analysis shows a case of conflict in the nature of approach adopted within the context of the same city. Amsterdam Smart City emerged as a top-down project with the Municipality of Amsterdam in a leading role whereas the Amsterdam Digital City emerged as a bottom-up phenomenon with citizens as the key to the process.

2.3.2 Geographic Analysis

A geographic analysis of the 162 empirical case studies by Cocchia (2014) presented the location of the smart or digital project across the globe. The Asia region is followed by Europe in second place for the highest number of empirical cases with cities from China in the top position.

Figure 4: Smart and Digital Cities Geo-location



Source: (Cocchia 2014)

2.3.3 Summary

The study by Cocchia (2014) with a literature database of 705 papers highlights the fact that both the Smart City approach and digital city approach when initiated were empirical and bottom-up in nature. This can be substantiated with the fact that most of the initiatives were not part of a defined strategy and were individual applications especially ICT based. These initiatives supported the city systems in achieving better performance and improving the quality of life. As mentioned in the case of Amsterdam (in section 2.3.1 Typology analysis), current Smart City movements are top-down with either municipalities, the state or federal government taking the lead in introducing the programme and implementation is expected to be bottom-up with extensive civic, industry, academia and civil society engagements.

2.4 Theory of Hexagonal Dimensions

2.4.1 Introduction

Smart City frameworks based on various dimensions have been published. In this section two studies which have presented the case of the six-dimensional model are analysed. The rationale for selecting these studies is the common element of ranking Smart Cities based on these hexagonal models. Understanding these models will enhance the knowledge about the relationship between dimensions associated with Smart Cities, what are the indicators of these dimensions and how Smart Cities are being ranked or assessed based on these models.

2.4.2 Case Study 01: "Smart Cities — Ranking of European medium-sized cities"

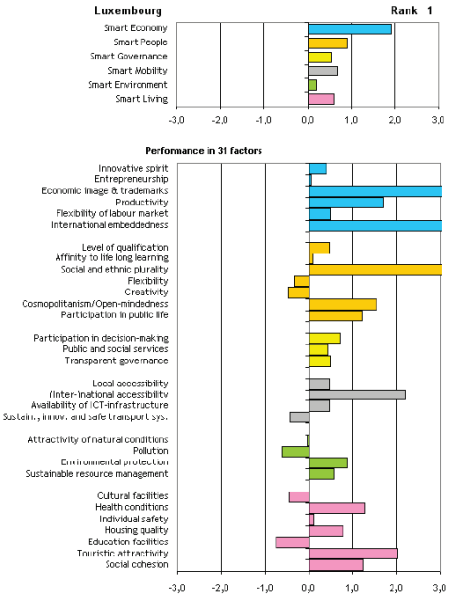
Giffinger et al. (2007) through the study titled "Smart Cities — Ranking of European medium-sized cities" evaluated the smartness of 70 medium-sized cities. The study defined a Smart City as "A city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments (local conditions) and activities (application) of self-decisive, independent and aware citizens." The study proposed following six dimensions of a Smart City.

Figure 5: Six Dimensional Model

Source: (Giffinger et al. 2007)

This study is accredited as the first attempt to understand the level of smartness in a city. The concept of Smart City based on these six dimensions relates to the neo-classical theory of regional and urban development and is considered as a theoretical base for definitions that followed (Deakin n.d.; Dawkins 2003; Todaro & Smith 2003). The systematic methodology adopted by this study identified the key factors based on consultation workshops and derived indicators for each of the factors. Finally the study analysis concluded with 31 major factors excluding two for non-availability of data and 75 indicators. This study also suggested that in cases where data is available these factors can be further derived to establish the framework as a robust model.

Figure 6: Profile of Luxembourg



Source: (Giffinger et al. 2007)

Figure 7: Characteristics and Factors of Six Dimensional Model

SMART ECONOMY	SMART PEOPLE
(Competitiveness)	(Social and Human Capital)
Innovative spirit	Level of qualification
Entrepreneurship	Affinity to life long learning
Economic image & trademarks	Social and ethnic plurality
Productivity	Flexibility
Flexibility of labour market	Creativity
International embeddedness	Cosmopolitanism/Openmindedness
Ability to transform	Participation in public life
SMART GOVERNANCE	**SMART MOBILITY**
(Participation)	(Transport and ICT)
Participation in decision-making	Local accessibility
Public and social services	(Inter-)national accessibility
Transparent governance	Availability of ICT-infrastructure
Political strategies & perspectives	Sustainable, innovative and safe transport systems
SMART ENVIRONMENT	**SMART LIVING**
(Natural resources)	(Quality of life)
Attractivity of natural conditions	Cultural facilities
Pollution	Health conditions
Environmental protection	Individual safety
Sustainable resource management	Housing quality
	Education facilities
	Touristic attractivity
	Social cohesion

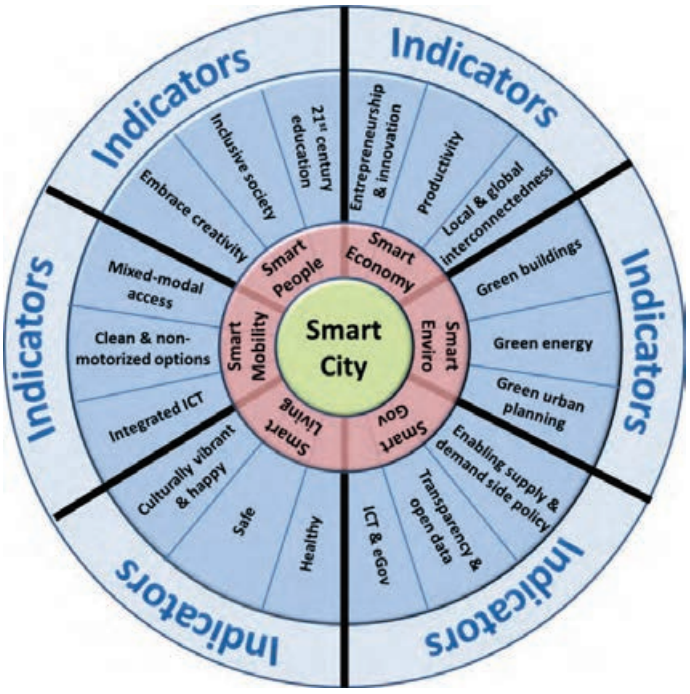
Source: (Giffinger et al. 2007)

Figure 7 presents the city profile of the top ranking city, Luxembourg, and indicates its performance across 31 indicators. As concluded in this study, the dimensions, factors and indicators will be a valuable resource to understand the process of Smart City development. One of the limitations of this model was that nearly 35 percent of the indicators identified were at national level. Primary component analysis of four dimensions, excluding environment through correlation of the indicators further revealed that, they were related to the dimension of economy (Santis et al. 2012; Giovannella 2013). More than the ranking of cities, further research needs to be aligned towards introducing the time-series data analysis which might indicate the progress of Smart Cities in each of the indicators. Setting a benchmark for progress across the indicators and then ranking the cities would be an informative comparative analysis of the sample cities selected.

2.4.3 Case Study 02: Boyd Cohen's "Smart Cities Wheel"

This model has the base six dimensions similar to Giffinger et al. (2007) but the number and type of factors for each dimension were different and limited to three. The objective of developing this tool by (Cohen 2011) was to support the development of holistic Smart City strategies, to develop baselines, and to transparently track the progress. As mentioned in the earlier section (2.2.4 Environment), Smart Cities are not 'one size fits all'.

Figure 8: Boyd Cohen Smart Cities Wheel



Source: Cohen 2011

Based on the Smart Cities wheel tool, Cohen has published ranking for the following categories:

a) Smart Cities in North America: The ranking of the top ten North American cities was based on the earlier ranking methodologies with the introduction of the Smart City wheel as the guiding tool. Publicly available data in combination with primary data shared by cities was used to rank cities in this case (Cohen 2013a).

b) Smart Cities in Asia/Pacific region: The methodology adopted was similar to North American cities but in this case none of the cites submitted primary data for the 28 indicators and the exercise was based on publicly available secondary data and ten cities were ranked accordingly (Cohen 2013c).
c) Smart Cities in Latin America: Similar to ranking of the Asia-Pacific region, Latin American cities did not provide primary data to supplement the publicly available data. Eight cities were ranked with Santiago on top with its complex institutional set-up of 34 independent communities with a separate mayor for each (Cohen 2013b).
d) Smart Cities in European region: Copenhagen led the ranking of Smart Cities in this region, which can be validated with the fact that it is the European Green Capital for 2014 and leading city in Siemens Green City Index (Cohen 2014a).
e) Smartest Cities in the World: The last in the series of Smart City Wheel Rankings, the world's smartest cities list was an advanced version toward bringing the comprehensive set of indicators into the evaluation. A global advisory panel was set up to develop a comprehensive list of indicators for ranking of cities. To an extent the attempt was successful in deriving around 400 indicators but to incorporate them in the evaluation was unsuccessful. Considering 400 indicators as huge for any city to share the data sets within the defined timeline the number was reduced to 62 indicators (Cohen 2014b). Taking into account the standardisation aspect, 25 percent of indicators were directly mapped to the International Organisation for Standardisation ISO37120. Out of the sample 120 eligible cities, only 11 were able to share the primary data within the given timeline.

An assumption in the Smart City Wheel is that all Smart Cities are on the journey towards becoming smarter, including the cities in the ranking list. Highlighting the importance of strategic priority analysis as mentioned in section (Challenges for Smart City model frameworks based on this priority area will be to balance between the built environment and natural environment in a city or region. Smart and innovative practices on how to integrate city planning functional frameworks with learnings from two movements in the theory and practice of planning in the early 1900s will be crucial. As mentioned in the earlier section (2.2.5 Summary), this model also suggests that cities should prioritise the six dimensions and a strategic plan should focus on achieving it.

2.5 Theory of the Triple Helix Model

2.5.1 Introduction

The hypothesis of the Triple Helix started around 1995 with the urge to bring together academia and industry for action research on innovative solutions for communities by policy makers. The hypothesis became articulated as a confluence between Henry Etzkowitz's long-term interest in the study of university-industry relations and Loet Leydesdorff's interest in an evolutionary model in which there is an overlay of communications between different and independent spheres of activity (Lawton & Leydesdorff 2012). The first published research was in Etzkowitz & Leydesdorff (1995) an outcome of the workshop; follow-up workshops to understand the concept were attempted during 1996. This model is seen as a shift from the industrial society model of Lowe (1982); Sábato and Mackenzi (1982 towards the knowledge society model.

2.5.2 First version of Triple Helix Model

(Etzkowitz & Leydesdorff 2000) structured the concept into a model for studying both knowledge based and developing economies. The productive competitiveness of industries and their permanence in terms of policy based decision making relating to areas such as the transfer of knowledge and technology have been included within this framework. Since then, the model has been in the process of refinement and facilitating the basic framework to boost regional innovation systems (Tuunainen 2002; Shinn 2002; Cooke & Leydesdorff 2006; Lawton Smith & Ho 2006; Etzkowitz & Dzisah 2008; Smith & Bagchi-Sen 2010; Carayannis & Campbell 2012; Rosenlund et al. 2014; Cai 2015).

The Triple Helix model of smart cities was introduced by (Leydesdorff & Deakin 2011). This model was based on the hypothetical framework that cities are considered as densities in networks within three significant activities - academia with its intellectual capital, industries with its capacity to create assets and government to manage the society.

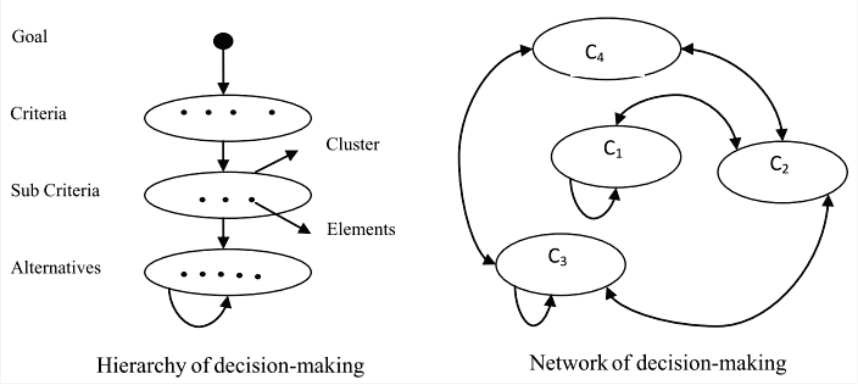
2.5.3 Second version of Triple Helix Model

A modified version of the traditional Triple Helix model was presented by (Lombardi 2011). This version included civil society as the fourth crucial element in today's city management context. In Lombardi's words: "This advanced model presupposes that the four helices operate in a complex urban environment, where civic involvement, along with cultural and social capital endowments, shape the relationships between the traditional helices of university, industry and government. The interplay between these actors and forces determines the success of a city in moving on a smart development path."

2.5.4 Theory of the multi-criteria decision framework

The Analytic Hierarchy Process (AHP) theory developed by Saaty in 1970 is extensively applied in group decision making. It structures a decision problem into a hierarchy or a set of three integrated levels: goal, criteria and alternatives. The challenges of linear structures in traditional multi-criteria decision making approaches were addressed with the introduction of Analytic Network Process (ANP) in 1996. It facilitates decision making across the areas of information by synthesising priorities of all the factors and interests that influence the outcome of a decision. ANP assumes that a decision is only as good as the framework we use to represent its clusters, their elements and the connections we identify among them that depict the influences we perceive (Saaty 1996; Saaty 1999; Saaty & Vargas 2006).

Figure 9: Hierarchy and Network Models of Decision Making



Source: Sadeghi et al. 2012

2.5.5 Integrated Helix Model

Smart city performance assessment for 'four EU policy visions of the Smart Cities by 2050'was based on ANP (Lombardi 2011). This comprehensive assessment included a selection of indicators from literature across the projects within the region and classification according to the dimensions of Smart Cities and by structuring the hexagonal dimensions within the revised Triple Helix model. The results indicated four helices prioritising the entrepreneurial city policy vision. This assumes maximising innovation and creative potential and gaining access to emerging markets outside its region as this will facilitate the survival of European cities in today's globalisation context and also provide an opportunity for cities to understand the alternative options practised to improve their performances.

2.5.6 Summary

There is need for an increased level of trust between the city government and communities and need for commitment between academia (through its research), industry (with viable financing models and innovative solutions), and government (by creating investor friendly cities). Civil society can facilitate the process with its inclusive planning and bridge urban inequity through empowerment of communities (for active engagement in envisioning, planning, execution and evaluation of the city development). Hypothesis of the revised Triple Helix model theory focuses on the interrelationships between the various dimensions of Smart Cities as defined in (2.4 Theory of Hexagonal Dimensions). It presumes that four key actors manage the complex urban environment and the dynamics between them determines the success of cities in moving on a smart development path. Analytic Network Process as a decision making tool for Smart City planning will facilitate in defining hierarchies, priorities and consistency. It also has the capability of conducting sensitivity analysis and doesn't require consensus as it synthesises a representative outcome from various judgments.

Integrating the helical model with multi-criteria methods like ANP can result in robust performance assessment or evaluation tools for Smart City solutions and visions of a region. Especially with increasing use of network information and communication technologies in a large-scale global urban phenomenon like Smart Cities, the analytic network hierarchy theory's interdependency and process repetition methodologies will improve the judgment and understanding of city administrators.

CHAPTER III: Layers of Smart Cities

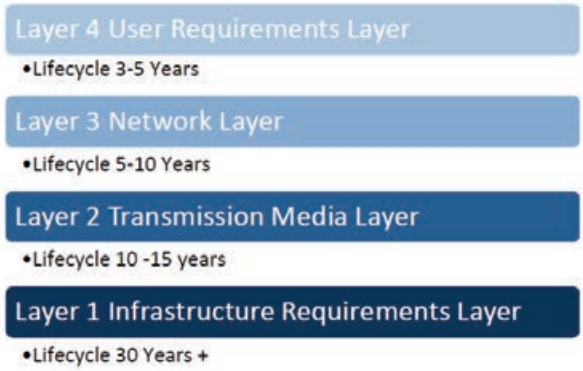
3.1 Introduction

This section is structured around the question mentioned in 1.4.2 What are the components of a Smart City?. The layers of a Smart City are ordered based on the nature of the proponent of the Smart City project, research study or policy programme.. Broadly these are designed around the city systems and act as decision making platforms. As part of this chapter various such models of layers are presented to understand the wide range of components that make a Smart City.

3.2 Layers based on Information and Communication Technology

The Smart City implementation model presented by (Goff 2013) highlights information and communication technology (ICT) as a key component and further subdivides it into four layers according to the lifecycle timeline. The bottom-up ICT requirement model approach focusing on spatial planning for physical infrastructure, network design for data communications, open protocols for control and supervisory platforms and development of city operating systems to facilitate system aggregation and integration considering the lifecycle of technology in the public realm is presented as layers of Smart Cities.

Figure 10: ICT Requirements Model



Source: (Goff 2013)

3.2.1 User requirements layer

This typically consists of software, user interfaces and functional technology. Applications will have short lifecycles typically in the region of 3—5 years and will be highly dependent upon the specific requirements of the city.

3.2.2 Network layer

This refers to the data communication technologies required to deliver the city's user applications. This layer may represent Ethernet transmissions, leased 'point to point' services and fibre to the premise (FTTP). Services at this layer tend to have lifecycles in the region of 5—10 years.

3.2.3 Transmission layer

Here the physical or wireless medium is utilised by the technology in question, e.g. copper, optical fibre or radio waves. This layer will be expected to provide 10—15 years service, particularly cabled infrastructure which should support several generations of application and transmission equipment.

3.2.4 Infrastructure layer

This encompasses above and below ground space and the infrastructure required to support the media layer, for example, underground ducts and interconnecting chambers, building entry points, equipment space, etc. This element of the overall solution should be designed to provide the city with at least 30 years service with minimal requirement for maintenance or further invasive civil engineering works.

3.2.5 Summary

Smart City infrastructures are assumed to be increasingly intelligent within the complex urban environment and will traverse dedicated infrastructure and converging systems thus increasing functionality provided by existing platforms. They will simultaneously provide opportunities for reduction in capital and operating expenditure. This is one of the key learnings from this model.

3.3 Layers Based on Urban Planning Framework

With the Campbell (1996) triangle of conflicting goals for planning as the framework and alternative Smart City approaches as the methodology Anthopoulos & Vakali (2012) presented the following four layer generic architecture. This encompasses all types of attributes related to Smart City planning as mentioned in (1.3 Evolution of smart cities) section on alternative approaches.

3.3.1 User layer

This concerns all e-service end-users and the stakeholders of a Smart City. This layer appears both at the top and at the bottom of the generic architecture because it concerns both the local stakeholders – who supervise, design and offer e-services in a Smart City and —and the endusers, who "consume" the Smart City's services and participate in decision making.

3.3.2 Service layer

This incorporates all the particular e-services being offered by the Smart City.

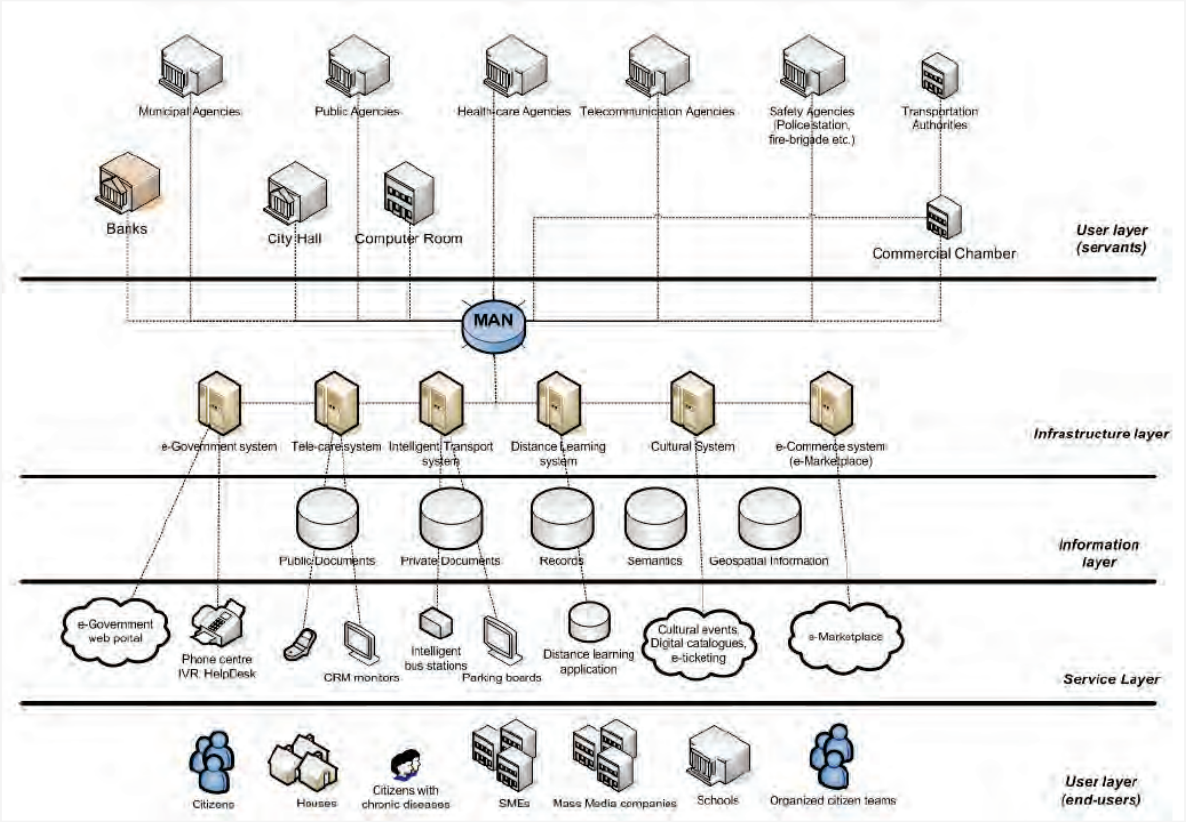
3.3.3 Infrastructure layer

This contains network, information systems and other facilities which contribute to e-Service deployment.

3.3.4 Data layer

This presents all the information which is required, produced and collected in the Smart City.

Figure 11: Multi-Tier Architecture of a Digital City

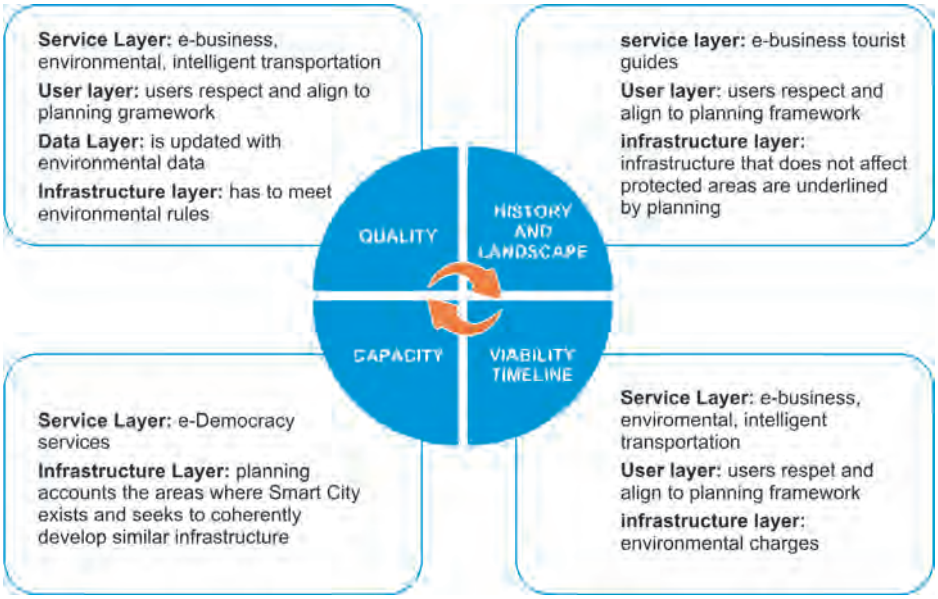


Source: Anthopoulos & Vakali 2012

An alternative approach based on the Smart City layer analysis highlights the importance of data layering. A layer-wise analysis is presented below:

- The User layer contributes significantly in all approaches except in Broadband and Mobile cities, where users mostly consume telecommunication services, and the networks extend to most populated areas.
- The Infrastructure layer does not contribute in Virtual and in Knowledge based cities, while Smart, Digital and Eco-Cities can mostly focus on e-services that can be deployed via alternative infrastructure providers.
- The Service layer makes a significant contribution to the approaches beyond the Smart City approach, while only a few services are offered in the other approaches. In the Virtual City the existence of various ICT infrastructures is not necessary, while data and user layers are crucial for city virtualisation.
- Finally, the Data layer is the basis for service delivery and thus contributes significantly to all the approaches except in the Broadband and the Mobile Cities, which offer telecommunication services.

Figure 12: Smart City layers align to Urban Planning Dimensions



Source: (Anthopoulos & Vakali 2012)

3.3.5 Summary

Alternative approaches to the Smart City were evaluated based on the above generic architecture. The methodology presented in this study will facilitate the selection of the most appropriate approach for any city and also identify the meeting points via which Smart City layers and planning dimensions interact. More specifically, the Smart City's service layer aligns and contributes to all the urban planning dimensions and various e-Services support sustainable local growth. On the other hand, planning dimensions can be affected by Smart City stakeholders via participatory policy making, while the infrastructure of Smart Cities has to be recognised and maximised.

3.4 CISCO Smart City Framework Layers

The CISCO Smart City Framework is presented as a decision methodology that facilitates the implementation process of Smart City initiatives in an effective manner for both public and private stakeholders. To make possible efficient city infrastructure systems and bring transparency in how cities operate, a structured approach is suggested. The circular flow of information within the four layers of the CISCO framework (Falconer 2012) with city objectives as base results in a feedback loop for city stakeholders. The components of each layer are further detailed for better understanding of the framework.

Figure 13: CISCO Smart City Framework Layers

Source: Falconer 2012

3.4.1 City Objectives Layer

This layer emphasises the need for links between the social, environmental, and economic objectives of a city and its projects, policies and initiatives to understand how a city operates.

3.4.2 City Indicators Layer

Considering that city objectives are transient in nature with changing leadership, in this layer of the Smart City framework importance is given to linking city objectives with the existing published city indicators based on a city's priority areas, and more importantly its vision and existing resources. An illustrative case of matching indicators to city objectives is in a city with the sustainability objective, where indicators of the Green City Index might be appropriate.

3.4.3 City Components Layer

This layer details a city's assets like utilities, transportation, real estate and services which are then linked to city objectives, indicators and content.

3.4.4 City Content Layer

The focus of this layer is to map objectives to best practices and policies and facilitate the city's learning process of how Smart City solutions are implemented. Considering replication of innovative solutions and ideas as important phenomena, it highlights the need for a structure, consistency and clarity in reporting successful Smart City solutions and is directly linked to the city component's layer and city objectives.

3.4.5 Summary

The framework presented as part of this model provides two distinct outcomes: how cities function, and the taxonomy for cities to benchmark based on a city's assets. This will enable city stakeholders in developing a Smart City blueprint and documenting innovate initiatives for replication.

3.5 Layers Based on Future Internet Technologies

3.5.1 Introduction

The innovation roadmap presented by Komninos et al. (2011) highlights a series of themes at the intersection of future internet technologies and Smart Cities. It focuses in particular on developments and the impact of three main Internet-based technologies: cloud computing; real-world user interfaces of sensors, tags and RFIDs; and the semantic web. The aim is to assess the expected effects of these technologies on Smart City solutions and operations, and the resulting changes on informational and cognitive processes of information collection and processing, real-time alert, learning, collective intelligence and problem solving, which characterise Smart Cities.

3.5.2 Two dimensional mapping

This includes layers and time periods. The vertical dimension considers the following layers: technological change, business change, policy change and social change. The time dimension includes the short-term, mid-term and longer term developments. At multiple sections of the roadmap transition to the cloud, Smart City pilots, and city-wide open platforms of embedded systems recur. These areas are of primary importance for city authorities all over the world that are deploying strategies for Smart Cities, e-infrastructure and e-services to address the contemporary challenges of competitiveness and sustainable development.

The policy relevance of this approach was enhanced with a focus on the systemic character of innovations related to Smart Cities, which require concurrent processes of socio-economic and technological change. To provide guidelines to this process, the road mapping approach draws from systemic change literature, taking into account several characteristics of systemic change, e.g. regimes, barriers, transitions, and niches of novel solutions.

Figure 14: An Innovation Roadmap to Smart Cities (Part I)

REGIME	*Short term (2014)*	*Medium term (2017)*	*Long term (2022)*
Technological change *(Dominant designs, emerging technologies, interoperability)*	-CLOUD: Virtualisation -CLOUD: IaaS for smart cities	-CLOUD: Web platform -CLOUD: SaaS for smart cities - Content-context fusion	-CLOUD: PaaS for smart cities -CLOUD: Service integration
	-IoT: RFID -IoT: Speech recognition -IoT: Open data apps [6], [8]	-IoT: Multimodal sensors -IoT: Location aware apps, [5], [6], [8]	-IoT: Urban IoT platforms -IoT: Cloud based ontologies -Content-centric networks [2], [9], [14], [16]
Industrial change *(Networks of technology developers, lobbying, standardisation)*	-CLOUD: Large companies clouds, Google, MS, Amazon global clouds	-CLOUD: Large cities clouds	-CLOUD: Standardisation of smart city applications / services
	-IoT: Sensors into utilities and energy networks [6], [8]	-IoT: Alliances of large companies and major cities [2], [6]	-IoT: Large scale applications [2], [3], [6]
Social change *(Behaviour, routines, values, preferences, demand, end-users)*	-CLOUD: Reduction of IT costs	-CLOUD: Security issues raised -CLOUD: Disaster management addressed	-CLOUD: Continuity of service -CLOUD: Learning curve
	- IoT: Experimental facilities -IoT: A few city pilots [6], [15]	-IoT: Multiple city pilots [9]	-IoT: Large scale demand for sensor-based city infrastructure [9], [15]
Policy change *(Regulations, economic instruments, governance, agreements)*	-CLOUD: Transition white papers -CLOUD: Preparing to the cloud	-CLOUD: Pilots at city levels -CLOUD: Legal and regulatory reform	-CLOUD: Whole smart cities on the Cloud [11], [15]
	-IoT: Preparing to the IoT [6], [11]	-IoT: Regulations and procurement [6], [9], [11]	

Figure 15: An Innovation Roadmap to Smart Cities (Part II)

NICHES of novelties	*Short term (2014)*	*Medium term (2017)*	*Long term (2022)*
Technological change	-CLOUD: SaaS -CLOUD: IaaS	-CLOUD: PaaS	
	-IoT: Experimental facilities -IoT: Open / linked data [9]	-IoT: M2M in city environments [2], [9], [15]	
Industrial change	-CLOUD: Private and hybrid clouds -CLOUD: Hosting of G city services	-CLOUD: SaaS and PaaS in the main domains of cities	
	-IoT: IPv6 and HTML5 [6], [11], [15]	-IoT: Smart gird / smart meters in cities [3], [15]	
Social change	-CLOUD: Pilot city applications in city utilities, districts, and gov.	-CLOUD: Large scale demand of smart city applications and services	
	-IoT: Sensors for city environment alert [6], [8], [15]	-IoT: Embedded city intelligence proof of concept [6], [9], [15]	-IoT: Extended demand for sensor over city networks [11]
Policy change	-CLOUD: Government roadmaps to G services -CLOUD: US reform of IT management	-CLOUD: Standards development and adoption	
	-IoT: China encouraging technologies for IoT [6], [9], [11]	-IoT: FP8 IoT PPP -IoT: Harmonisation of frequency bands [6], [10]	

Source: Komninos et al. 2011

Summary

It is believed that a common roadmap for urban innovation and economic development will facilitate in finding consensus on common longer term objectives. Innovation policies and strategies based on this roadmap can concentrate primarily on the management of fundamental layers for achieving a spatial intelligence of cities.

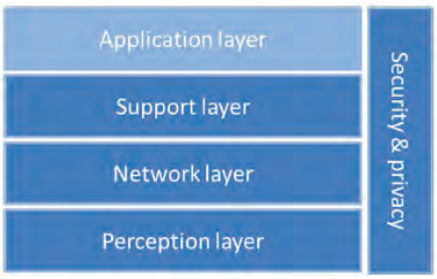
3.6 Layers Based on Intelligent Transport Systems (ITS)

3.6.1 Introduction

This model is an outcome of the study titled "ICT concepts for optimisation of mobility in Smart Cities" conducted for the European Commission by Böhm et al. (2012).

A basic assumption of this model is that Smart Cities are enabled by ICT for sensing, analysing and integrating information systems. The conceptual framework of this model is based on the methodology of how digital infrastructure will enhance and optimise the use of physical infrastructure in the case of emerging Smart Cities in the European region. This model is expected to support the decision making process by providing an assessment of the most important systems that address the challenges related to smart, efficient, safe and clean mobility in cities.

Figure 16: Technical Architecture for ITS and Smart City



Source: (Böhm et al. 2012)

3.6.2 Technical Architecture model for ITS based Smart City

To understand the impact of ICT technology trends on the development and deployment of emerging ICT services for urban mobility a detailed inventory of ICT technology trends was carried out and analysed based on descriptions provided for individual services. The common technical architecture proposed for ITS and Smart City includes the following four layers:

- Perception layer: obtains information of all components of the infrastructure with sensors, actuators, tags and readers
- Network layer: enables data transmission between sensors and actuators and the application support layer by using either wired or increasingly often wireless connections
- Application support layer: provides massive data processing capabilities by using cloud computing
- Application layer: analyses and processes data related to environmental monitoring and intelligent transportation

3.6.3 Summary

Security and privacy have been the overarching layer in this model. From the mobility point of view, the most important aspect is the location of both humans and vehicles; accordingly sensors with positioning technologies were considered for detailed analysis as part of this study.

3.7 Layers based on Data

3.7.1 Introduction

This model by Hawkins (2014) is based on fundamental elements and presents the underlying components of the smart solution. The framework in based on the concept of, 'measuring, moving and managing' data. This simple smart solution framework broadly consists of the following elements: hardware and smart software with supporting common elements like end-to-end security, power provision, local communication paths, and data quality and veracity.

3.7.2 Layers of simplified smart solution framework

3.7.2. (a) Hardware

Working in concert with infrastructure, a combination of devices, sensors, microprocessors and communications technology allow the elements to become aware of their environment:

- Infrastructure: This is the foundation of the smart solution and includes things like water and wastewater treatment facilities, energy infrastructure, transportation systems, street lighting and waste management systems, to name a few.
- Devices and Sensors: These units are responsible for measuring key performance parameters relating to infrastructure. Measurements can range from a few to many hundreds or thousands of parameters. Examples include measurements of temperature, power, volume, vibration, fluid flow, light levels, proximity and stress. The sensors may be part of the deployed infrastructure or retrofitted in the case of upgrading existing infrastructure.
- Embedded Processing: With the processing power available today from relatively simple modem chipsets, data processing and even analytics can be undertaken at the edge. This data processing might consist of data aggregation, data parsing, local process control, etc. The advantage of undertaking edge processing is that it optimises data and control flows by ensuring only the required information is passed to the central core.
- Wide Area Connectivity: This describes the often complex web of connectivity path(s) required to transport data between the infrastructure under consideration to the central place(s) where it will be stored, processed and acted upon. These connective paths may include wired and wireless technologies including, but not limited to, fiber, mesh networks, local area networks and cellular networks. In many ways you can think of communications, or more generally ICT

(Information and Communications Technology), as the glue that holds the smart solution together.

3.7.2 (b) Smart Software

Smart Software complements and leverages the data coming from physical hardware and acts as the heart of any smart solution.

- **Data Management:** Data must be aggregated and stored to be available for further processing into valuable information. Although utilities have traditionally favoured firewalled and isolated standalone data storage located within their own network, cloud-sponsored capabilities are quickly growing. The degree of data in the cloud is often dependent on the size of the IT organisation. In fact, the capabilities of the cloud allow smaller utilities or businesses to take advantage of the same tools that their bigger brethren use, further increasing the reach of the technology revolution.
- **Analytics**: Analytics applications are the brains of the smart solution and involve the discovery and communication of meaningful patterns in data to drive improved performance and identify future opportunities and risks. Analytics include the application of statistics, first-principle models, simulation and data aggregation techniques using data from a wide array of system-based or cloud-based sources. In addition to directing control functions, analytics are used to perform complex assessments of things like maintenance, operations or compliance strategies. Although centralised analytics are important for complex, multi-system challenges, the sheer volume of data is also driving some analytics to move closer to where the data is produced to enable faster action and require less processing.
- **Optimisation and Control**: The final, critical step in this end-to-end model is to take appropriate actions. Realising the value from data and analytics requires taking actions that positively impact performance. Analytics help control and manage "local" optimisation systems by evaluating performance against system or "global" goals and helping to find the right recipe for improvements. Optimisation and control closes the loop within the smart solution.

3.7.2 (c) Supporting Elements

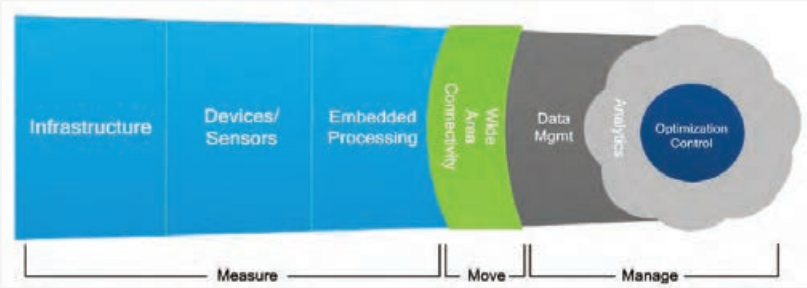
End-to-end security: Security is a major consideration within any smart solution. This is particularly true for critical infrastructure such as electricity or water systems and for processes that require the transport of personal and financial information.

Power provision: Smart systems cannot function without power. At the device/sensor level typically only low power is required but deployments can be in the hundreds or thousands of units and making power available at all locations can be a challenge. For centrally-based elements, like cloud-based analytics and control systems, there are just a few physical installations but their power requirements are more onerous. Where new infrastructure is being deployed, power provisioning through the local utility is often required.

Local communication paths: In addition to wide area connectivity, the majority of smart solutions will incorporate many localised connectivity paths. These paths make use of a variety of wired and wireless communications technologies. With so many and such diverse potential for communication paths, it is important to manage how data is routed and which end-users it reaches. Further, different data types require differing levels of Quality of Service (QoS), often entailing the prioritisation of different traffic flows.

Data Quality and Veracity. It is critical that data quality and veracity is adequate for the job at hand; it is often necessary to employ specialised analytics to cleanse and/or augment the raw data streams.

Figure 17: A Simple Smart Solution Network



Source: Hawkins 2014

3.7.3 Summary

Infrastructure is the base layer for a Smart City framework and ICT is the binding element for various components of the system while analytics is the processor for this framework. Smart Analytics provide context to problems and enable a much clearer view into what is an increasingly complex urban environment. To address large, complex and dynamic optimisation challenges an integrated enterprise data management and analytics approach is recommended.

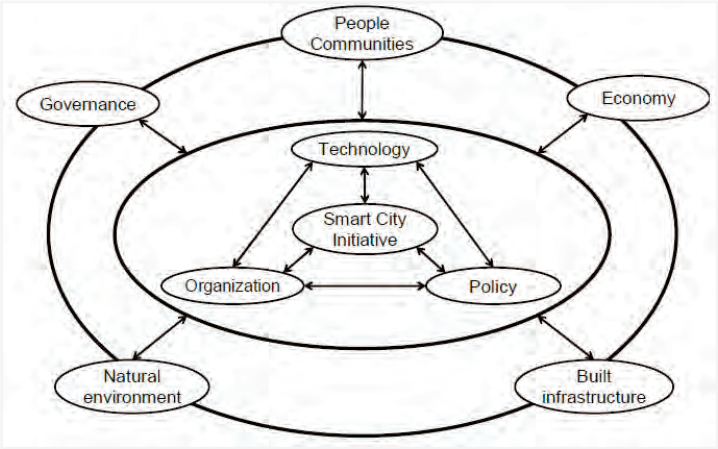
3.8 Layers based on an Integrated Approach

3.8.1 Introduction

This model focuses on the integrated framework and is proposed by Chourabi et al. (2011) based on literature from various disciplinary areas. The following eight critical factors of Smart City initiatives were identified to develop this model: management and organisation, technology, governance, policy, context, people and communities, economy, built infrastructure, and natural environment. These factors form the basis of an integrative framework that can be used to examine how local governments are envisioning Smart City initiatives.

3.8.2 Smart Cities Initiatives Framework

Figure 18: Smart City Initiatives Framework



Source: Chourabi et al. 2011

The diagram explains the relationships and influences between the listed factors and initiatives.

3.8.3 Summary

This integrated framework could facilitate the relative success of an analysis of Smart City initiatives, and also assess the actual impact on types of variables (organisational, technical, contextual) on the success of Smart City initiatives.

3.9 Layers Based on Integrated Solutions Framework

3.9.1 Introduction

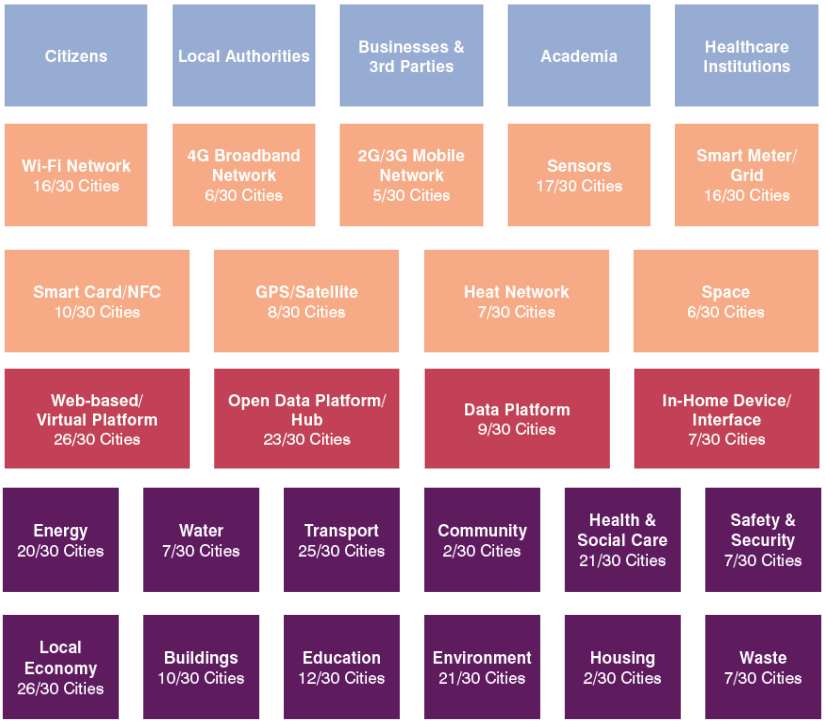
This model is based on the Kessides (2013) Future Cities Demonstrator Programme call for projects that integrate city systems at a large scale. The aim of the programme was to fund one city to enable it to make its vision a reality. The proposals included real challenges that cities are facing and the solutions. The model evolved from the evaluation methodology of the proposals received from various cities for a feasibility assessment as part of the grouping stage.

3.9.2 Four Layers for Common Integration Themes

The following are the four layers that were derived from the proposals for analysis:

i. **Organisation** with the stakeholders (e.g. citizens, local authorities, private sector).
ii. **Infrastructure** with the support infrastructures such as wi-fi and broadband communication networks as well as sensors such as smart meters.
iii. **Platform** dealing with data integration, visualisation and in-home interfaces.
iv. **Systems applications** showing the city infrastructures (e.g. energy, transport, education).

Figure 19: Integrated Solutions Framework



Source: Kessides (2013)

3.10 Layers Based on Development Growth Model

3.10.1 Introduction

The (NEC n.d.) model argues to help cities flexibly respond to challenges that arise during each stage of development with Smart City solutions designed to enable high-quality urban living. The implementation strategy of this model as mentioned in its brief, is an alternative to rigid solutions optimised to projected needs by providing flexible infrastructure solutions in response to the ever-changing needs of needs.

3.10.2 Stages of Development and Layers

City development is a continuous process with incremental evolution at each stage. (NEC n.d.) defines city evolution as a three-stage process consisting of growth, maturation and reconstruction. During the Growth stage, a city's infrastructure develops rapidly in response to industrial growth and a rising population. To a large degree, quantity is prioritised over quality. In the Maturation stage, growth stabilises and residents seek a higher standard of living by purchasing higher quality goods and services, moving to the suburbs, etc. Quality is prioritised over quantity during this phase. During the Reconstruction stage, mature cities undergo renewal to maintain services and enable further development. These cities collaborate with other cities to meet new challenges. They also redevelop to satisfy the changing expectations of residents, who may otherwise relocate.

3.10.3 Summary

The model suggests that by collecting and sharing information more effectively and linking the network layers that support urban life, state-of-the-art ICT can bring people closer together, strengthen the fabric of society. Information in each network layer is monitored in real time and transmitted where necessary based on everyday demands and special needs that arise during disasters and other emergencies.

Figure 20: Layers Based on City Development Needs

Layer	Growth stage	Maturation stage	Reconstruction stage
Infrastructure	A base for industry and lifestyles	Additional Investment and expansion	Renewal & maintenance
Transportation	Mass transit such as railroads	Private cars	Collaborative multi-system transportation
Energy	Supply that meets growing demand	Stability to meet emergencies	Efficient supply of multiple sources
Lifestyle	Living essentials	Quality products & services that raise satisfaction	Services that bond people & offer social benefits
NEC solution	Streamlining services within a layer	Services that connect layers	Inter-city services & functions

Source: NEC (n.d.)

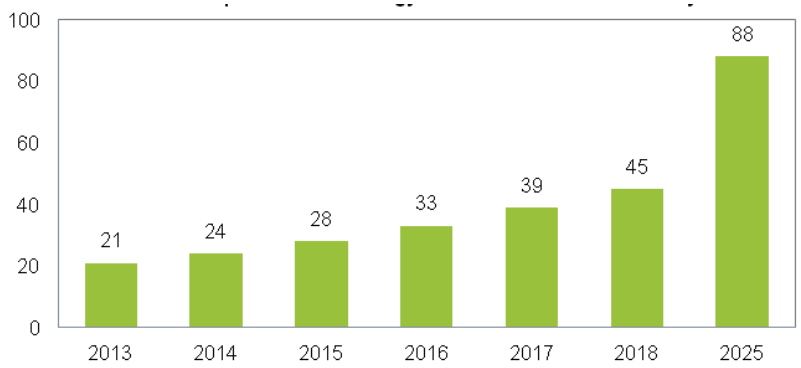
CHAPTER IV - Practice of Smart Cities

4.1 Introduction

This chapter is structured around the key questions stated in Chapter 1. Smart Cities development models are presented in the first part followed by empirical case studies of how Smart Cities, Smart City Projects and Smart City initiatives around the globe have been successful in implementing innovative solutions, and the spectrum of tools in a Smart City toolkit, enablers and barriers.

The number of Smart Cities worldwide is expected to quadruple within the 12-year period from 2013 based on the analysis by Arrowsmith (2014). There will be at least 88 Smart Cities all over the world by 2025, up from 21 in 2013 as shown in the graph below, based on the IHS definition of a Smart City. While the combined Europe-Middle East-Africa (EMEA) region represented the largest number of Smart Cities in 2013, Asia-Pacific is expected to take the lead in 2025. In all, Asia-Pacific will account for 32 Smart Cities of the total in nine years' time; Europe will have 31, and the Americas will contribute 25.

Figure 21: Number of Smart Cities Worldwide,
as per IHS Technology's Definition of a 'Smart City'



Source: IHS Technology, July 2014 (Arrowsmith 2014)

4.2 Smart Cities Development Models

The development of Smart cities usually differs between various urban contexts in relation to the driving forces, the investment requirements and the stakeholders involved. The process of development of a Smart City can be based on two different development models called Greenfield and Brownfield. The ICT solutions implemented in the creation of a Smart City can change significantly in different urban contexts (Amitrano et al. 2014). The choice of technological patterns is linked to each project's requirements: a Greenfield city requires larger ICT investments for the development of new builds from scratch, while Brownfield cities require an evolution/transformation of existing ICT capabilities.

4.2.1 Greenfield Development

These are also defined as the new build cities (Accenture et al. 2011) or simply new cities. They are urban contexts created Smart starting from their construction. They are often purpose-built, strategically placed and designed to attract businesses and communities with a master plan that incorporates ICT infrastructure and world class services such as renewable energy, green buildings,

seamless broadband connectivity, intelligent transportation systems and other intelligent city systems (Bélissent 2010).

These projects have long-term plans that range between 10 and 25 years. Because of their extensive time span, these projects can also focus on revenue realisation and returns on investment. As their "turn-key" dealings, these projects have strong budgets for long-term execution.

Examples of these cities are increasing around the world, especially in emerging markets: Masdar in Abu Dhabi, Lusail in Qatar, Songdo in Korea, Caofeidian and Meixi Lake in China, Lavasa in India, Ganthoot Green City in Emirates, King Abdullah Economic City in Saudi Arabia, Skolkovo in Russia. These initiatives can help to build momentum and accelerate the move to a broader intelligent infrastructure by demonstrating success through offering case studies that can be transferred to other urban environments (Accenture et al. 2011). This model also includes projects involving the development of new smart neighbourhoods or new Smart Cities in suburban areas, a kind of 'city within a city'. Examples of this typology are Fujisawa in Japan, Plan IT Valley in Portugal, and Najing Green City and Tianjin Eco City in China.

4.2.2 Brownfield Development

Smart Cities often related to smart interventions in the existing context are referred to as Brownfield cities (The European House -Ambrosetti 2014) or 'existing cities' (Bélissent 2010). In this case Smart City development process allows one to proceed by incremental steps, focusing on priority issues and drivers.

Brownfield projects are much smaller sized projects focused on a limited number of implementation areas. These projects have a shorter term of 3 to 6 years for project execution. Because of their fast implementation process, investors prefer these projects as they bring project revenue and investment return. Implementation of Brownfield projects is challenging and restricted as these are connected to existing infrastructure and are located within the existing urban contexts.

For example, in cities placed in developed market countries, the main smart experiences are inspired to achieve energy efficiency and sustainable mobility, while in developing countries, cities face the primary challenges of over-congestion, both in population density and traffic volume (Accenture et al. 2011). Some researchers have pointed out that these interventions are so essential to cities that they "arguably need to become smart in order to remain cities at all" (Bélissent 2010). Brownfield Development often includes various approaches like redevelopment, regeneration, and retrofitting. The scale and extent of development is defined by the approach adopted.

Effective management of urban land use is central to global strategies to achieve sustainable development. An important component of the land management is the increase in and persistence of Brownfield areas and difficulties in regenerating these areas. For example, in Europe, land use changes over the last fifty years have resulted in swift and wide scale dereliction in some areas and slow decline elsewhere, leading to a significant legacy of Brownfield areas in these regions. During this time of land use change, rather than addressing the problem, cases of poor land management practices have led to urban decay, deprivation and social conflicts. Brownfields can have a negative impact on the surrounding area and community, and hinder effective regeneration. Regenerating Brownfields can stimulate opportunities at numerous levels, improving urban quality of life enhancing urban competitiveness, and reducing urban sprawl. Although there are numerous urban challenges, such as identifying solutions for transportation pressures, etc, the beneficial re-use of Brownfields is significant, pervading and impacting on so many other urban issues, that it warrants a high level of both technical and political attention. Finding solutions for Brownfield sites is an increasingly

important part of the search for effective policies that are aimed at ensuring a sustainable future for land, and Smart Cities in particular (Ferber et al. 2006).

Some of the examples of Smart City Initiatives across the Brownfield development approaches are Porto Maraviliha in Brazil, Dockside Green in Victoria (Canada), HafenCity in Hamburg (Germany), Fujisawa in Japan, Christchurch in New Zealand, Guangzhou Intelligent City in China, Amsterdam in Netherlands, HammarbySjöstad in Stockholm's Urban Regeneration Project, Copenhagen in Denmark, Newcastle in Australia, and New York in the United States.

4.3. Smart City Case Studies

4.3.1 The London suburb of Hackbridge (UK)

Hackbridge is a largely residential suburb located within the London Borough of Sutton, South West London. Having first experienced significant development in the 1890's, Hackbridge today has a population of approximately 8,000 people, living in a diverse range of house types ranging from early Victorian terraces to the internationally renowned 'eco-village' that is BedZED. In 2005, Sutton Council announced their commitment to sustainability in adopting the concept of 'One Planet Living', a series of environmental principles developed by specialist consultants BioRegional, in an innovative partnership known as One Planet Sutton. The 10 One Planet Living principles promoted by BioRegional are intended to underpin the transformation of Hackbridge as a pilot area within the borough, with the aim of creating the UK's first zero-carbon sustainable suburb by 2025. In order to meet such objectives, Sutton Council have announced plans to mass-retrofit hundreds of homes across Hackbridge to improve energy performance (Mark n.d.). The London Borough of Sutton has an ambitious vision to make the Hackbridge suburb the UK's most sustainable place to live in, and a zero-

Figure 22: Beddington Zero (fossil) Energy Development (BedZED)

Source: (Twinn 2003)

carbon area based on the principles of One Planet Living. Sustainable travel comprises part of an integrated approach which also includes decentralised energy systems, energy-efficient homes, green businesses (featuring workplace travel plans) and local food schemes, which will cut CO_2 emissions and reduce our impact on the environment. The council is working with the Hackbridge community and enjoys an overwhelming level of support – over 90 percent of Hackbridge respondents confirmed that they were supportive of the proposed vision (Forrest 2009).

4.3.2 Hafencity in Hamburg (Germany)

HafenCity is currently Europe's largest inner-city development project. Here, city leaders planned pilot projects including an integrated e-mobility solution to help reduce and optimize traffic by offering alternative ways of transportation using cars/electric cars, bicycles/electric bicycles in a car-sharing model. Further on, a smart building solution will be tested (Sinko n.d.).

Figure 23: Hafen City

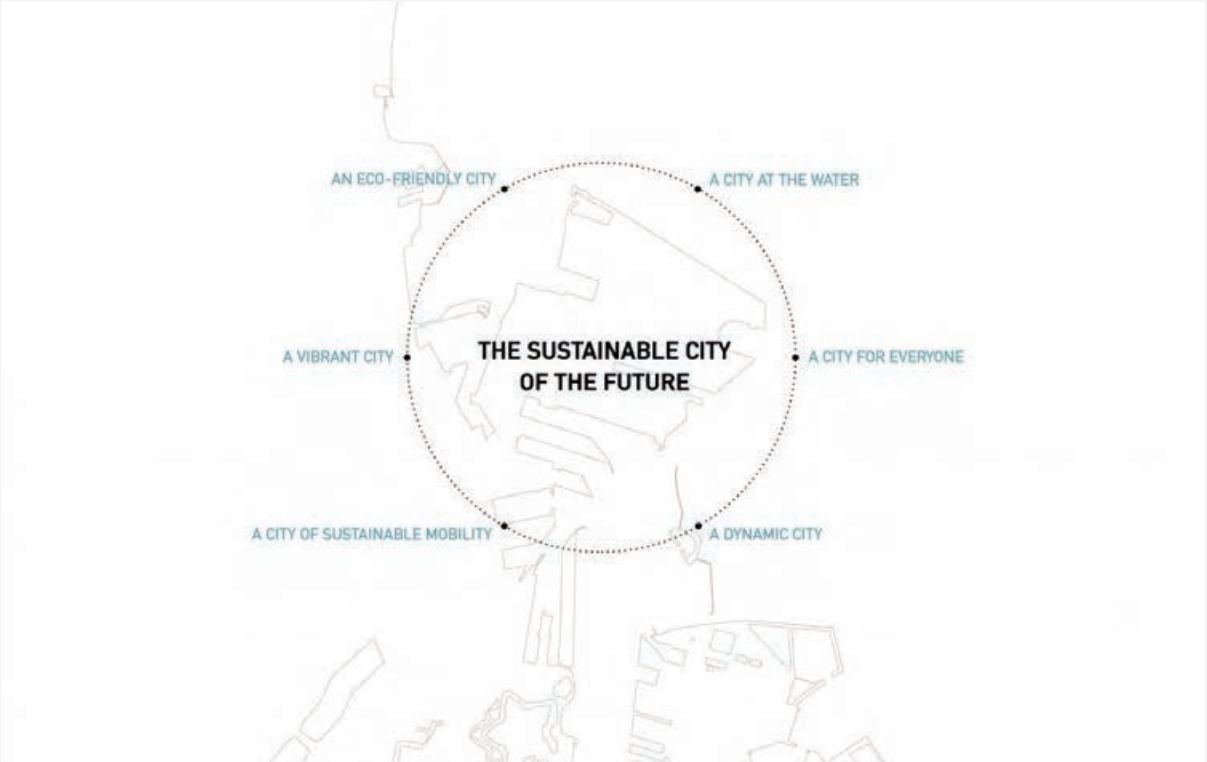
Source: Bruns-Berentelg (n.d.)

HafenCity – currently Europe’s largest inner-city development project – is a blueprint for the development of a European city on the waterfront. Almost 1,500 living spaces have been completed; more than 450 companies have moved into HafenCity.

4.3.3 Nordhavn in Copenhagen (Denmark)

Nordhavn, the second big project in Europe, covers 200 hectares. This former industrial area is being transformed into an entirely new, sustainable district. Creating a sustainable city is not just about environmental responsibility. It is also about value creation and social diversity, and Nordhavn overcomes some of Orestad’s negatives, like outdoor living space. It is expected to have a denser, lower structure, with homes, offices and retailing units 'on a traditional Copenhagen scale'.

Figure 24: The Six Visions for the Nordhavn District



Source: Danish Architecture Centre (n.d.)

Nordhavn's master plan includes two large - public spaces, alongside smaller parks that will give residents play and exercise areas, drawing on Copenhagen's wider interest in so-called pocket parks: attractive, well-lit green spaces of fewer than 5,000 square meters, often created on irregular plots, where friends can meet or take a lunch break and children can play safely. Nordhavn is essentially an urban regeneration plan, on and around former shipping docks with provision of space for 40,000 residents and 40,000 jobs.

Contributing to realising the vision of becoming the world's first carbon neutral capital, the City of Copenhagen has launched one of the most extensive and most ambitious urban development projects in Scandinavia -Nordhavn. The project spearheads efforts to improve climate conditions and shows how cities can help reverse climate change without losing out on quality of life, welfare and democracy. Renewable energy and new types of energy, optimal use of resources, recycling of resources and sustainable transport will help make Nordhavn a model for sustainable development and design. The development of Nordhavn is based on close dialogue with residents, future users of the area and other stakeholders to ensure that people in Copenhagen take joint ownership of the new sustainable city district (CPH City 2009).

4.3.4 Stockholm Royal Seaport (Sweden)

Stockholm is already a world leader in many areas of the world in creating climate-adapted society. Like other big cities, Stockholm is contending with the challenge of reconciling a rapidly growing city with a high level of environmental ambition. In its environmental programme 2008‹2011, Stockholm City Council decided that Stockholm Royal Seaport should be given a distinctive environmental profile, drawing on experiences gained from HammarbySjostad. Stockholm Royal Seaport environment profile should:

- Consolidate Stockholm's position as a leading capital city in climate work
- Support the marketing of Swedish Environmental Technology
- Contribute to the development of new technology, benefitting all housing construction in Sweden

The vision for the Stockholm Royal Seaport has three generic targets for 'a world-class urban district':

1. By 2020 carbon dioxide emission should be less than 1.5 tonnes per person. This can be compared with the current average of approximately 4.5 tonnes per person.
2. To adapt to future climate change, for example increased precipitation, neighbourhood development design should be adapted according to the prognosis for future sea-level rise.
3. By 2030 the Stockholm Royal Seaport should be fossil fuel-free. This ambition is higher than for the city as a whole, where the same target has been set for 2050.

In order to achieve these targets, efforts will focus on five areas: energy use, environmentally efficient transport, adaptation to a changed climate, cycles and cyclic models at system level, and lifestyle issues.

The urban district spread over 236 hectares when completed in 2030, is expected to provide 10,000 apartments and 30,000 workspaces. The Stockholm Royal Seaport aims to be a diverse neighbourhood combining offices and climate-adapted housing with a green inner-city character. To meet environmental targets, the neighbourhood will provide public transport in the form of subways, biogas-powered buses, tram and boat buses. It includes a closed-loop integrated waste management system and LEED-certified buildings. The area is prepared for a future smart grid electrical system (Stockholm stad 2010).

Figure 25: Stockholm Royal Seaport Vision 2030

Source: Stockholm stad (2010)

4.3.5 Oulu Arctic City (Finland)

The City of Oulu, the capital of Northern Scandinavia, plans to build a city district that will serve as a model for environmental design in the northern hemisphere. Hiukkavaara, the Arctic Smart City, will be the largest city district to be built in Northern Finland and the most important future construction and investment area in Oulu. The total investment of the Hiukkavaara district amounts to 1.8 billion euros. The new Hiukkavaara district is a model for sustainable, building and living in the Arctic region. By the year 2035 Hiukkavaara will be a modern urban district with 20,000 people, 10,000 housing units, 1,800 workplaces and smart services for 40,000 consumers.

Development themes of Hiukkavaara include energy efficient city living with smart grids, alternative and renewable forms of energy, ecological water system, and centralized waste management. Additionally, ICT services for a Smart City, functional public transportation, and safe wintertime cycling are also being researched. The district will also include facilities for a creative sector (City of Oulu 2013).

Figure 26: Hiukkavaara - Arctic Smart City

Source: Congress (2012)

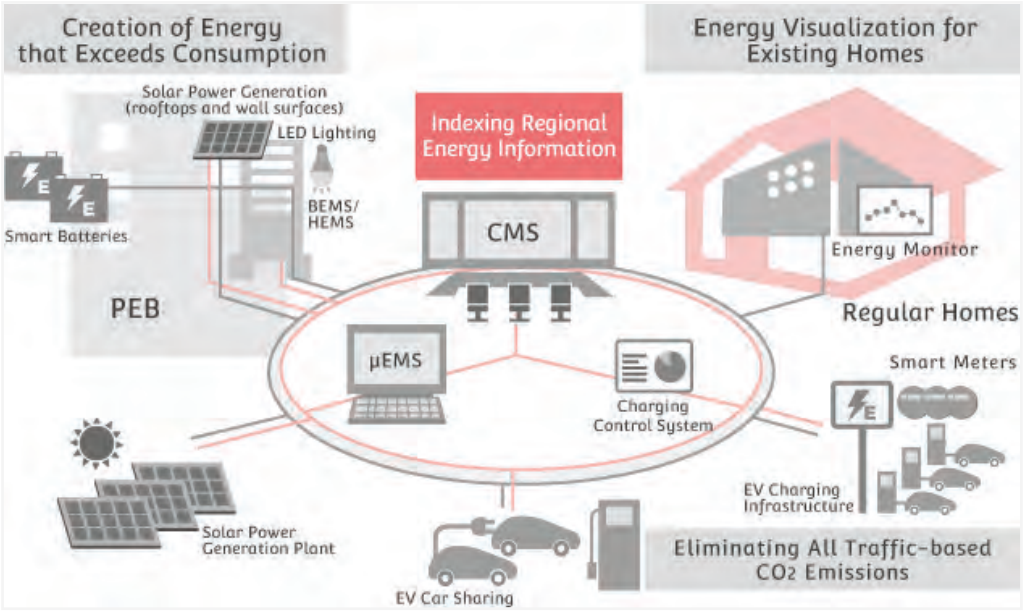
4.3.5.1 Hiukkavaara Living Lab

Building in sub Arctic and Arctic areas requires special solutions and knowhow: skill and technology to build climate friendly, energy efficient and user oriented winter cities with innovative services and logistic processes. Building cities is a long-term activity in which a 10–20 year period is a relatively short time. Finnish real estate and building clusters must immediately in their global strategy take into consideration the rising significance of the northern hemisphere. Located in the capital of northern Scandinavia, Hiukkavaara Living Lab with its research, development, testing facilities offers a excellent possibility and test bed in such activities. One such facility is its Arctic Smart City Living Lab which focuses on:

- Landuse: Integrating city development, participatory planning throughout the lifespan of a city
- Building solutions: Arctic smart buildings, energy efficient and durable buildings in extreme conditions
- ICT: Smart city solutions, Smart grids, ICT platform, solutions, services

4.3.6 Lyon Smart Community (France)

Figure 27: Lyon Smart Community



Source: Toshibha (n.d.)

An urban redevelopment project is underway in the Confluence district of Lyon, France. The district is a sandbank nestled between rivers, and to coincide with the redevelopment, smart devices will be introduced to the urban infrastructure being newly built. The project, which includes homes, buildings and transportation in an area of roughly 150 hectares, will involve the active adoption of solutions such as solar power generation, and establish management technologies for its effective use under the theme of "a sustainable city through renewable energy utilization and management systems."

The project will aim to change the way residents behave with respect to energy by visualising in-home electricity, gas and water energy, and providing recommendations on energy usage. On the transportation front, a car sharing project using electric vehicles which use solar power generation as their energy source will be launched to create a traffic system producing zero-emission that will also help ease traffic congestion (Toshibha n.d.).

4.3.7 Aspern in Vienna (Austria)

Aspern Vienna's Urban Lakeside is a project of new dimensions. The 240-hectare project area makes it one of Europe's largest urban developments; it is a city within the city. Quality of life and cooperation rank at the top of the agenda. Aspern Vienna's Urban Lakeside will be built in the northeast of the city by 2028. In the future, 8,500 housing units will accommodate 20,000 people. Furthermore, 20,000 jobs will be created in the fields of service, trade and industry, science, research and education.

Figure 28: Aspern - Urban Lakeside Project

Source: SES (2013)

The project has a prime location at the centre of the economic growth region CENTROPE, right on the Vienna-Bratislava axis: Bratislava's central station can be reached within 28 minutes and Vienna airport within 15 minutes. Construction works have started to connect the Urban Lakeside to Vienna's underground system, which will reduce journey time from the city centre to 25 minutes. Aspern will become a new centre for Vienna's 22nd municipal district, providing new stimuli for the region's economic development by creating new jobs. This project represents an opportunity to develop a long-term integrated concept for an energy-optimised city district using appropriate technologies, products, and solutions in a real-world infrastructure.

The following are some of the key principles on which Aspern is based:

- Urban density and generous leisure areas (50 % space)
- Quality of public space (manual of public space, quality assurance)
- City of short distances (mixed-use quarters, public transport first)
- Eco-friendly mobility first
- Sustainability as a principle (buildings, energy, public space, mobility)

4.3.8 Tianjin Eco-city (China)

Located just two hours west of Beijing by car and 30 minutes by high-speed rail, Tianjin is among the fastest-growing cities in China in terms of population and economy. It has a population of 12.9 million and is expected to grow by 500,000 a year. The city's GDP per capita surpasses many countries such as

Russia and Brazil. In 2011, Tianjin's GDP was 1,119 billion CNY (US$ 177 billion) with a year-over-year increase of 16 percent.

The Chinese government set two criteria for the location of the Eco-city site. Firstly, it should be developed on non-arable land; secondly, it should be located in an area facing water shortage. Four possible locations for the project were identified – in Baotou (Inner Mongolia), Tangshan (Hebei province), Tianjin municipality, and Urumqi (Xinjiang). The Tianjin site was eventually selected after a thorough study of both sides, taking into account considerations such as the state of development of the surrounding infrastructure, ease of accessibility and commercial viability.

Tianjin Eco-city has a total land area of 30 sq. km. The Eco-city is planned for a population of 350,000. The goal is to develop the Eco-city over 10—15 years. The start-up area is scheduled for completion by end-2013. Prior to the development of the Eco-city, the site comprised mainly saltpans, barren land and polluted water-bodies, including a 2.6 sq. km large wastewater pond.

Figure 29: Tianjin Development Timeframe

Source: Singapore (n.d.)

The Tianjin Eco-city's vision is to be "A thriving city which is socially harmonious, environmentally-friendly and resource-efficient – a model for sustainable development." This vision is underpinned by the concepts of "Three Harmonies" and "Three Abilities".

"Three Harmonies" refers to:

- People living in harmony with other people, i.e. social harmony
- People living in harmony with economic activities, i.e. economic vibrancy
- People living in harmony with the environment, i.e. environmental sustainability

"Three Abilities" refers to the Eco-city being:

- Practicable —the technologies adopted in the Eco-city must be affordable and commercially viable

- Replicable —the principles and models of the Eco-city could be applied to other cities in China and even in other countries
- Scalable —the principles and models could be adapted for another project or development of a different scale

Figure 30: Tianjin Ecocity (2013)

Source: Singapore (n.d.)

Figure 31: Public Utilities Operations & Maintenance Centre commences operation

Source: Singapore (n.d.)

4.3.9 New Songdo City, Incheon (South Korea)

Songdo International Business District (IBD) is a $35 billon dollar venture of a new smart city, located in South Korea. It was built from scratch on 1,500 acres (610 ha) of reclaimed land along Incheon's waterfront in South Korea, 65 km from the capital, Seoul. Songdo IBD aspires to become a business hub in northeast Asia. The main developers are Gale International, Posco and Morgan Stanley Real Estate. The city is master planned according to LEED-ND principles (a globally accredited rating system for green neighbourhoods) that call for a synergistic mix of uses. Open spaces account for 40 percent of the area and walking is encouraged. On its completion the district will contain 80,000 apartments, 50,000,000 square feet (4,600,000 m2) of office space and 10,000,000 square feet (930,000 m2) of retail space. In this newly-built city, CISCO showcases their Smart+Connected Communities

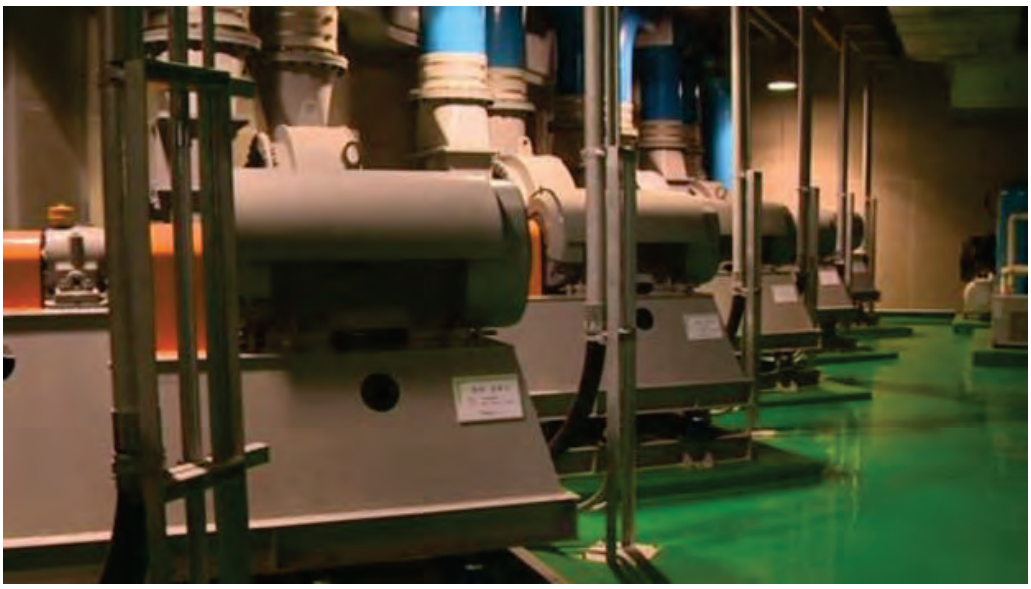
programme. The technology vendor employed state-of-the-art technology in buildings, forging a network that connects all the components of the city, including residences, offices and schools. Residents are able to control the functions of their homes remotely and everyone is able to interact through video from anywhere through CISCO's Telepresence System. The first phase of Songdo opened in August 2009. However, the construction of the city has been progressing slower than anticipated ever since. According to Shwayri (2013), for now Songdo is more of a wealthy suburb of Incheon city, mostly populated by locals.

On the technological front, a brand new city offers the chance to build some futuristic hardware. Songdo has been designed with sensors to monitor temperature, energy use and traffic flow. These sensors can —in theory —alert you, personally, when your bus is due; or let the local authority know about any problems.

A lot of these innovations are designed with the environment in mind —charging stations for electric cars, for example, or a water-recycling system that prevents clean drinking water being used to flush office toilets.

The waste disposal system has no rubbish trucks trawling the streets or vast bins dotted around blocks of flats. Instead, all household waste is sucked directly from individual kitchens through a vast underground network of tunnels to waste processing centres where it's automatically sorted, deodorised and treated to be kinder to the environment. Once fully operational the household waste will be used to produce renewable energy .

Figure 32: The Waste Collection System



Source: Williamson (2013)

4.3.10 Sino-Singapore Guangzhou Knowledge City (China)

The Sino-Singapore Guangzhou Knowledge City (SSGKC) project continues as the next iconic project of Sino-Singapore cooperation after the Suzhou Industrial Park and Tianjin Eco-city. The vision of SSGKC is to be a unique, vibrant and sustainable city that is highly attractive to both talents and knowledge-based industries, and to serve as a model and catalyst for Guangdong's economic transformation.

SSGKC is located in the northeast of Guangzhou City, between the second and third ring roads. It sits 35 km, or merely a half-hour drive, from the Guangzhou city centre and 25 km from Guangzhou Baiyun International Airport. SSGKC itself has a total site area of 123 sq km, half of which will be

preserved as forest; the remaining 60 sq km of land is being developed in phases over the next 15 to 20 years. The Metro, regional high speed rail and expressways are also being constructed to serve the site in tandem with its development phasing. When fully completed, SSGKC is expected to house a live-in population of more than 500,000 people, serving more than two million people in the immediate vicinity.

Figure 33: Location of Sino-Singapore Guangzhou Knowledge City – at the Heart of Pearl River Delta

Source: SSGKC (n.d.)

Six pillar industries have been identified for development, namely: Next Generation Information & Communication Technology (ICT); Biotechnology & Pharmaceuticals; Clean Technology; Next Generation Materials; Culture & Creative Industries; and Science & Education services.

The goal is to build a home for all to live, work and play through the strategic initiatives of Smart City, Eco City and Learning City, complemented by Software Collaboration projects and programmes where Singapore's experience can be adapted. These three major elements underlie and permeate every aspect of SSGKC's development, making it a hub for innovative knowledge-based industries and an ideal habitat for living.

SSGKC will be a Smart City, integrating urban management systems, powered by leading information and telecommunication technologies which will drive sustainable economic growth, a high quality of life, and wise management of natural resources.

SSGKC will be an Eco City, integrating urban planning with energy efficiency, water efficiency and other sustainability solutions. All buildings in SSGKC will comply with green building standards, and the transportation system will comprise of green vehicles that use renewable energy.

SSGKC will be a Learning City, to enable the city's government, residents and enterprises to interact and to provide the foundation for transformation into a knowledge economy. In the Learning City, all residents will have access to information resources and quality educational opportunities.

Figure 34: Sino-Singapore Guangzhou Knowledge City – Strategic Collaboration

Source: SSGKC (n.d.)

4.3.11 Masdar City (UAE)

Masdar City combines state-of-the-art technologies with the planning principles of traditional Arab settlements to create a desert community that aims to be carbon neutral and zero waste. The 640-hectare project is a key component of the Masdar Initiative, established by the government of Abu Dhabi to advance the development of renewable energy and clean-technology solutions for a life beyond oil. The city will become a centre for the advancement of new ideas for energy production, with the ambition of attracting the highest levels of expertise. Knowledge gained here has already aided the development of Abu Dhabi's 'Estidama' rating system for sustainable building.

Figure 35: Masdar City Project

Source: Foster+Partners (2008)

A mixed-use, low-rise, high-density development, Masdar City includes the headquarters for the International Renewable Energy Agency and the Masdar Institute. Strategically located for Abu Dhabi's transport infrastructure, Masdar is linked to neighbouring communities and the international airport by existing road and rail routes. The city itself will be the first modern community in the world to operate without fossil-fuelled vehicles at street level. With a maximum distance of 200 metres to the nearest rapid transport links and amenities, the city is designed to encourage walking, while its shaded streets and courtyards offer an attractive pedestrian environment, sheltered from climatic extremes. The land surrounding the city will contain wind and photovoltaic farms, research fields and plantations, allowing the community to be entirely energy self-sufficient.

The development is divided into two sectors, bridged by a linear park, and is being constructed in phases, beginning with the larger sector. The master plan is designed to be highly flexible, to allow it to benefit from emergent technologies and to respond to lessons learnt during the implementation of the initial phases. Expansion has been anticipated from the outset, allowing for growth while avoiding the sprawl that besets so many cities. While Masdar's design represents a specific response to its location and climate, the underlying principles are applicable anywhere the world. In that sense it offers a blueprint for the sustainable city of the future (Foster+Partners 2008).

Masdar City covers an area of 6 sq. km. By 2020 it is hoped that the new town will have 50,000 inhabitants, plus 40,000 non-resident workers. It is certainly one of the most radical Smart City projects. With its ambitious energy policy, meticulous architecture and high quality research and innovation centre, Masdar could become a model for future town planning from scratch, although it might not be feasible to apply all aspects of the project to the re-development of traditional cities (Villemandy n.d.).

Figure 36: Masdar Personal Rapid Transit (PRT) Station

Source: Seifert (n.d.)

Figure 37: Masdar PST Pod Car Running Underground

Source: Seifert (n.d.)

4.3.12 Boston Innovation District, Boston, (USA)

The Innovation District is the City of Boston's initiative to transform 1,000 acres (405 ha) of the South Boston waterfront into an urban environment that fosters innovation, collaboration, and entrepreneurship. It is located on the South Boston waterfront, and includes the Fort Point neighbourhood, Seaport Square, Fan Pier, as well as the Marine Industrial Park. It is adjacent to Logan International Airport, and at the nexus of two major interstate highways.

It also contains the largest tract of underdeveloped land in the city of Boston, and is an area with opportunity for growth, a strong existing knowledge base, and the ideal location for producing new ideas, new services and new products. In a short span of time it added over 5,000 new jobs in over 200 new companies (Boston University n.d.).

The Innovation District emphasises three core principles:

1. Urban Lab: Opportunities for testing groundbreaking technologies

- New chances to experiment with clean energy, citizen participation, transportation, and social infrastructure
- It is a testing ground for collaborative efforts between the city and its partners
- Successes can be scaled and translated to benefit all neighbourhoods

2. Sustainable Leadership: Breaking new ground for sustainable growth

- The development of 1,000 acres (405 ha) of iconic waterfront property will change the way residents, workers, and visitors interact with the environment
- The district can maximise this waterfront land in the present while ensuring sufficient resources and enjoyment for future generations

3. Shared Innovation: All Bostonians can benefit from the shared idea economy

- The establishment of a hub for emerging ideas and a development space to create new best practices will benefit citizens throughout the city
- New creative policy strategies can position Boston at the forefront of urban economic development

In addition to core principles, three key strategies guide the development of the Innovation District:

1. Promote Collaboration: Create clusters of innovative people

- People in close proximity innovate faster and share technologies and knowledge more easily
- Ideas need a supportive and close-knit ecosystem to foster creative growth

- Small firms can generate ideas and intermingle with larger firms that provide access to capital

2. Provide Public Space + Programming: Support social infrastructure to foster an innovative ecosystem

- An abundance of collaborative venues and open space is critical for fostering the creative process
- District Hall, now open, is the world's first free-standing public innovation centre.

3. Develop a 24-Hour Neighbourhood: Provide amenities for flexible lifestyles

- Innovation housing, like the apartments found at Factory 63, provide a residential-work spaces for innovators to collaborate
- The City of Boston is working to introduce more housing options to fit the range of lifestyles and needs of the innovation workforce
- The Innovation District is filled with world-class restaurants, an active nightlife, and cultural institutions
- Transit options are readily available, as the Innovation District has easy access to South Station, Logan Airport, and the MBTA Red and Silver lines

Figure 38: Location of Boston Innovation District

Source: Boston Innovation District (n.d.)

Figure 39: A Growing Mix of Innovation Business

Source: Boston University (n.d.)

4.3.13 Smart City Malta

Malta is situated at strategic crossroads of the established European market, the rapidly growing North African market and the Middle Eastern market. The island is logistically well placed with its modern port and efficient distribution facilities and has considerable experience in serving some of the world's most demanding markets.

Located in the heart of the Mediterranean and known for its stable economy and pro-business government, Malta is the ideal setting for companies looking to serve the Europe and North Africa region.

Figure 40: Schematic 3D Model of Malta Smart City

Source: (Smart City n.d.)

Figure 41: Malta Smart City Master Plan (Residential Units highlighted)

Source: Smart City (n.d.)

Smart City Malta claims the most advanced and reliable ICT infrastructure available in Malta today. In 2007, the World Economic Forum ranked the Government of Malta as the second most successful in the world in terms of promoting ICT. Through a progressive integration of technology and services, Smart City Malta has developed its proprietary ICT Infrastructure concept to meet the technical demands of mission critical digital operations.

Key features include:

- Access to the Metro ethernet network, which enables a high bandwidth of up to 1GB and a secure remote connection.
- High-speed internet connections for all homes and businesses
- A propriety network distribution centre and a fully digital telecommunications network with high-capacity undersea fibre-optic cables linking Malta to mainland Europe
- A fully redundancy power system, with a large scale power distribution centre that is fed with 33kV power from two sources via a dedicated protected tunnel – assuring business continuity

Within its modern campus, Smart City Malta provides ready-to-operate, modern, fully serviced commercial spaces that cater to the needs of knowledge-based enterprises for a range of companies. From development through to execution, Smart City Malta has consulted with construction specialists to ensure that the environmental impact of the campus remains at a minimum and benefits of practices result in transferrable cost savings for the business partner.

Harmonious in design, Smart City Malta has been created as a self-sustaining township, balancing office spaces with unique lifestyle elements that foster job creation, encourage job retention and employee satisfaction.

Open green spaces and thoughtful outdoor areas create a community that enriches quality of life. Spacious homes will be available for employees, while visitors are welcomed with an array of hotel choices. Convenient retail outlets, restaurants and cafés enliven each day, while educational and

health-care institutions are all well within reach, promoting individual well-being, development and peace of mind.

4.3.14 Smart City Kochi (India)

Smart City Kochi (SCK), a joint venture between Smart City Dubai and the Kerala government, has approved the concept master plan of the project. The project will enjoy a single special economic zone (SEZ) status as per guidelines for SEZs being initiated by the Government of India.

The project will be considered single even though there is a water-body separating the land into two parts. The project, sprawling over 246 acres (100 acres) at Edachira, Kakkanad is expected to generate 90,000 direct jobs when fully complete in 2019.

The first IT building of Smart City Kochi is being constructed on 11acres (4.45 ha) and is expected to become operational sometime in mid 2015.

Figure 42: Smart City Kochi Master Plan

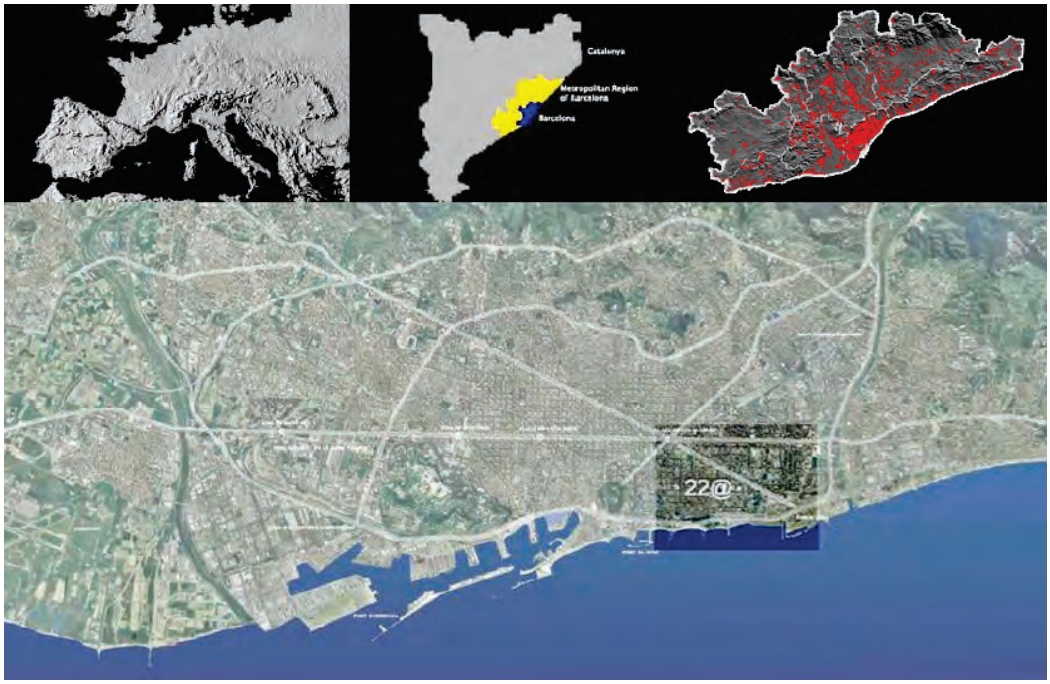
Source: Smart City (n.d.)

4.3.15 Barcelona's 22@ Barcelona (Spain)

22@Barcelona project transforms two hundred hectares of industrial land of Poblenou into an innovative district offering modern spaces for the strategic concentration of intensive knowledge-based activities. This initiative is also a project of urban refurbishment and a new model of city providing a response to the challenges posed by the knowledge-based society.

It is the most important project of urban transformation in Barcelona city in the last few years and one of the most ambitious in Europe, with a high real estate potential and a 180 million euros public investment infrastructure plan. The transformation of the old industrial areas of Poblenou into a high-quality environment for working, living and learning as part of the 22@Barcelona project is seen as an urban, economic and social refurbishment achievement (Barcelona City Council n.d.).

Figure 43: Location of 22@Barcelona in Barcelona Metropolitan Area



Source: Barcelona City Council (n.d.)

As a project of urban refurbishment it to recover the social and economic dynamism of Poblenou and creates a diverse and balanced environment where the different facilities coexist with subsidised buildings, equipment and green spaces that improve life and working quality.

As a project of economic refurbishment, it constitutes a unique opportunity to turn Poblenou into an important scientific, technological and cultural platform, transforming Barcelona into one of the most dynamic and innovative cities in the world.

As a project of social refurbishment, it facilitates interrelationships between different professionals who work in the area and encourages participation of the district's neighbours in the opportunities information technologies offer.

The 22@ district of Barcelona will become a region where companies, knowledge centres and entrepreneurial institutions converge to create a new cluster of innovation that will educate, research and develop solutions for Smart Cities and the City Protocol (CISCO 2011).

In the 22@ district, Barcelona has consolidated a diverse, balanced, sustainable environment, in which the most innovative companies and universities coexist with housing, facilities and green zones. On one hand, the area features the Smart City Campus-22@, which will be home to companies, universities, entrepreneurs and research centres in ICT, ecology and urban planning, with the aim of becoming a benchmark technology for Smart Cities. On the other, the UPC and administrations are promoting the Diagonal Besòs -22@ Campus (b_TEC) in order to create an area of excellence in internationally renowned research in the energy, sustainable mobility, materials technology and biomedical engineering sectors.

22@Barcelona is a case that shows the creation of an innovation ecology in a city from a public policy. The project layering in Hard Factors, Soft Factors, Business and Talent, vertically integrated by Governance is establishing a model exportable to other cities.

Figure 44: 22@Barcelona Metamodel

Source: Pique (2013)

The communication process has been a key project. From the constitution of the trademark (22@) to media appearances, it has responded to the communication strategies to position itself both locally and globally. From an international perspective, 22@ has been a landmark project visited by hundreds of delegations. 22@ is a model of inspiration. But the challenge of every city is find their own 22@, one that maximises its assets and articulates a smart strategy to create the best economic and social development (Pique 2013).

4.3.16 Climate Smart Hyllie, Malmo (Sweden)

Hyllie is an unrealised housing project in the 1970s which left a gap in the city's outer rim. A 3000km^2 undeveloped land, mostly owned by the City of Malmo and its potential has been realised by the City Tunnel connection. Hyllie can be reached in six minutes from Malmo Central, 13 minutes from Kastrup International Airport and 27 minutes from Copenhagen Central. It is being planned for 9,000 apartments and 9,000 work places in a dense city-structure.

According to a contractual agreement between the city of Malmö and the main energy and waste and water providers, Hyllie, a new district made up of 8,000 homes, will become the most climate-smart area in the entire Öresund region. By 2020 its energy provision will be 100 percent renewable (WWF Earth Hour Challenge n.d.).

Figure 45: Malmo and Hyllie Region

Source: Nordqvist (2014)

Hyllie, Malmö´s largest development area, will lead the way towards Malmö becoming a sustainable city. It is at the forefront of the development of a sustainable energy system. By as early as 2020, Hyllie will be 100 percent sustained by renewable or recycled energy. To reach this high sustainability goal, the City of Malmö, VA SYD and E.ON, in 2011, signed a climate contract for Hyllie. Under this contract, the City of Malmö, VA SYD and E.ON, jointly undertake to lay the foundation for it to become the most climate-Smart City district in the Öresund region and a global benchmark for sustainable urban development. The area will integrate, for both electricity, heating and cooling, the smart grids and other intelligent energy solutions that will hallmark the future. A sustainable approach to transportation, waste management and recycling are other key cornerstones in Hyllie.

Malmö is the first major city in Sweden to introduce mandatory sorting of food waste. This waste will be used to make biogas for such purposes as fueling buses and garbage trucks. In Hyllie solutions that will make recycling and waste sorting easy will be developed. For transportation the city aims to make it easy to walk, bike or use public transportation instead of taking your car. If you still need a car, there will be access to carpooling. It will also be easy to charge your electric car or fill up using biogas (Malmo Stad 2014).

Figure 46: Development Timeframe of Hyllie

Source: Nordqvist (2014)

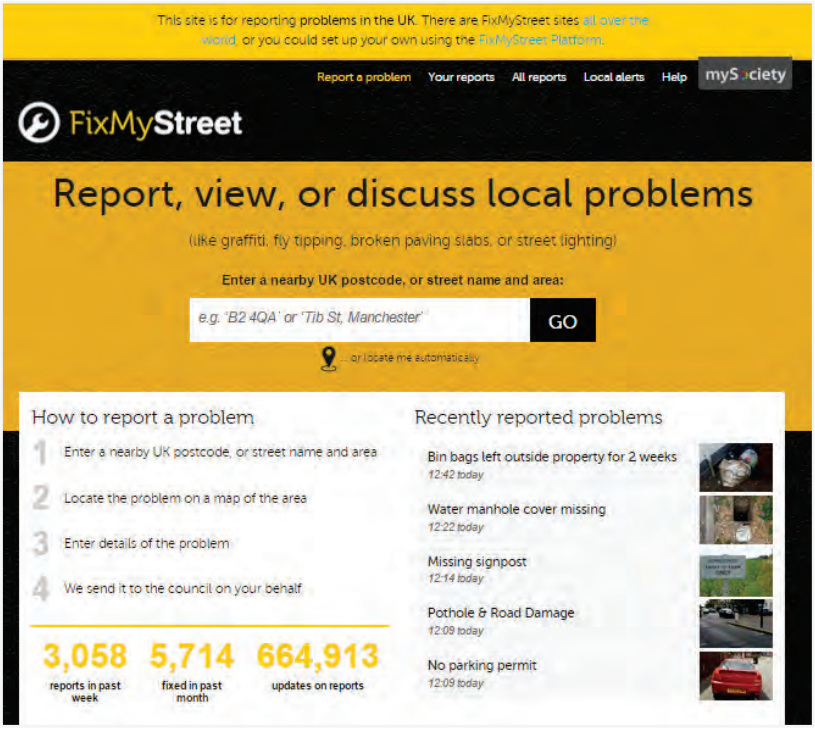
4.4 Smart Initiatives

4.4.1 Fix my street (UK)

Launched in February 2007, Fix My Street is a web service to help people report, view, or discuss local problems with their local council by simply locating them on a map. Built by MySociety, a not-for-

profit company, in conjunction with The Young Foundation, Fix My Street smartly routes reports of things that are broken or dumped or need fixing, cleaning or clearing, direct to the relevant council in the UK. Similar systems include CitySourced in the USA, which uses an iPhone 'app' as the primary interface (Arup 2011).

Figure 47: Fix My Street



Source: Arup (2011)

4.4.2 Low2No, Helsinki (Finland)

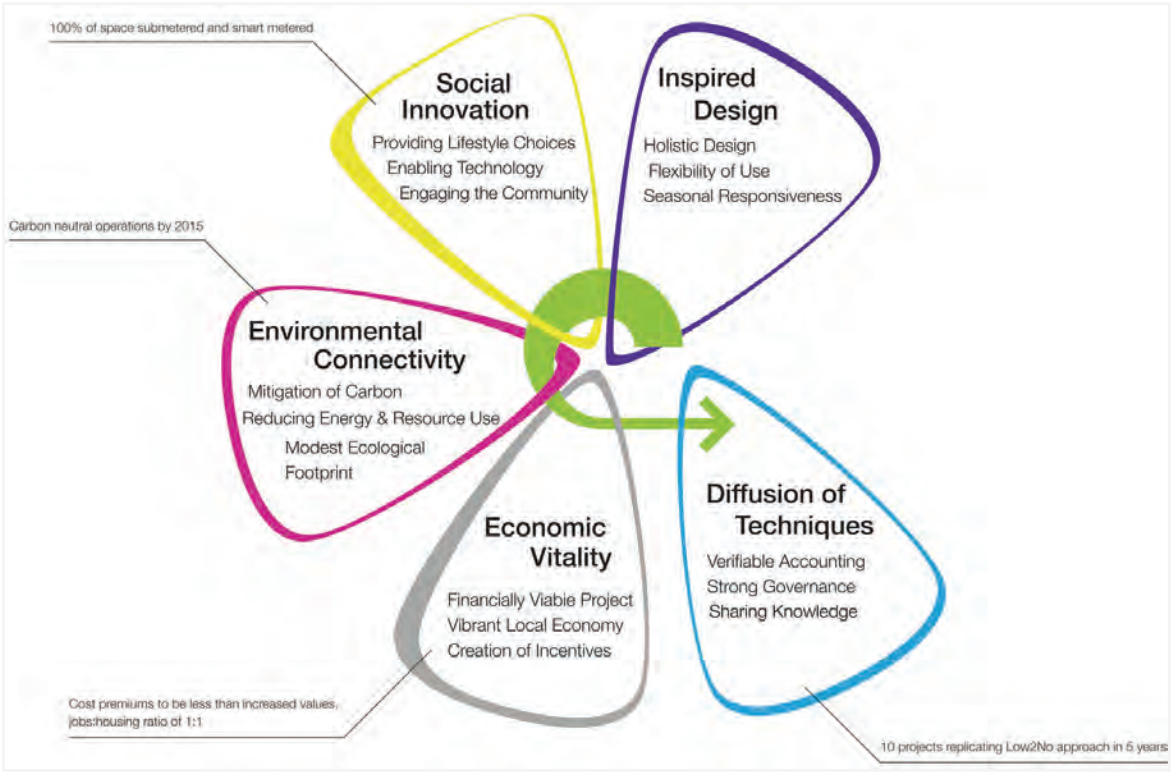
Low2No is a design and construction project which seeks to deliver a more sustainable built environment and lays a foundation for ecological urban living. Low2No is designed to engage the existing city; balance economy, ecology and society through strategic investments and interventions, and catalyse the long-term market transformation away from energy and material intensive urbanism.

The term "Low2No" originates from the belief that a gradual and iterative transition from low carbon to no-carbon city building is a more viable and resilient approach to the sustainability challenge than building new eco-cities on uncontested ground. The model, and its first iteration in a city block in downtown Helsinki test the regulatory, financial and cultural barriers to low carbon building, and work to overcome them through targeted projects, investments, events and partnerships. For instance, one of the project's early successes was to work with the authorities to make multi-story timber construction legal in Finland, providing future projects with the possibility of using low carbon building materials, whilst opening a new market to the Finnish forest industry.

By building a city block in partnership with private companies Low2No demonstrated that a broader built environment will become more sustainable only through achieving social and environmental objectives with economically viable solutions. In many of the world's cities, this means navigating an often messy regulatory environment, overcoming the challenges and inertia of legacy and engaging an expanded group of stakeholders to ensure that solutions are possible, impactful and lasting. "After all, building sustainable cities is no longer a technological challenge - we have the technology in hand - it is a cultural challenge."

Low2No approaches the city from the side, oblique, bottom and top. Policy, finance and culture are the Low2No designer's central capacities.

Figure 48: Low2No Sustainability Framework



Source: Sitra (n.d.)

The Low2No development is intended to become an exemplar in terms of carbon neutral urban development, including Smart City solutions.

4.4.3 Barangaroo, Sydney (Australia)

Barangaroo is one of the most ambitious smart urban renewal projects in the world today, embodying world-class design excellence and sustainability. It is one of the world's foremost waterfront renewal projects and showcases Sydney as Australia's gateway to the world. The 22 hectare, $6 billion Barangaroo precinct will help redefine the western edge of Sydney Harbour and be a lasting legacy for future generations. Barangaroo will provide space for over 24,000 permanent jobs, generate approximately $2 billion per annum to the New South Wales (NSW) economy and provide over 11 hectares of newly accessible public domain.

The site is owned by the NSW government and managed by the Barangaroo Delivery Authority. The renewal of Barangaroo will achieve outcomes for the environment field, as being water positive (exporting more water than it uses), generating zero waste (eliminating more than generating) and achieving carbon neutrality (generating more renewable energy than it uses). Barangaroo is divided into three project areas: Barangaroo Point Reserve, Central Barangaroo and Barangaroo South (BDA n.d.).

Figure 49: Barangaroo Outline Design Plan

Source: BDA (n.d.)

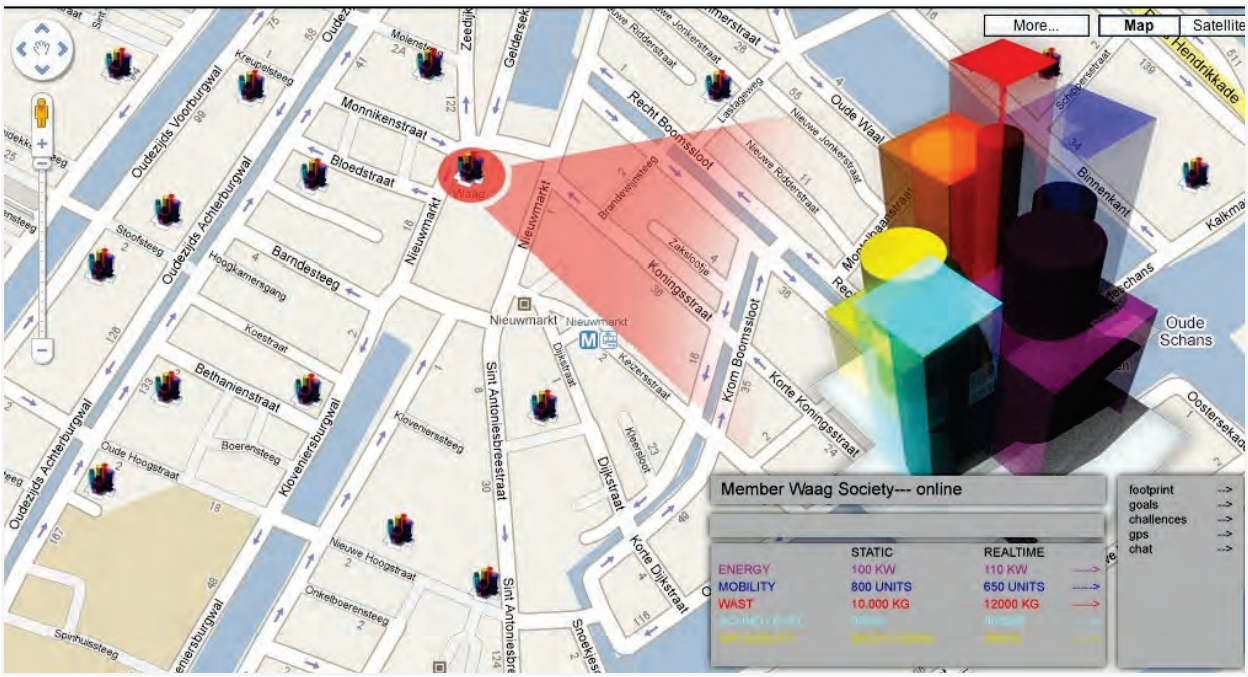
An informatics strategy for the Barangaroo project includes smart demand management techniques through engaging public interfaces onto the state-of-the-art sustainable infrastructure. The informatics services will address water use, energy use and other resource use. Yet the development will also benefit from a pervasive approach to ICT that enables smart workplaces and co-working spaces across the public domain. Responsive public interfaces will display sustainable infrastructure patterns, real-time transit activity and community information, as well as enable a public art strategy (Arup 2011).

4.4.4 Urban EcoMap, Amsterdam (Netherlands) and San Francisco (USA)

Urbanecomap.org is an interactive web service that displays environmental footprints for Amsterdam and San Francisco (footprints comprises CO_2 emissions, waste and transportation activity, broken down by postal code). Created by CISCO with collaboration on the Urban EcoMap programme with industry, government and academic leaders, such as Arup, CH2MHill, NASA, the Swiss Federal Institute of Technology Zurich, the city and county of San Francisco, city of Amsterdam, Amsterdam Innovation Motor (AIM) and Amsterdam Smart City (ASC), EcoMap attempts to raise awareness and build community activity around reduction of GHG emissions.

Citizens can make decisions to help decrease the carbon footprint of their geographic regions, their particular zip code, and their city. They can make these choices by gaining visibility into several key factors, including the effort required to make the change, the associated cost or financial benefit, and the environmental impact of the action. Citizens can then share their climate actions with others via social networking.

Figure 50: Waag Society Urban EcoMap



Source: Kresin & Schuurkamp (2009)

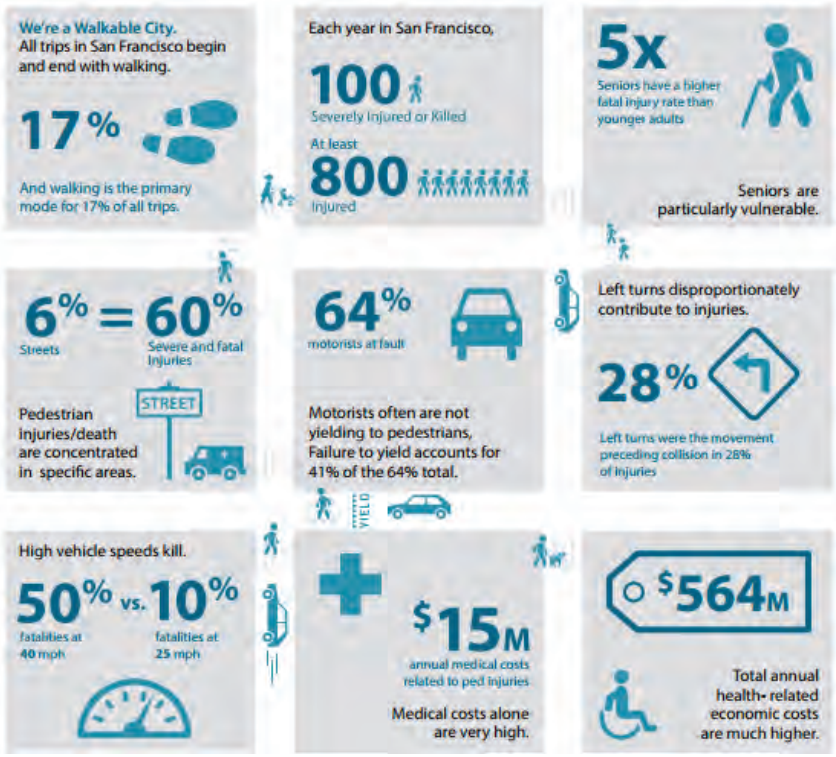
4.4.5 WalkFirst, San Francisco (USA)

In April 2013, Mayor Lee issued the Pedestrian Strategy which directed city departments to implement solutions that would reduce serious or fatal pedestrian injuries by 25 percent by 2016 and by 50 percent by 2021, increase the walkability of San Francisco and make all neighbourhoods safer for pedestrians. As part of this effort, WalkFirst was initiated to prioritise capital improvements needed over the next five years to make San Francisco a safer place to walk.

From November 2013 to February 2014, over 3,700 people visited the WalkFirst website and 400 more provided direct feedback through focus groups and an online survey to share their thoughts about the pedestrian improvements that they would like to see the city implement. Based on the crowd sourcing of requirements for the WalkFirst the following elements were prioritised:

- Leading Pedestrian Intervals
- Pedestrian Countdown Signals
- Automated Speed Enforcement
- Locations with seniors, children, and people with disabilities to be prioritised for safety improvements
- Solutions that recognise the diversity of neighbourhoods and have community support
- Complex intersections to be made safer and less confusing for people who walk

Figure 51: Learning's from pedestrian safety data

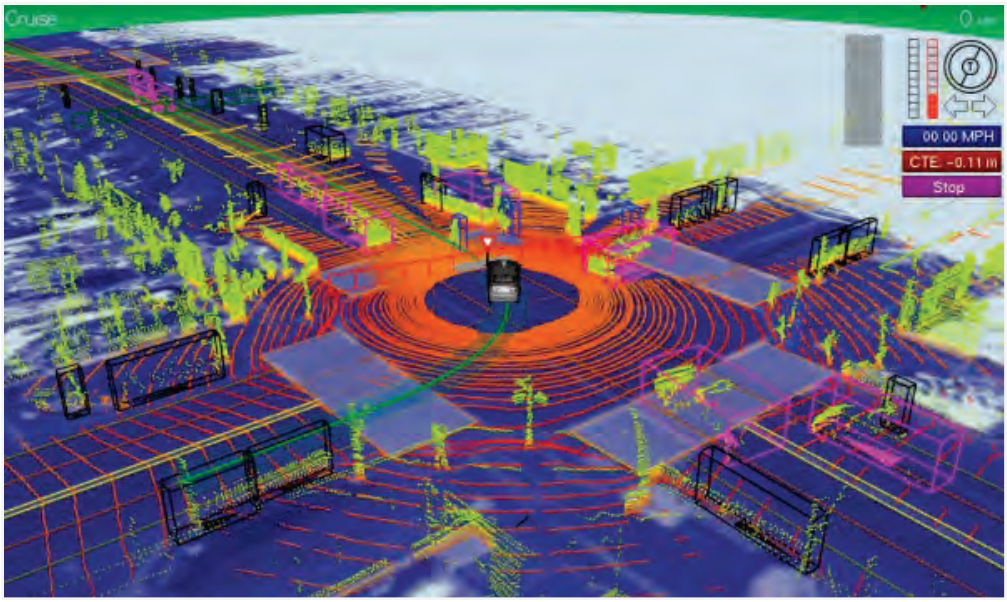


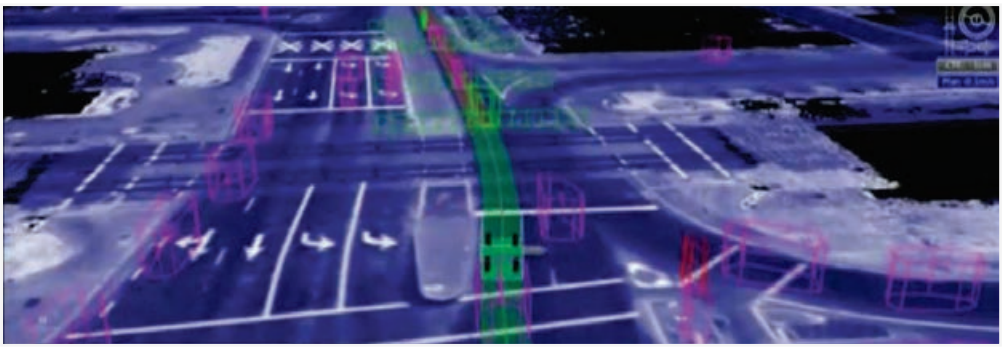
Source: SFMTA (2014a)

4.4.6 Driverless Vehicles, Las Vegas (USA)

Nevada has become the first state to approve driverless cars by accepting an application for the Google car to drive on its roads. Bruce Breslow of the Nevada Department of Motor Vehicles also revealed a special license plate for driverless cars. The plate will display an infinity symbol, which according to Breslow is a symbol that best represents this futuristic technology. Nevada defines driverless cars as using "artificial intelligence, sensors and global positioning system coordinates to drive itself without the active intervention of a human operator" (Peckham 2012).

Figure 52: A Google Rendering of What a Self-driving Car “sees.”





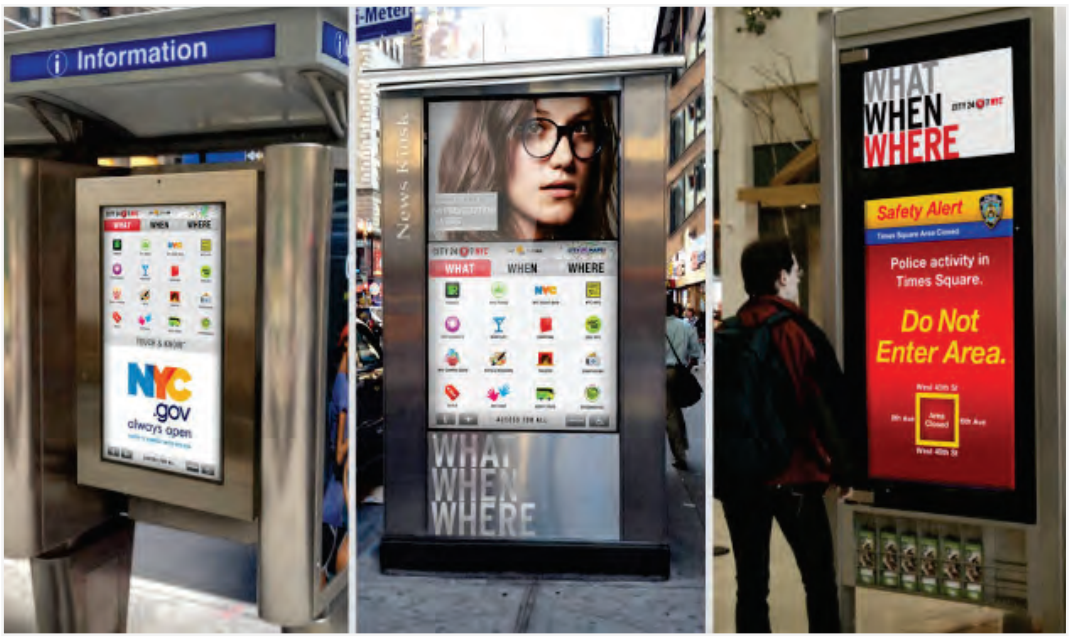
Source: Peckham (2012)

Owners of a Google car or similar driveless cars will need to obtain a special driver license and comply with specific regulations. For example, the cars must be equipped with smart boxes and owners will be responsible for how the car functions. California, Hawaii and Florida are also considering similar legislation for driverless cars (Belaire 2012).

4.4.7 NYC Hyper-local Smart Screens, New York (USA)

This is an interactive platform that integrates information from open government programmes, local businesses, and citizens to provide meaningful and powerful knowledge anytime, anywhere, on any device. In short, City24/7 delivers the information people need to know, where and when it helps them most. This information is displayed on durable, yet easy-to-use Smart Screens that replace unused and often outdated public furniture such as pay phones located at bus stops, train stations, major entryways, shopping malls, and sports facilities.

Figure 53: City 24/7 Smart Screen Solutions



Source: Frazier & Touchet (2012)

City24/7 Smart Screens incorporate touch, voice, and audio technology to deliver a wide array of hyper-local (about two square city blocks) information, services, and offerings in real time. The Smart Screens can also be accessed via Wi-Fi on nearby smartphones, tablets, and laptop computers. In addition to supplying information about local events and merchants, City24/7 Smart Screens keep people safe by providing security alerts for the immediate area. The City24/7 Smart Screens are also

designed to deliver "access for all" by offering information in a variety of languages and supporting people with disabilities. According to Frazier & Touchet (2012) Smart Screens include:

- An induction loop and headphone jacks for the hearing-impaired
- A high-contrast screen mode for the sight-impaired
- Visual recognition for people with guide dogs and walking canes
- Way finder key-fob access and mobile applications for the blind
- A patent-pending flip screen for people in wheelchairs

4.4.8 'Oyster' smart ticketing Cards and London Data Store, London (UK)

The capital is already considered a pioneer in the field of smart mobility, mainly through the implementation of congestion charging, 'Oyster' smart ticketing, and the release of real time travel information for buses. To develop this further, with the help of UCL, Transport for London is using the data collected from Oyster cards to understand congestion patterns and plan future investment. Other initiatives include Talk London, which is an interactive website aimed to involve citizens in policy debates, and the London Data Store, which gives citizens access to data from different public departments.

Figure 54: TFL Oyster Smart Card

Source: GLA (2014)

4.4.9 Go ON, Manchester (UK)

Go ON is a national campaign to promote digital inclusion. The key focus is to bring the benefits of the Internet to every individual, organisation and community in the UK. Local partnerships are being encouraged to plan local action including recruiting Digital Champions to support this.

Figure 55: Go ON UK Campaign Cover for Digital Champ 2015

Source: Go ON UK (2015)

Manchester City Council is working on the Manchester partnership with a range of organisations, including Unionlearn, Manchester College, the Chamber of Commerce, the Manchester Digital trade association, social housing organisations, local digital and creative networks, including the Manchester Digital Lab (MadLab) and a wide range of voluntary and community organisations.

As part of their support for the partnership, leading local organisations are pledging to support Go ON Manchester and are encouraging their staff and users to become Digital Champions.

The benefits of digital inclusion can be life transforming:

- Small businesses that go online grow twice as fast as their competitors
- Households save up to £560 per year shopping and paying bills online
- The estimated increased lifetime earnings of all children being online in Manchester is £78.5 million
- The estimated increased lifetime earnings of the unemployed going online in Manchester is £6.7 million
- Government services are going online. Residents and businesses can make a payment, report a problem and request a service, anytime and anywhere they want, with all the convenience that this brings
- Online transactions will keep Council costs down and improve efficiencies, so encouraging customers to do it online will benefit the Council substantially and sustainably
- Customers will have a personalised, self-service web experience with a breadth of localised services at their fingertips.

The Go ON Manchester Digital Champions campaign is aimed at everyone who feels they have something to offer. It will help people to go online in the first place, help local businesses to improve their online presence and enable people, businesses and community organisations to develop new skills and capacities.

4.4.10 Solar-Powered Supertrees, Singapore

The Asian city-state of Singapore is abundant with vegetation. Tall trees form canopies along roadways and their branches thread through narrow gaps between highway ramps and overpasses. Palm trees cluster everywhere, and exotic ferns and flowering plants adorn the exteriors of office complexes, government ministries and the ubiquitous public housing high-rises that are home to 80 percent of the citizenry. Median strips brim with lush green hues of carefully maintained flora. Rising above the downtown jungle are still more trees, these of an otherworldly height. They're 18 man-made "supertrees," some 50 meters tall, erected by the city as part of a new downtown development. The metal-frame sculptures are hung with vertical gardens, mimicking the fronds and blooms below. They're futuristic and bold: a perfect encapsulation of the Singapore of the moment.

Figure 56: Solar Powered Supertrees

Source: Hatch (2013)

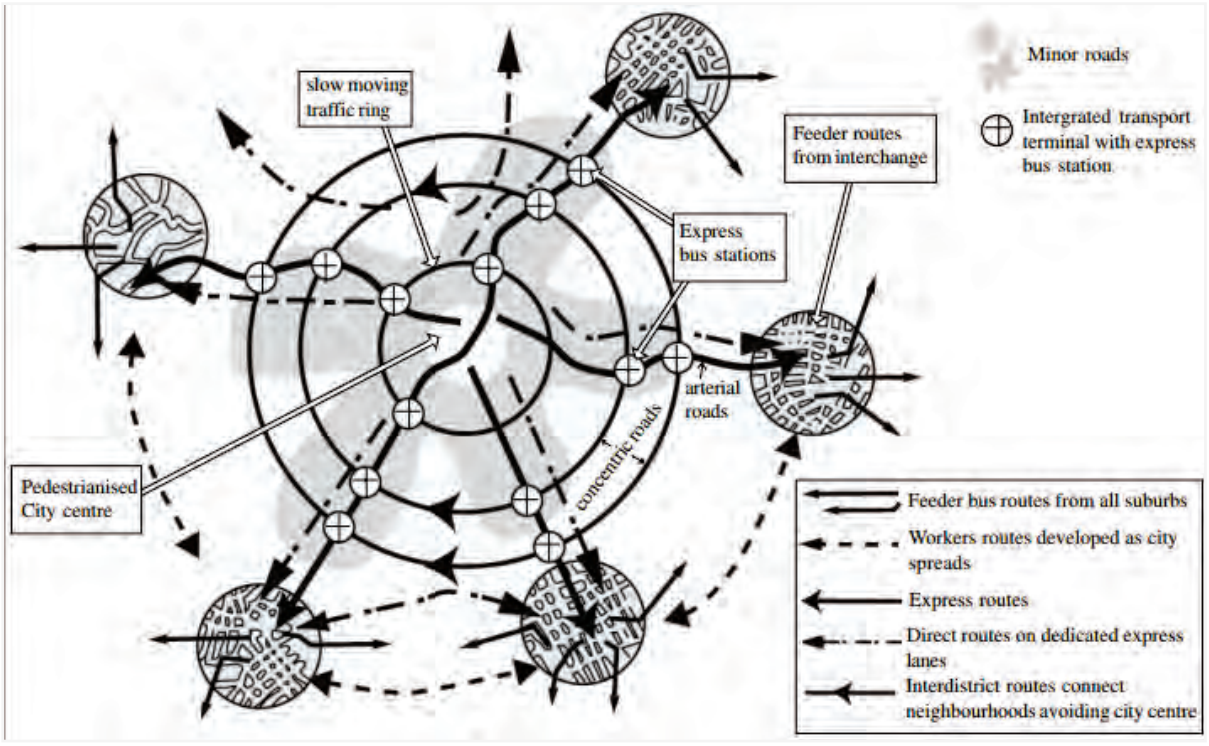
Singapore teems with greenery, but it also pulsates with information —streams of data run through almost every part of the city's physical geography. The supertrees aren't merely aesthetic. They operate as temperature moderators, absorbing and dispersing heat. They collect rainwater and act as ventilation ducts for conservatories nearby. Several are outfitted with photovoltaic cells to generate solar power. A Biodiversity Index, launched in 2008, mines data on 23 indicators — such as the proportion of natural versus developed areas and the amount of carbon dioxide that trees convert to oxygen —to help balance development with green space (Hatch 2013).

4.4.11 Sustainable City Management, Curitiba (Brazil)

The south Brazilian city is regarded as an innovator in everything from bus-based rapid transit, used by approximately 70 percent of residents, and its balanced, diverse economic development strategy.

With a population of 3.5 million, Curitiba demonstrates how to achieve the evolving Brazilian dream without the mass violence, transportation dysfunction and ubiquitous grinding poverty that plague many other Latin American metro areas. The bus system has been a key feature of Curitiba's development. The buses are long, split into three sections and stop at designated elevated tubes, complete with disabled access. There is only one price, no matter how far you travel, and you pay at the bus stop. It has been a model for other cities trying to achieve more sustainable movement of people and is used by 85 percent people living in the city (Newint.org 2014).

Figure 57: Curitiba Transit System



Source: I4P (2014)

The city's programme of building "lighthouses" – essentially electronic libraries – for poorer residents – has become a model for developing cities worldwide (Kotkin 2009).

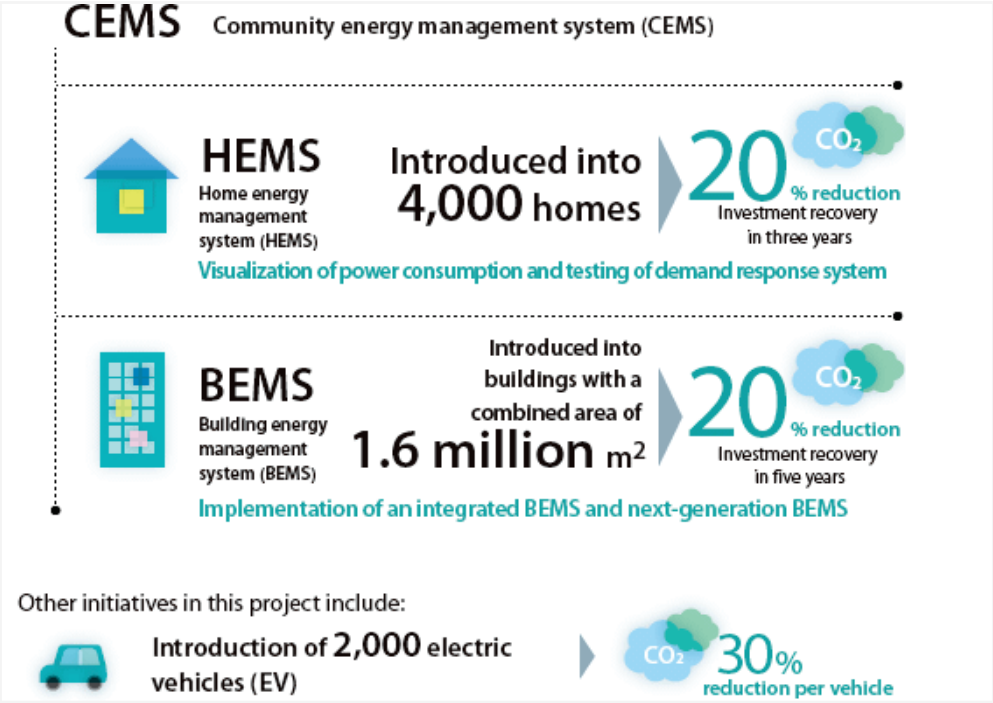
The city of Curitiba, in Brazil, started in the 1990s the "Lighthouses of Knowledge" project. Fifty of them, brightly coloured, glassy lighthouse-shaped towers, are spotted through the neighbourhoods. These Lighthouses are free educational centres which include libraries, Internet access, and other cultural resources for citizens aged three to 80. This community libraries work with municipal schools,

have a collection of approximately 5,000 books, are a cultural reference and leisure centre for the community, and are designed to diversify the opportunities of access to knowledge, expanding the area of formal education (I4P 2014).

4.4.12 Yokohama Smart City Project, Yokohama (Japan)

The Yokohama Smart City Project (YSCP) is one of the largest Smart City demonstration projects in Japan. The project targets three Yokohama-based areas, Minato Mirai, Kohoku New Town, and Kanazawa Green Valley, with a combined area of around 60 sq.km and a population of more than 420,000 people in 170,000 households. The project will demonstrate energy management and demand response (DR) across a wide area with the goal of "building social systems targeting a 30% reduction in CO2." Wide-area energy management will be conducted by linking CEMS for regional control, HEMS in homes and BEMS in commercial-district buildings. HEMS will be introduced in 4,000 homes in a bid to save electricity and reduce CO2 through power usage visualisation and support for demand response (Toshiba 2013).

Figure 58: Community Energy Management System (CEMS)



Source: Toshiba (2013)

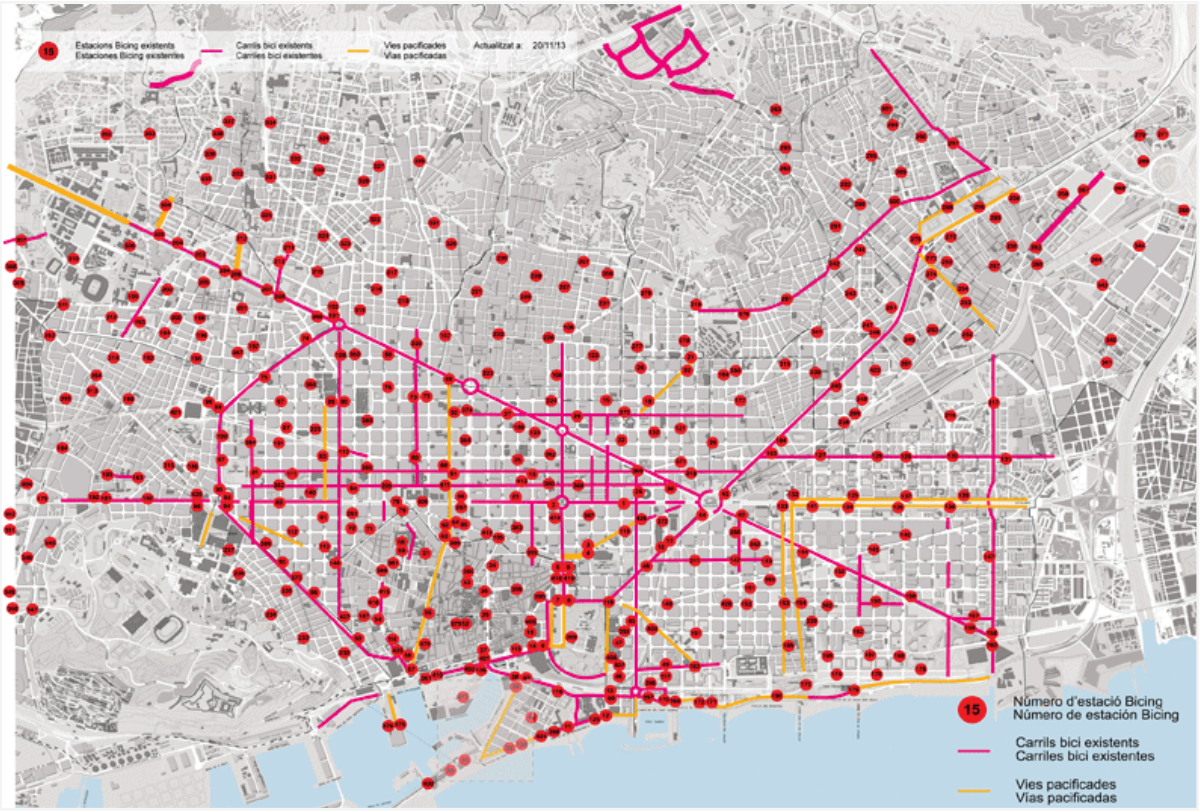
4.4.13 Bicing, Barcelona (Spain)

Bicing is the name of a community bicycle programme of the city of Barcelona created in March 2007. It aims to make available to citizens bicycles for commuting within the city, with an economical and sustainable transportation mode. Its purpose is to facilitate short daily trips but not for tourism or recreational use.

Users must acquire a yearly membership. The system has a network of more than 400 stations to loan and return the bicycles distributed throughout the city. Most stations are situated next to public transport stops or public parking to facilitate and promote intermodality. Since the start, the service has registered more than 50 million uses and has 120,000 registered users.

A number of types of traffic separators for bicycle lanes have been tested in the 22@ district to find out which of the pilot projects contributed to improved circulation and safety for cyclists while not preventing traffic from running normally. One of the products tested and commercially developed is ZEBRA, a traffic separator for cycle lanes with high reflecting painted strips for increased visibility, and engineered curves and internal structure to ensure mechanical resistance. A ZEBRA separator is 100 percent recycled and recyclable made of the heavy fraction of the electrical wires plastic covers.

Figure 59: Bicing Map with Stations



Source: (Barcelona City Council 2014)

4.4.14 San Francisco SF*park* Pilot (USA)

SF*park* is a federally-funded demonstration of a new approach to managing parking. It used better information, including real-time data where parking is available, and demand-responsive parking pricing to help make parking easier to find. As a federally-funded demonstration of a new approach to managing parking, the SF*park* project collected an unprecedented data set to enable a thorough evaluation of its effectiveness.

The San Francisco Municipal Transportation Agency (SFMTA) evaluated the SF*park* pilot project to see how effectively this approach to managing parking delivered the expected benefits. The evaluation showed that after implementing SF*park*, San Francisco saw:

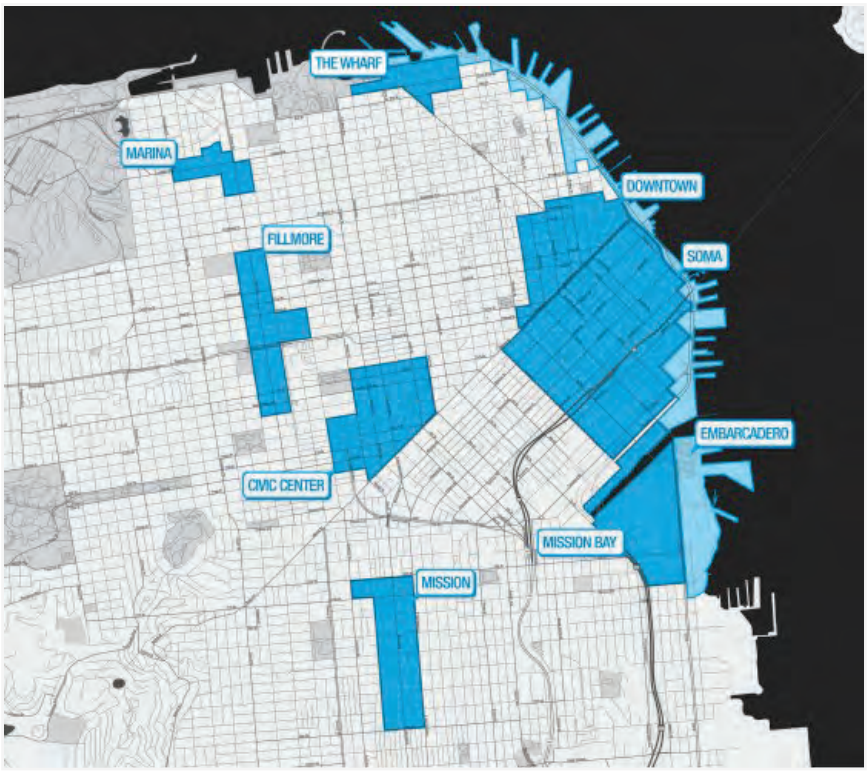
- Average parking rates became lower
- Parking availability improved
- It is easier to find a parking space
- It is easier to pay and avoid parking citations
- Greenhouse gas emissions decreased
- Vehicle miles travelled decreased

SF*park* optimises the use of existing parking resources to benefit drivers and everyone else who spends time in San Francisco. Public transit riders, bicyclists, pedestrians, business owners, residents and visitors can all expect this innovative new parking management project to improve their quality of life in the following ways.

- Easier parking: SF*park* makes finding and paying for parking faster and easier. Demand-responsive pricing information online, via text, and through smartphone apps helps drivers find a space. Longer time limits and new meters that accept credit/debit cards, SFMTA parking cards and coins make parking more convenient and result in fewer parking tickets.
- Faster public transit: Decreasing the number of drivers circling and double-parking will help keep roads clear so Muni and emergency vehicles can get through streets faster and more reliably.
- Safer bicyclists and pedestrians: Drivers looking for parking are frequently distracted and fail to see bicyclists and pedestrians. Less double-parking and circling means fewer accidents and safer roads.
- Better business neighbourhoods: With parking faster to find and pay for, it's easier to enjoy the city's commercial areas. Less congested, safer and more pleasant neighbourhoods mean better business. Plus, with less smog and greenhouse gas, the air is cleaner.

SF*park* tested wireless parking sensors, new meters and demand-responsive pricing in neighbourhoods across the City from spring 2011 to spring 2013. The pilot areas include Civic Center/Hayes Valley, the Financial District, SoMa/Mission Bay, the Mission, Fisherman's Wharf, the Fillmore and the Marina. SF*park* publicly shares extensive information about the project.

Figure 60: SF*park* Pilot Areas



Source: SFMTA (2014b)

4.4.15 Big Data and Da Nang (Vietnam)

Vietnam's fourth-largest city has one of the highest population growth rates in the country. It's challenging to keep its drinking water clean and its traffic moving.

During water treatment, samples used to be manually collected and analysed. But the city's water utility has automated the process by installing sensors throughout the system to measure salinity, pH and chlorine levels in real time. The utility's workers receive alerts and notifications when readings stray from norms or when analysis indicates that water quality has changed.

Figure 61: Da Nang City

Source: Whitworth (2014)

Da Nang is reducing traffic congestion by installing a traffic-control centre that uses big-data techniques and predictive analyses to better coordinate city responses to accidents and bad weather. With its system, Da Nang's transportation department also has real-time information on its buses, including their location, speed, and predicted journey times. From a website, travellers can find timetables and learn about estimated arrival times and changes to bus routes (Pretz 2014).

4.4.16 Rio Operations Centre, Rio De Janeiro, Brazil

Rio Operations Center employs a high resolution weather-forecasting and hydrological-modelling system that can predict heavy rains up to 48 hours in advance. Forecasts are based on a unified mathematical model of Rio that pulls data from the city's river basin, topographic surveys, the municipality's historical rainfall logs, and radar feeds. Along with predicting rainfall, the system can anticipate flash floods and mudslides, and the city has begun to evaluate the effects of weather on traffic and on the supply of electric power.

Figure 62: Rio De Janeiro Operations Centre

Source: Tama (2014)

Residents can access daily information from the centre's Facebook and Twitter feeds to get updates on weather and traffic as well as recommendations for alternate routes during crowded special events (Pretz 2014).

CHAPTER V -
India's Smart Cities Mission

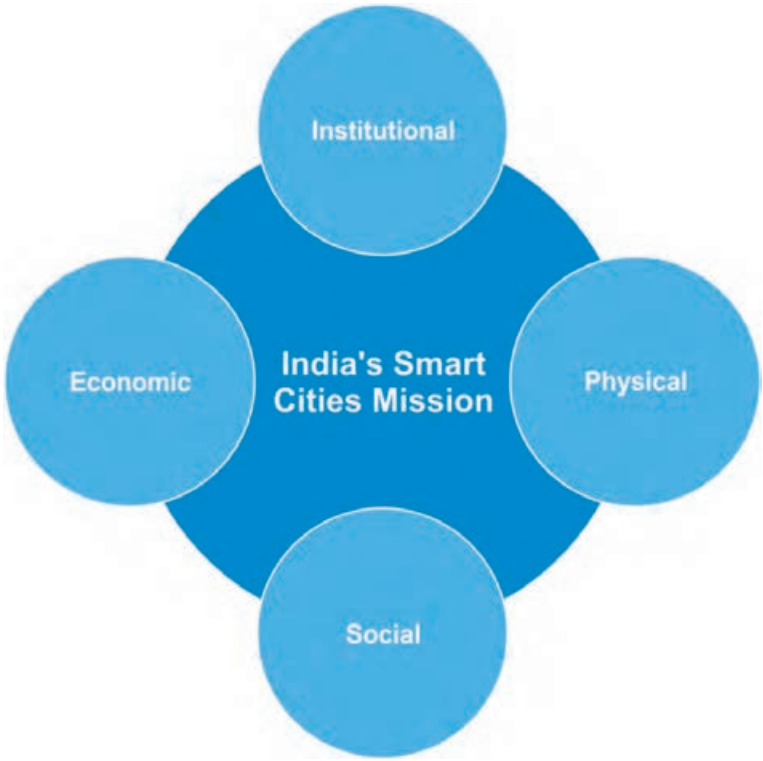
5.1 Introduction

This chapter is structured on the four key aspects - Definition analysis, Approach, Financing, and Challenges of the India's Smart Cities Mission. The mission guidelines (annexure 02) include outline of the roll out strategy and implementation mechanisms. Analysis of the relationship between the theory (Chapter 1,2,3), practice (Chapter 4), and policy framework of India's mission is presented as part of this chapter.

5.2 Definition Analysis

The mission guidelines explicitly agree to the fact that there is no universally accepted definition of a Smart City. Definitional boundaries required to guide the cities under this mission are based on holistic development of urban ecosystem. The strategic areas (as mentioned in section 2.2 Theory of Strategic Priority Areas) of the mission are derived from the four pillars of comprehensive development - institutional, physical, social and economic. It is envisaged that the cities will eventually achieve the goal of comprehensive development incrementally, by adding on the layers of 'smartness'.

Figure 63: Strategic Priority Areas of the Mission



The layers of smartness of the mission are:

1) 'Core' Infrastructure layer
2) 'Sustainable' Environment layer
3) 'Area based' Development layer
4) 'Smart' Technology layer

Based on the taxonomy analysis of the strategic priority areas, mission statement, literature in guidelines document, a hexagonal model of Smart Cities dimensions is derived with the following as the components:

1. Infrastructure
2. Governance
3. Inclusive
4. Sustainable
5. Citizen Centric
6. Safety

Although the model is not an adaptation of the existing framework, it is robust in nature considering the relevance of components with the status quo of Indian cities and its potential to leapfrog the challenges. In addition, cities have the flexibility of prioritizing these strategic areas based on the city vision and aspirations of the communities.

5.3 Approach

The Smart Cities mission focus is on sustainable and inclusive development. The mission approach is unique in concept with established methodologies for various levels such as visioning, planning, implementation, and evaluation; and integrative model of smart city framework. The following are the five key sub-systems of this framework:

i. Convergence approach for Comprehensive Development (Visioning)
ii. Compact area approach for city development (Planning)
iii. Strategic Planning approach for Smart City Proposals (Implementation)
iv. 'Smart Citizenry' approach for participatory planning (Implementation)
v. Incremental approach in selection of cities (Evaluation)

5.4 Financing of the Smart Cities

5.4.1 Introduction

Inadequate funding is a serious challenge facing local governments in developing countries for financing the smart cities and to smarten up urban infrastructure, operation and maintenance mechanism, and urban basic services delivery. These projects are capital intensive and expensive because of their nature, size, technologies and materials they use, and area they cover. They are built to last for a long time and hence require capital improvements on a periodical basis. To most municipal governments, raising adequate revenues from own sources is a mammoth task and this requires strategic urban planning with efficient and effective legal, regulatory frameworks. Mobilization of

adequate revenue by local governments from own sources is key to manoeuvring this locally driven development process.

5.4.2 Financial Mechanisms

While there is a need for greater sharing of financial resources between the central and local governments, the potential sources currently available to local authorities for generating revenue should also be fully exploited. In addition, urban authorities should also explore the use of non-conventional instruments for generating additional financial resources.

Government-led financing, development exactions and public-private partnerships are all groups of financing tools in which public sector money plays a significant role. The challenge in recent years has been attracting more private investment into the finance market for smart infrastructure projects. Leveraging private sector funds, which are potentially larger pools of finance capital, can be useful for financing projects that will improve liveability and have long-term impacts on a city's economy. (BCC & Habitat n.d.).

5.4.3 Categories of investments

The core infrastructure layer as mentioned in the mission guidelines is key to transform the Indian cities into smart. Primarily three categories of investments in infrastructure are required for delivering smart urban infrastructure, i.e., basic infrastructure, network level infrastructure-sensors installed to monitor parameters related to service delivery, and, integrating infrastructure - Information and communication technology (ICT) solutions. In terms of cost, the second category requires significantly lower investments and usually accounts for only 8-10 percent of investments in basic infrastructure. Given the significant time and investments required for new basic infrastructure, augmentation of the existing infrastructure by installing network level sensors and integrating ICT solutions can transform them into smart infrastructure. This intervention will increasing the operational efficiency and thereby overall basic infrastructure gaps can be bridged (Guha 2015).

5.4.4 Financing Models

Implementing Smart City solutions is financially challenging. Urban services models can streamline this transition by defining the city's baseline capital projects, schedule during land use master planning, and ICT needs upfront. In essence, Urban Services models allow the private sector to build a roadmap for the public sector's Smart City vision with realistic deliverables that are grounded with tangible service level agreements and metrics over a multi-year operations contract. The right financial environment is necessary to ensure sound risk return profiles and sustainable business models (Guha et al. 2015). The following is an indicative list of some of the innovative financing models for Smart Cities in India by Guha et al. (2015):

i. Municipal bonds / Sector Specific bonds
ii. Pooled finance development fund
iii. Public Private Partnership (PPP) models and performance contracts
iv. Land use financing
v. Securitization through structured finance

5.4.5 Opportunities for financing Smart Cities in India

Since the Government of India's proposal to develop 100 Smart Cities in May 2014 till May 2015, prioritization of existing cities and proposals for new cities. The proponents include State government,

city government, industry, multilateral donor agencies, research communities and academia. This included proposals for transformation of existing into Smart Cities and Greenfield Smart Cities across India. The partnerships between city/state governments and national & global agencies marked the beginning of this ambitious and necessary step. A cognitive mapping exercise was done as part of this research study to understand the dynamics of the Smart Cities development in India and present the status quo and funding opportunities available for cities. The analysis shows the other side of the Smart Cities market in India. A detailed matrix as annexure 01 includes the details about the partnership and stakeholders agencies.

The total anticipated outlay of budget proposed by various agencies (national and global) to build Smart Cities in India, to support the existing innovative initiatives of cities for transforming themselves into Smart cities is INR 3,59,555 lakh crore, a major 77 percent of the total plan expenditure of the Union Government of India. The following are some of the countries the donor agencies represent or are currently located in: United States, Switzerland, Singapore, California, Germany, Dubai, Spain, China, Hong Kong, Japan, Korea, Qatar Sweden and Netherlands. Cities can and should take leverage of the external funding sources while preparing the Smart City proposals.

Securing funding sources and establishing financial mechanisms prior to the selection of the Smart City and non-participation of state-owned infrastructure financing companies are some of the challenges in the roll out and implementation of Smart Cities (Roychoudhury 2015).

5.5 Challenges

The challenges of climate change, population growth, demographic change, urbanisation and resource depletion is a common challenge for cities across the world. (Buscher et al. 2010). The following are some of the specific challenges cities competing to be smart need to address:

- Business models for rolling out smart technologies are still underdeveloped. Even if money was available for investment, most of the smart technologies are still in their pre-commercial stage of development and the risk-sharing mechanisms and business models needed to take them forward are yet to be tested and developed. These mechanisms need to be available before smart technologies can be publicly procured, mainly because they represent a higher-risk investment for the cash-strapped public sector. The lack of business models also restricts the availability of private sector financing, since the uncertain financial returns and long payback periods of many smart initiatives makes capital markets and traditional commercial financing rather inaccessible (Hirst et al. 2012).
- Successful implementation of smart city solutions need effective horizontal and vertical coordination between various institutions involving institutions providing various municipal amenities as well as effective coordination between central government (MoUD), state government as well as local government agencies on various issues related to financing, sharing of best practices and sharing of service delivery processes (Guha et al. 2015).
- Cities find it difficult to work across departments and boundaries. Many of the smart cities initiatives include integrating different policies and information systems such as linking cycling with carbon reduction or integrating data relating to unemployed individuals from different departments onto a single platform. This requires breaking down silos and joint working between

departments and across boundaries. At present, budgets and strategies are rarely coordinated across departments and data is rarely shared.

- Cities have limited influence over some basic services. Utilities such as gas, electricity, water as well as bus services, are privatised which makes it challenging for cities to implement city-wide smart strategies that need the commitment of private utility companies.
- Most ULBs have limited technical capacity to ensure timely and cost effective implementation and subsequent operations & maintenance due to limited recruitment over a number of years along with inability of the ULBs to attract best of talent at market competitive compensation rate (Guha et al. 2015).
- Concerns about data privacy, security and value. Data needed for initiatives such as open data platforms and the integration of health services is not always accessible. This is mainly due to privacy and security issues or other difficulties such as the lack of technical knowledge to generate or manipulate data (Williams 2013).
- Increasing citizen take up and participation is difficult. Currently, cities and the private sector are finding it difficult to increase citizen participation in the smart agenda beyond the committed few. This is due to some people having limited access to broadband or not having the skills and confidence to use the internet – especially in low income communities and among older people. With e-services and online consultations becoming more popular, this creates the risk of social and political exclusion among these groups. Moreover, people might not have enough information on how the technology (such as smart meters) can be used or see it as irrelevant to their daily lives. Issues around what kind of data citizens value, whether they understand the privacy and security implications of sharing their data and how smart technologies can benefit them are yet to be fully explored and understood.

5.6 Summary

India's Smart Cities mission is a catalyst in defining the first roadmap of urban transformation of the Indian cities and towns into 'Smart and Sustainable Urban Eco-systems'. The vision to build 100 smart cities in the country has attracted huge investments in the past one year, cities need to develop integrated strategies to comply with future challenges of urbanization and depleting land resources; and take leverage of this opportunity. The synchronized launch of three urban missions reflects the integrated approach of the government to urban development and the connecting elements in the framework are complementary to enable urban transformation.

Chapter VI - Seven Point Agenda

6.1 Introduction

This section will briefly highlight some of the key areas which should be looked into to understand the DNA of the Smart Cities through three lens - theory, practice and policy. This will enhance the knowledge of cities and policy makers in spearheading the smart cities movement both globally and in India.

1. Research studies to derive the smart city definition is an ongoing and iterative process. A static definition is not the solution. Further research to arrive at the city specific definition will be of great value to the city agencies in defining the smart city proposal and resulting in high level of cohesion between the actual needs of the city and perception of proponents of smart cities.
2. Models analysing the phenomenon of Smart City facilitate the capacity building and knowledge management within Communities of Practice. With the increasing dynamics in the stakeholder community, the role of existing actors within the dimensions of Smart City are either changing or new functions are being added to their portfolio to bring in the robustness to the implementation strategies. One such attempt is the revised triple helix model by (Lombardi et al. 2012). In order to reap the benefits from the new data sources like mobile and internet penetration, sensors on public systems, social media, crowd sourcing of ideas etc., Smart Cities require reliable models to estimate the impacts of new initiatives and also to highlight any unfavourable emerging trends that require intervention. These are unparalleled in their scope, scale and resolution, and can reveal deep insight into the complex micro-interactions that drive urban systems. These new insights can be used effectively to improve the efficiency, sustainability and resilience of cities. Agent based modelling coupled with social insights from new 'big data' can be a useful resource tool for cities planning to be smart. (Helbing 2011).
3. Strengthening of municipalities by institutionalizing the municipal cadre and emphasizing on collaboration between the academia, industry and local government can synergize the local government initiatives with scope for innovation.
4. Government of India's vision is a leapfrog movement in timeline of Indian cities with respect economic, environmental and social impact. To operationalise the new urban agenda cities and move towards Sustainable Development Goals (SDGs), cities needs to adopt the co-creation approach. It is recommended that cities need to adopt a combination of horizontal and vertical co-creation so as to increase the possibility of achieving integrative solutions which are need of the hour.

   Solutions derived out of co-creation process have broader impact and yet have potential failure modes identified before they are implemented at scale. Apart from the solutions being holistic and integrative, one of the key advantages to co-creation is the engagement of diverse groups and the various stakeholders buying into the initiative with an increased level of motivation and ownership.

   In case of India's Smart Cities Mission a case of 'How to make use of co-creation tool?' in presented. 'Horizontal' co-creation can be the capacity building especially peer-to-peer

learning at both national and global level across the urban local bodies. 'Vertical' form of co-creation can be increasing citizen engagement.

5. India Smart Cities Mission emphasizes following principles integrated, citizen centric and urban planning. To achieve these aspects the current approach towards city planning needs to be preceded by a strategic planning exercise which is human-focused and evidence-based policy scenarios to increase the efficiency of traditional planning approach and also shorten the planning cycles. It can be based on scenario task methodology to facilitate efficient decision making, to gauge the impact and performance forecasting apart from real-time analyses and participative. Moving towards open data and urban planning based on standardized GIS will augment the strategic planning process by cities as a major step towards the goal of Smart Cities.
6. Timeline of the Smart City Proposals should be based on principles of New Urbanism. It should facilitate the transition of incrementally transforming cities towards Smart Urbanism (Campbell 2011).
7. Cities need to adopt social equity as a key criteria in planning, design, development and implementation of information and communications technologies (Karlenzig et al. 2011).

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Annexure 1

STATE	CITY	AUTHORITY INVOLVED	INTERESTED ORGANIZATION	MoUs SIGNED	FINANCE (IN CRORE RS.)	TIMELINE	KEY NOTES	SOURCE
Andhra Pradesh	Vishakhapatnam	Greater Vishakhapatnam Municipal Corporation (GVMC) Visakhapatnam Metropolitan Development Authority (VMDA) Visakhapatnam Urban Development Authority (VUDA)	United States Trade Development Agency (USTDA) United States Industry Organization (USIO) United States Exim Bank	Yes	23555	25/1/2015 first phase will start in 6 months	Under this agreement, the US Trade Development Agency intends to contribute fund for feasibility studies or pilot projects, study tour workshops and trainings. It will also support consultancies and advisories for the development of Visakhapatnam into a smart city. Other agencies of the US Government like the Department of Commerce, US Exim Bank will also support the efforts of the two parties to the MoU.	Various news articles, MOUD press release & official organization's websites.
	-	Not known	Swiss Solar Technology Consortium (SSTC)		-	22/1/2015 information unavailable	Swiss Solar Technology Consortium has agreed to partner with the Andhra Pradesh government by setting up a committee and work on smart cities initiative. A memorandum of understanding is expected to be signed shortly. Companies based in Switzerland, a hotbed for solar photo voltaic innovation and energy efficiency, have the potential to work on renewable energy projects, including solar energy and wind energy, solid waste management, water management and smart grids.	Various news articles
	Amravati-the capital city between Vijayawada and Guntur	Infrastructure Corporation of Andhra Pradesh (ICAP) Andhra Pradesh Capital Region Development Authority (APCRDA)	International Enterprise Singapore (IES) Center for Livable Cities (CLC) Singapore Cooperation Enterprise (SCE)	Yes	1 lakh	8/12/2014 the first phase of the capital city will complete before 2019 (5 yrs)	International Enterprise Singapore and the infrastructure corporation of Andhra Pradesh signed a deal to train Andhra Pradesh officials in urban planning and governance, supported by the Centre for Livable Cities and the Singapore Cooperation Enterprise. The deal with Andhra Pradesh is the first arrangement between Singapore and an Indian state on smart city management, a partnership which shares knowledge on water and port management and infrastructure development with India's new wave of cities	Various news articles & official organization's websites
	Kakinada	Andhra Pradesh Government	Softbank Corp New Energy and Industrial Technology Development Organization(NEDO) Sumitomo Corporation; Japan Ministry of Economy, Trade and Industry(METI)	Yes	-	-	Yokohama city council in Japan have come forward to collaborate with Andhra Pradesh government in making Kakinada a smart city.	Various news articles & official organization's websites

	Kirlampudi Smart City pilot project, Vishakhapatnam	Greater Vishakhapatnam Municipal Corporation (GVMC)	Phoenix IT Solutions	Yes	-	-	Creating an interactive technology platform on key civic issues, a portal www.onevizag.org was launched and an MoU signed between Kirlampudi residents welfare association and citizen, the CSR arm of Phoenix IT Solutions Ltd. The pilot project, an initiative under "Let's Get Smart Kirlampudi", will be implemented over a period of 25 weeks. The five issues to be taken up are cleanliness, greening, health, safety and digital Vizag (through the portal and web app). Citizens have contributed Rs.2 lakh to KRWA to get litter bins, rain water pits etc but, more importantly for technology support, consultation and programme management.	Various news articles & official organization's websites
Karnataka	Bangalore	Not known	CISCO; Electronics City Industries Association (ELCIA)	Yes	40000	First phase was started in January 2015	The smart city will be built in the electronics city industrial township as a pilot project in partnership with the electronics city industries association (ELCIA) to provide smart parking, smart CCTV surveillance, smart street lighting, smart water management and community messaging	Various news articles & official organization's websites
Madhya Pradesh	Bhopal	Town and Country Planning Department of Madhya Pradesh (TCPDMP) ; Bhopal Municipal Corporation (BMC)	SAP	Yes	1000	-	State government has published Sehore master plan 2031 (blue-print) in collaboration with town and country planning department of Madhya Pradesh. As per the master-plan, the smart city shall be constructed on Sehore-Bhopal bypass and will be developed in an area of 12,355 acres. The project is in drafting phase and deadline has not yet been declared. The total worth of the project is around Rs 1,000 Crores as per the town and country planning department. Smart city will have interstate bus stand in an area of three hectares, advanced traffic system with automatic traffic signals,5 over bridges and three flyovers. In the published blueprint there is no plan of residential complexes and apartments. The industry delegates from Dubai also handed proposals of investments in sectors like food processing, renewable energy and infrastructure development. Bhopal municipal corporation (BMC) with the help of software giant sap has implemented solutions from company to automate and centralize public service offerings.	Various news articles & official organization's websites
	Bhopal	-	TECOM-a Dubai firm may partner in developing smart city between Bhopal and Indore		-	-		Various news articles & official organization's websites
	-	Madhya Pradesh Government	Essel group	Yes	-	4/10/2014 1st phase duration-2 year	The group had signed an MoU with the Madhya Pradesh government for developing five smart cities. The group hopes to be able to showcase its first smart city within two years of signing a definite agreement with the Madhya Pradesh government.	Various news articles, MOUD press release & official organization's websites
Delhi	Delhi	Delhi Development Authority (DDA)	Government of Kingdom of Spain Barcelona Government	Yes	-	28/5/2015 DDA sets 3 years target to give Delhi its first smart city duration of 1st phase-3 year	The project has been proposed to de-congest the capital and facilitate it with all amenities. Focus will be to build global educational and health institutes and entertainment facilities. The city will be zoned out of Dwarka, Rohini and Narela and will be equipped with the latest technologies and waste management techniques.	Various news articles, MOUD press release & official organization's websites

STATE	CITY	AUTHORITY INVOLVED	INTERESTED ORGANIZATION	MoUs SIGNED	FINANCE (IN CRORE RS.)	TIMELINE	KEY NOTES	SOURCE
	Karkardooma	Delhi Development Authority (DDA)	National Buildings Construction Corporation (NBCC)	Yes		DDA sets 3 years target to give Delhi its first smart city duration of 1st phase-3 year	As per the MoU between NBCC and DDA, the project, which will be spread over an area of 30 hectares, will be completed in phases and the first phase of construction will be completed within a period of 36 months. As per the MoU, NBCC will manage the project and a joint team of VC, DDA and CMD of NBCC will monitor its progress. The finalization of designs etc will be done by a committee represented by both the organizations and experts. NBCC shall be paid project management charges at 10 percent of the final project cost for coordination, supervision and monitoring of the project as per approved detailed project report.	Various news articles & official organization's websites
Uttar pradesh	-	Uttar Pradesh Government	ESSEL Infra Project Limited		-	-	ESSEL have made an offer to the Uttar Pradesh government. The state government is now appointing a consultant to create a bid document for the project	Various news articles & official organization's websites
	Allahabad	Uttar Pradesh Government	United States Trade Development Agency (USTDA) United States Industry Organization (USIO) United States Exim Bank	Yes	-	-	The three pacts will focus on solutions related to urban issues such as transportation, communication and energy related infrastructure	Various news articles & MoUD press release
	Varanasi	Varanasi city Government	Kyoto Government (Government of Japan)	Yes	-	25/12/2014 the entire makeover is expected to be complete in three phases, ending by 2019.	Under the smart heritage cities program, Kyoto will provide cooperation in the fields of conservation and modernization of cities, as well as art, culture and academics. While Kyoto and Kashi share many similarities historically, there is a wide gap in where they stand today. The river beautification involves the redevelopment of a 100 'ghat's in Varanasi. An inland waterway between Allahabad to Kolkata is also proposed. Three sub cities — Sarnath, Banaras Hindu university and airport city — will be carved out as smart sub cities, interconnected by a network of flyovers. The idea is to ensure that commuting from one sub city to another does not take more than 30 minutes. The proposed transport infrastructure also includes a metro rail, IT park, a skill development center and an it research and development centre are also mooted.	Various news articles, MoUD press release & official organization's websites
West Bengal	-	West Bengal Government	Essel Infra Project Limited		-	-	Essel have made an offer to the West Bengal government. The state government is now appointing a consultant to create a bid document for the project	Various news articles & official organization's websites

Gujarat	-	Government of Gujarat	China Small and Medium Enterprise Investment Limited (CSMEI)	Yes	19000	-	An MoU, pledging investments worth Rs. 19,000 cr. To build a new smart city in Gujarat, was signed between Gujarat government and China Small and Medium Enterprise Investment Limited (CSMEI) which is a subsidiary of China Association for Small and Medium Enterprises (CASME),for developing a new smart city on 20 square kilometers area in the state, stated an official release from the state government. Gujarat already has GIFT city and Dholera which are being developed as smart cities.	Various news articles, MoUD press release & official organization's websites
	Surat	Surat Municipal Corporation (SMC)	Microsoft	Yes	-	-	Microsoft India along with Surat Municipal corporation (SMC) has announced to take initiative in building Surat as the smart city. With help from Microsoft and its partner ecosystem, the city administration is evaluating technology infrastructure to meet the changing needs of its citizens.	Various news articles,& official organization's websites
	Gujarat international finance tech-city (GIFT)	Government of Gujarat	Morden Services Industry Cooperation Zone (MSICZ) Qianhai Shenzhen	Yes	-	-	Gujarat International Finance Tech-city (GIFT) and Qianhai Shenzhen, the silicon valley of china have entered into intent of co-operation to develop smart cities in a reciprocal manner on Wednesday during Gujarat cm visit to china. The Qianhai Shenzhen - Hong Kong modern services industry cooperation zone (MSICZ) and gift city signed the agreement for the purpose to provide world-class infrastructure and facilities to finance and technology firms. It is being designed as a smart city of the future and is expected to become a major financial hub of the country in the coming decades.	Various news articles, MOUD press release & official organization's websites
Rajasthan	Mahindra world city, Jaipur	Rajasthan State Industrial Development and Investment Corporation (RIICO)	Deutsche Bank Vamani Overseas Mahindra	Yes	-	-	These MoUs entails that Deutsche Bank, Tech Mahindra and QH Talbros will establish their operations within the upcoming Mahindra world city at Jaipur. This has the potential to establish Jaipur as a truly global city and will help usher an era of economic growth and employment opportunities. Mahindra world city, Jaipur is being developed as a multi-product SEZ spread over an area of 3000 acres. Prior to the signing of MoUs today, Mahindra world city, Jaipur has already signed ten MoUs with leading organizations including Infosys & Wipro. Vamani overseas to set-up a 4 acre campus in Mahindra world city, Jaipur's handicraft zone. Vamani overseas will use this facility to produce handicrafts for global clients. Vamani overseas is based in the Delhi-NCR region and is the first handicraft company from outside Rajasthan to set up shop in MWC, Jaipur's handicraft zone. This significant milestone marks the beginning of direct investments in MWC Jaipur's handicraft zone from other states.	Various news articles,& official organization's websites

STATE	CITY	AUTHORITY INVOLVED	INTERESTED ORGANIZATION	MoUs SIGNED	FINANCE (IN CRORE RS.)	TIMELINE	KEY NOTES	SOURCE
	Ajmer	Rajasthan Government	United States Trade Development Agency (USTDA) United States Industry Organization (USIO) United States Exim bank	Yes	-	-	The three pacts will focus on solutions related to urban issues such as transportation, communication and energy related infrastructure	Various news articles & MOUD press release
Kerala	Kochi smart city	Government of Kerala	TECOM investments	Yes	3000	Started-5/10/2011 the first it building of Smart City Kochi (SCK) phase-I will be inaugurated in June 2015	Smart city Kochi is an it special economic zone under construction in Kochi, Kerala. Smart City (Kochi) Infrastructure Pvt. Ltd. Is a joint venture company formed to develop the Kochi smart city project. Government of Kerala (16% share), TECOM investments (84% share), a subsidiary of Dubai holding are the main investors of the company. This project envisions minimum 8.8 million sq. Ft. Of built up space out of which at least 6.21 million sq. Ft. Will be specifically for it/ITES/allied services. The project is expected to create over 90,000 direct jobs.	Various news articles & official organization's websites
Maharashtra	Pune	Maharashtra government	Government of china		-	-	China interested to initiate smart city project in Pune.	Various news articles
	Palava city, Thane	-	Lodha Group IBM	Yes	25000	By 2025	Palava is one of the largest "planned city" initiatives in the world. Located in the Mumbai metropolitan region, Palava is the largest-ever private, completely planned urban development in India – it aims to be India's most livable city, and one of the top 50 most livable places in the world, by 2025. Developed by the Lodha group as a sister city to Mumbai. Palava city, the integrated smart city being developed by the Lodha group, is set to complete the phase I project by December as it plans to commence works on the development of phase ii spread over 900 acres.	Various news articles & official organization's websites
Gujarat, Uttar Pradesh, Andhra Pradesh	Surat; Allahabad; Vishakhapatnam	Respective State Government	IBM	Yes	-	-	Tech giant IBM has chosen Surat, Allahabad and Vizag among 16 global locations for its smart cities programme to help them address challenges like waste management, disaster management and citizen services. Under the programme, IBM will send a team of experts to each of the chosen cities where they will spend three weeks working closely with city staff analyzing data about critical issues faced by its local bodies.	Various news articles & official organization's websites
Uttar Pradesh, Andhra Pradesh, Karnataka, Telangana		Respective State Government	NEC Corporation		-	-	Japanese Conglomerate NEC (earlier known as Nippon electric company) is one such, holding conversation with the centre and several state governments to take up smart city, is learnt to be in advanced talks with Uttar Pradesh, Andhra Pradesh, Telangana and Karnataka, among others. It is already working with the Gujarat government for a security project in Surat, primarily on CCTV surveillance and forensic criminal investigation.	Various news articles

Delhi Mumbai Industrial Corridor Project	Central Government of India	NEC Corporation		-	-	NEC is in discussion with the government for Delhi Mumbai Industrial Corridor (DMIC) project. Also, it could work with the government on a cyber security plan for India.	Various news articles
Pan India	-	CISCO IL&FS	Yes	-	-	Cisco and IL&FS technologies will partner jointly to develop digital solutions to tap into the multibillion dollar opportunity in the smart city space in India. The companies will jointly develop internet of everything (IOE) based digital solutions to pursue opportunities in the infrastructure sector and smart cities in India. A broader set of next generation urban services like parking, lighting, traffic and citizen engagement services built on top of CISCO's city infrastructure management will also be worked on.	Various news articles & official organization's websites
Pan India	Essel Infra Project Limited	Schneider Electric	Yes	12687	3 yrs	Essel group inks technology transfer pact with three German firms for smart cities and green energy projects in India. The Essel group is planning to adopt a revenue sharing model for developing smart cities. It plans to invest over $2 billion over the next 3 years in transforming major cities across India.	Various news articles & official organization's websites
Pan India	Ministry of Urban Development of India (MoUD)	Bloomberg Philanthropies	Yes	-	-	There is a partnership between Bloomberg philanthropies and the Ministry of Urban Development, Government Of India, to advance the "Smart Cities Initiative." Under the partnership, Bloomberg philanthropies will provide assistance to the Ministry of Urban Development to select cities for smart cities mission funding on a continuous basis. This approach is different from the conventional approach, which involved preparation of detailed project reports, and their appraisal and approval by the central government. It will ensure that real citizen engagement happens, as people get involved both in design and execution of city development plans. This will actualize the idea of cooperative and competitive federalism.	Various news articles & MoUD press release
Pan India	-	Hitachi India limited Confederation of Indian Industry(CII)	Yes	-	By 2022	Hitachi India limited and Siemens limited signed a memorandum of understanding (MoU) with Confederation of Indian Industry (CII) to form a consortium that would create pilots and replicate them throughout the country setting up 100 smart cities.	Various news articles,& official organization's websites
Pan India	-	Siemens Limited; Confederation of Indian Industry(CII)	Yes	-	By 2022	Siemens and the confederation of the Indian Industry(CII) signed a memorandum of understanding (MoU) to spearhead the conceptualization and implementation of pilot projects in smart cities. CII has set up a "national mission on smart cities" and the objective of this mission is to play the role of a facilitator and a thought leader to assist the government in the process of the development of 100 smart cities by 2022. The MoU is part of the implementation strategy to take forward the smart city initiative.	

STATE	CITY	AUTHORITY INVOLVED	INTERESTED ORGANIZATION	MoUs SIGNED	FINANCE (IN CRORE RS.)	TIMELINE	KEY NOTES	SOURCE
Pan India		-	Intel Corporation		-	-	Intel to take initiative in India's smart cities initiative. American multinational corporation and Intel corporation is looking forward to take initiative in India government's smart cities plan.	Various news articles & official organization's websites
Pan India		Ministry of urban development of India (MOUD)	Korean Government	Yes	60000	-	South Korea will provide US $10 billion to India for infrastructure, development of smart cities, railways, power generation and other diversified areas as the two countries agreed to upgrade their bilateral relationship to a special strategic partnership	Various news articles & MoUD press release
Pan India		-	Individual	Yes	1 lakh	-	Rs. 1 lakh crores to be invested by prince of Qatar in smart city project in India.	Various news articles
Not decided		-	German Government	Yes	-	-	German government has agreed to support the development of three smart cities. A six member joint committee was set up to evolve in three months a way forward including identification of three cities to be taken for making them smart, projects to be taken up with German assistance	Various news articles
Not decided		-	Government of Sweden		-	-	Sweden is keen on partnering with Indian companies to build 'smart cities' through the public private partnership (PPP) mode in states like Karnataka, Telangana and Maharashtra.	Various news articles
Not decided		-	Dutch Government		-	-	Dutch tie upon smart cities may be a carry forward of last Indian government pact.	Various news articles

Annexure 2

Smart Cities

Mission Statement & Guidelines

Government of India
Ministry of Urban Development
(June, 2015)

Smart Cities Mission

1. The Challenge of Urbanization

1.1 Cities are engines of growth for the economy of every nation, including India. Nearly 31% of India's current population lives in urban areas and contributes 63% of India's GDP (Census 2011). With increasing urbanization, urban areas are expected to house 40% of India's population and contribute 75% of India's GDP by 2030. This requires comprehensive development of physical, institutional, social and economic infrastructure. All are important in improving the quality of life and attracting people and investments to the City, setting in motion a virtuous cycle of growth and development. Development of Smart Cities is a step in that direction.

2. What is a 'smart city'

2.1 The first question is what is meant by a 'smart city'. The answer is, there is no universally accepted definition of a Smart City. It means different things to different people. The conceptualisation of Smart City, therefore, varies from city to city and country to country, depending on the level of development, willingness to change and reform, resources and aspirations of the city residents. A Smart City would have a different connotation in India than, say, Europe. Even in India, there is no one way of defining a Smart City.

2.2 Some definitional boundaries are required to guide cities in the Mission. In the imagination of any city dweller in India, the picture of a Smart City contains a wish list of infrastructure and services that describes his or her level of aspiration. To provide for the aspirations and needs of the citizens, urban planners ideally aim at developing the entire urban eco-system, which is represented by the four pillars of comprehensive development — institutional, physical, social and economic infrastructure. This can be a long term goal and cities can work towards developing such comprehensive infrastructure incrementally, adding on layers of 'smartness'.

2.3 In the approach to the Smart Cities Mission, the objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions. The focus is on sustainable and inclusive development and the idea is to look at compact areas, create a **replicable model which will act like a light house to other aspiring cities**. The Smart Cities Mission of the Government is a bold, new initiative. It is meant to set examples that can be replicated both within and outside the Smart City, catalysing the creation of similar Smart Cities in various regions and parts of the country.

2.4 The core infrastructure elements in a Smart City would include:

i. adequate water supply,

ii. assured electricity supply,

iii. sanitation, including solid waste management,

iv. efficient urban mobility and public transport,

v. affordable housing, especially for the poor,

vi. robust IT connectivity and digitalization,

vii. good governance, especially e-Governance and citizen participation,

viii. sustainable environment,

ix. safety and security of citizens, particularly women, children and the elderly, and

x. health and education.

2.5 As far as Smart Solutions are concerned, an illustrative list is given below. This is not, however, an exhaustive list, and cities are free to add more applications.

2.6 Accordingly, the purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes. Area-based development will transform existing areas (retrofit and redevelop), including slums, into better planned ones, thereby improving liveability of the whole City. New areas (greenfield) will be developed around cities

in order to accommodate the expanding population in urban areas. Application of Smart Solutions will enable cities to use technology, information and data to improve infrastructure and services. Comprehensive development in this way will improve quality of life, create employment and enhance incomes for all, especially the poor and the disadvantaged, leading to inclusive Cities.

3. Smart City Features

3.1 Some typical features of comprehensive development in Smart Cities are described below.

i. Promoting mixed land use in area-based developments — planning for 'unplanned areas' containing a range of compatible activities and land uses close to one another in order to make land use more efficient. The States will enable some flexibility in land use and building bye-laws to adapt to change;

ii. Housing and inclusiveness — expand housing opportunities for all;

iii. Creating walkable localities — reduce congestion, air pollution and resource depletion, boost local economy, promote interactions and ensure security. The road network is created or refurbished not only for vehicles and public transport, but also for pedestrians and cyclists, and necessary administrative services are offered within walking or cycling distance;

iv. Preserving and developing open spaces — parks, playgrounds, and recreational spaces in order to enhance the quality of life of citizens, reduce the urban heat effects in Areas and generally promote eco-balance;

v. Promoting a variety of transport options — Transit Oriented Development (TOD), public transport and last mile para-transport connectivity;

vi. Making governance citizen-friendly and cost effective — increasingly rely on online services to bring about accountability and transparency, especially using mobiles to reduce cost of services and providing services without having to go to municipal offices; form e-groups to listen to people and obtain feedback and use online monitoring of programs and activities with the aid of cyber tour of worksites;

vii. Giving an identity to the city — based on its main economic activity, such as local cuisine, health, education, arts and craft, culture, sports goods, furniture, hosiery, textile, dairy, etc;

viii. Applying Smart Solutions to infrastructure and services in area-based development in order to make them better. For example, making Areas less vulnerable to disasters, using fewer resources, and providing cheaper services.

4. Coverage and Duration

4.1 The Mission will cover 100 cities and its duration will be five years (FY2015-16 to FY2019-20). The Mission may be continued thereafter in the light of an evaluation to be done by the Ministry of Urban Development (MoUD) and incorporating the learnings into the Mission.

5. Strategy

5.1 The strategic components of Area-based development in the Smart Cities Mission are city improvement (retrofitting), city renewal (redevelopment) and city extension (greenfield development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city. Below are given the descriptions of the three models of Area-based Smart City Development:

5.1.1 **Retrofitting** will introduce planning in an existing built-up area to achieve Smart City objectives, along with other objectives, to make the existing area more efficient and liveable. In retrofitting, an area consisting of more than 500 acres will be identified by the city in consultation with citizens. Depending on the existing level of infrastructure services in the identified area and the vision of the residents, the cities will prepare a strategy to become smart. Since existing structures are largely to remain intact in this model, it is expected that more intensive infrastructure service levels and a large number of smart applications will be packed into the retrofitted Smart City. This strategy may also be completed in a shorter time frame, leading to its replication in another part of the city.

5.1.2 **Redevelopment** will effect a replacement of the existing built-up environment and enable co-creation of a new layout with enhanced infrastructure using mixed land use and increased density. Redevelopment envisages an area of more than 50 acres, identified by Urban Local Bodies (ULBs) in consultation with citizens. For instance, a new layout plan of the identified area will be prepared with mixed land-use, higher FSI and high ground coverage. Two examples of the redevelopment model are the Saifee Burhani Upliftment Project in Mumbai (also called the Bhendi Bazaar Project) and the redevelopment of East Kidwai Nagar in New Delhi being undertaken by the National Building Construction Corporation.

5.1.3 **Greenfield** development will introduce most of the Smart Solutions in a previously vacant area (more than 250 acres) using innovative planning, plan financing and plan implementation tools (e.g. land pooling/ land reconstitution) with provision for affordable housing, especially for the poor. Greenfield developments are required around cities in order to address the needs of the expanding population. One well known example is the GIFT City in Gujarat. Unlike retrofitting and redevelopment, greenfield developments could be located either within the limits of the ULB or within the limits of the local Urban Development Authority (UDA).

5.1.4 **Pan-city** development envisages application of selected Smart Solutions to the existing city-wide infrastructure. Application of Smart Solutions will involve the use of technology, information and data to make infrastructure and services better. For example, applying Smart Solutions in the transport sector (intelligent traffic management system) and reducing average commute time or cost to citizens will have positive effects on productivity and quality of life of citizens. Another example can be waste water recycling and smart metering which can make a substantial contribution to better water management in the city.

5.2 The Smart City proposal of each shortlisted city is expected to encapsulate either a retrofitting ***or*** redevelopment ***or*** greenfield development model, ***or*** a mix thereof ***and*** a Pan-city feature with Smart Solution(s). It is important to note that pan-city is an **additional** feature to be

provided. Since Smart City is taking a compact area approach, it is necessary that **all the city residents feel there is something in it for them also.** Therefore, the additional requirement of some (at least one) city-wide smart solution has been put in the scheme to make it inclusive.

5.3 For North Eastern and Himalayan States, the area proposed to be developed will be one-half of what is prescribed for any of the alternative models - retrofitting, redevelopment or greenfield development.

6. Proposal Preparation

6.1 The Government is not prescribing any particular model to be adopted by the Smart Cities. The approach is not 'one-size-fits-all'; each city has to formulate its own concept, vision, mission and plan (proposal) for a Smart City that is appropriate to its local context, resources and levels of ambition. Accordingly, they have to choose their model of Smart City and answer the question: What kind of Smart City do they want? For this, cities will prepare their Smart City Proposal (SCP) containing the vision, plan for mobilisation of resources and intended outcomes in terms of infrastructure up-gradation and smart applications.

6.2 **Essential features of SCP :** It may be noted that even though a particular model is not being prescribed, it is expected that the SCPs will include a large number of infrastructure services and smart solutions highlighted in paras 2.4 and 2.5. In particular, the elements that must form part of a SCP are assured electricity supply with at least 10% of the Smart City's energy requirement coming from solar, adequate water supply including waste water recycling and storm water reuse, sanitation including solid waste management, rain water harvesting, smart metering, robust IT connectivity and digitalization, pedestrian friendly pathways, encouragement to non-motorised transport (e.g. walking and cycling), intelligent traffic management, non-vehicle streets/zones, smart parking, energy efficient street lighting, innovative use of open spaces, visible improvement in the Area (e.g. replacing overhead electric wiring with underground wiring, encroachment-free public areas, and ensuring safety of citizens especially children, women and elderly). Cities will have to add more 'smart' applications to this list in order to improve their SCP. In the case of redevelopment and greenfield models of Smart Cities, in addition to the essential features mentioned above, at least 80% buildings should be energy efficient and green buildings. Additionally, of the total housing provided in greenfield development, there should be at least 15% in the affordable housing category. It must be emphasized that, since cities are competing with each other for selection under the Smart Cities Mission, the SCPs have to be prepared with great care and the proposed Smart City made 'smart' enough.

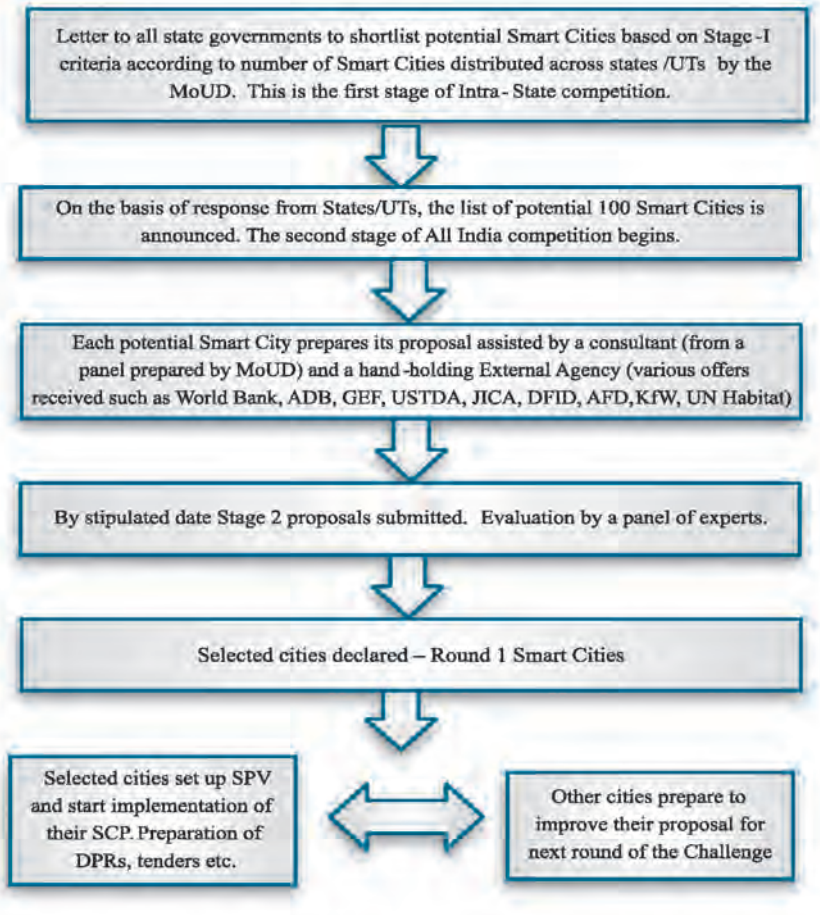
6.3 Cities will prepare SCPs using the principles of strategic planning process and the proposal will contain area-based development plans and Pan-city initiatives. The SCP is collaborative because the objectives and funds of all government departments, parastatals, private agencies and the citizens are dovetailed during the process of preparing the SCP. It is realized that the task of preparing the SCPs is quite challenging and States/ULBs will require assistance of experts. There are two ways of obtaining technical assistance support — by hiring consulting firms and engaging with handholding agencies

6.3.1. **Consulting Firms:** The Ministry of Urban Development will technically qualify a panel of consulting firms and the States/UTs are at liberty to draw upon this panel. As considered necessary, the States/UTs may request financial proposals from these firms in the template RFP given in the Toolkit and do a selection based on applicable procurement rules and guidelines. The scope of work for the Smart City Consulting firms is given in Annexure 1. The States have the option of appointing a consulting firm outside the panel by following transparent and fair procedures as per State financial rules.

6.3.2. **Handholding Agencies:** During the preparation of the Smart Cities Mission, a number of foreign Governments have offered to provide Technical Assistance (TA) support. Additionally, other external organizations, including bilateral and multilateral institutions, as well as domestic organizations have suggested to the Ministry of Urban Development that they can give technical assistance support. These include World Bank, ADB, JICA, USTDA, AFD, KfW, DFID, UN Habitat, UNIDO, etc. Such organizations, which have experience in the field of Smart City development, can also extend support to the States/UTs as hand-holding agencies in preparing the SCPs. The Ministry will assist in tying up the arrangements.

7 Smart Cities Selection Process

Different steps in the selection of Smart Cities are given below.



8. How Many Smart Cities in Each State/UT?

8.1 The total number of 100 Smart Cities have been distributed among the States and UTs on the basis of an equitable criteria. The formula gives equal weightage (50:50) to urban population of the State/UT and the number of statutory towns in the State/UT. Based on this formula, each State/UT will, therefore, have a certain number of potential Smart Cities, with each State/UT having at least one. This distribution is given in Annexure 2. The number of potential Smart Cities from each State/UT will be capped at the indicated number. (This distribution formula has also been used for allocation of funds under Atal Mission for Rejuvenation and Urban Transformation - AMRUT).

8.2 The distribution of Smart Cities will be reviewed after two years of the implementation of the Mission. Based on an assessment of the performance of States/ULBs in the Challenge, some re-allocation of the remaining potential Smart Cities among States may be required to be done by MoUD.

9. The Process of Selection of Smart Cities

9.1 Each aspiring city competes for selection as a Smart City in what is called a 'City Challenge'. There are two stages in the selection process. After the number has been indicated to the respective Chief Secretaries, as outlined in para 8 above, the State/UT will undertake the following steps:-

9.1.1 Stage 1 of the competition: **Shortlisting of cities by States**

The State/UT begins with shortlisting the potential Smart Cities on the basis of conditions precedent and scoring criteria and in accordance with the total number allocated to it. The first stage of the competition will be intra-state, in which cities in the State will compete on the conditions precedent and the scoring criteria laid out. These conditions precedent have to be met by the potential cities to succeed in the first round of competition and the highest scoring potential Smart Cities will be shortlisted and recommended to participate in Stage 2 of the Challenge. The conditions precedent and the forms are given in the Annexure 3. The information sent by the ULBs in the forms has to be evaluated by the State Mission Director and the evaluation placed before the State-level High Powered Steering Committee (HPSC) for approval. The composition of the State HPSC is given in para 13.

The cities emerging successful in the first round of competition will be sent by the State/UT as the recommended shortlist of Smart Cities to MoUD by the stipulated date (to be indicated in the letter to Chief Secretaries). The State Government has to fill the form (given in Annexure 3) and send with the recommended list. The MoUD will thereafter announce the list of 100 Smart Cities.

9.1.2 Stage 2 of the competition: **The Challenge round for selection**

In the second stage of the competition, each of the potential 100 Smart Cities prepare their proposals for participation in the 'City Challenge'. This is a crucial stage as each city's Smart City

Proposal is expected to contain the model chosen, whether retrofitting or redevelopment or greenfield development or a mix thereof, and additionally include a Pan-City dimension with Smart Solutions. The SCP will also outline the consultations held with the city residents and other stakeholders, how the aspirations are matched with the vision contained in the SCP and importantly, what is the proposal for financing of the Smart City plan including the revenue model to attract private participation. An evaluation criteria for the SCPs has been worked out by MoUD based on professional advice and this should act as guidance to the cities for preparing their proposal. The criteria and the documents to be sent with the application are given in Annexure-4.

9.1.3 By a stipulated date, to be indicated by MoUD to the States/UTs, proposals will be submitted to MoUD for all these 100 cities. These will be evaluated by a Committee involving a panel of national and international experts, organizations and institutions. The winners of the first round of Challenge will be announced by MoUD. Thereafter, while the winning cities start taking action on making their city smart, those who do not get selected will start work on improving their SCPs for consideration in the second round. Depending on the nature of the SCPs and outcomes of the first round of the Challenge, the MoUD may decide to provide handholding assistance to the potential Smart Cities to upgrade their proposals before starting the second round.

10. Implementation by Special Purpose Vehicle (SPV)

10.1 The implementation of the Mission at the City level will be done by a Special Purpose Vehicle (SPV) created for the purpose. The SPV will plan, appraise, approve, release funds, implement, manage, operate, monitor and evaluate the Smart City development projects. Each Smart City will have a SPV which will be headed by a full time CEO and have nominees of Central Government, State Government and ULB on its Board. The States/ULBs shall ensure that, (a) a dedicated and substantial revenue stream is made available to the SPV so as to make it self-sustainable and could evolve its own credit worthiness for raising additional resources from the market and (b) Government contribution for Smart City is used only to create infrastructure that has public benefit outcomes. The execution of projects may be done through joint ventures, subsidiaries, public-private partnership (PPP), turnkey contracts, etc. suitably dovetailed with revenue streams.

10.2 The SPV will be a limited company incorporated under the Companies Act, 2013 at the city-level, in which the State/UT and the ULB will be the promoters having 50:50 equity shareholding. The private sector or financial institutions could be considered for taking equity stake in the SPV, provided the shareholding pattern of 50:50 of the State/UT and the ULB is maintained and the State/UT and the ULB together have majority shareholding and control of the SPV.

10.3 Funds provided by the Government of India in the Smart Cities Mission to the SPV will be in the form of tied grant and kept in a separate Grant Fund. These funds will be utilized only for the purposes for which the grants have been given and subject to the conditions laid down by the MoUD.

10.4 The State Government and the ULB will determine the paid up capital requirements of the SPV commensurate with the size of the project, commercial financing required and the financing modalities. To enable the building up of the equity base of the SPV and to enable ULBs to contribute their share of the equity capital, GoI grants will be permitted to be utilized as ULBs share of equity capital in the SPV, subject to the conditions given in Annexure 5. Initially, to ensure a minimum capital base for the SPV, the paid up capital of the SPV should be such that the ULB's share is at least equal to Rs.100 crore with an option to increase it to the full amount of the first instalment of Funds provided by GoI (Rs.194 crore). With a matching equity contribution by State/ULB, the initial paid up capital of the SPV will thus be Rs. 200 crore (Rs. 100 crore of GoI contribution and Rs. 100 crore of State/UT share). Since the initial GoI contribution is Rs.194 crore, along with the matching contribution of the State Government, the initial paid up capital can go up to Rs.384 crore at the option of the SPV. The paid up capital may be enhanced in the subsequent years as per project requirements, with the provision mentioned above ensuring that ULB is enabled to match its shareholding in the SPV with that of the State/UT.

10.5 The structure and functions of the SPV are given in Annexure 5 and the Articles of Association will contain such provisions. A model Article of Association is given in the Toolkit.

10.6 After selection of the cities in Stage II of the Challenge, the process of implementation will start with the setting up of the SPV. As already stated, it is proposed to give complete flexibility to the SPV to implement and manage the Smart City project and the State/ULB will undertake measures as detailed in Annexure 5 for this purpose. The SPV may appoint Project Management Consultants (PMC) for designing, developing, managing and implementing area-based projects. SPVs may take assistance from any of the empanelled consulting firms in the list prepared by MoUD and the handholding agencies. For procurement of goods and services, transparent and fair procedures as prescribed under the State/ULB financial rules may be followed. Model frameworks as developed by MoUD may also be used for Smart City projects.

11. Financing of Smart Cities

11.1 The Smart City Mission will be operated as a Centrally Sponsored Scheme (CSS) and the Central Government proposes to give financial support to the Mission to the extent of Rs. 48,000 crores over five years i.e. on an average Rs. 100 crore per city per year. An equal amount, on a matching basis, will have to be contributed by the State/ULB; therefore, nearly Rupees one lakh crore of Government/ULB funds will be available for Smart Cities development.

11.2 The project cost of each Smart City proposal will vary depending upon the level of ambition, model and capacity to execute and repay. It is anticipated that substantial funds will be required to implement the Smart City proposal and towards this end, Government grants of both the Centre and State will be leveraged to attract funding from internal and external sources. The success of this endeavour will depend upon the robustness of SPV's revenue model and comfort provided to lenders and investors. A number of State Governments have successfully set up financial intermediaries (such as Tamil Nadu, Gujarat, Orissa, Punjab, Maharashtra,

Karnataka, Madhya Pradesh and Bihar) which can be tapped for support and other States may consider some similar set up in their respective States. Some form of guarantee by the State or such a financial intermediary could also be considered as instrument of comfort referred to above. It is expected that a number of schemes in the Smart City will be taken up on PPP basis and the SPVs have to accomplish this.

11.3 The GOI funds and the matching contribution by the States/ULB will meet only a part of the project cost. Balance funds are expected to be mobilized from:

i. States/ ULBs own resources from collection of user fees, beneficiary charges and impact fees, land monetization, debt, loans, etc.

ii. Additional resources transferred due to acceptance of the recommendations of the Fourteenth Finance Commission (FFC).

iii. Innovative finance mechanisms such as municipal bonds with credit rating of ULBs, Pooled Finance Mechanism, Tax Increment Financing (TIF).

iv. Other Central Government schemes like Swachh Bharat Mission, AMRUT, National Heritage City Development and Augmentation Yojana (HRIDAY).

v. Leverage borrowings from financial institutions, including bilateral and multilateral institutions, both domestic and external sources.

vi. States/UTs may also access the National Investment and Infrastructure Fund (NIIF), which was announced by the Finance Minister in his 2015 Budget Speech, and is likely to be set up this year.

vii. Private sector through PPPs.

11.4 The distribution of funds under the Scheme will be as follows:

i. 93% project funds.

ii. 5% Administrative and Office Expenses (A&OE) funds for state/ULB (towards preparation of SCPs and for PMCs, Pilot studies connected to area-based developments and deployment and generation of Smart Solutions, capacity building as approved in the Challenge and online services).

iii. 2% A&OE funds for MoUD (Mission Directorate and connected activities/structures, Research, Pilot studies, Capacity Building, and concurrent evaluation).

12. Funds Release

12.1 After the Stage 1 of the challenge, each potential Smart City will be given an advance of Rs. two crore for preparation of SCP which will come from the city's share of the A&OE funds and will be adjusted in the share of the city.

12.2 In the first year, Government proposes to give Rs.200 crore to each selected Smart City to create a higher initial corpus. After deducting the Rs. two crore advance and A&OE share of the MoUD, each selected Smart City will be given Rs. 194 crore out of Rs. 200 crore in the first year followed by Rs. 98 crore out of Rs. 100 crore every year for the next three years.

12.3 The yearly instalment of funds will be released to SPVs after they meet the following conditions:

i. timely submission of the City Score Card every quarter to the MoUD,

ii. satisfactory physical and financial progress as shown in the Utilization Certificate (Annexure 6) and the annual City Score Card (Annexure 7),

iii. achievement of milestones given in the roadmap contained in SCP, and

iv. fully functioning SPV as set out in the Guidelines and the Articles of Association. A Board Resolution should certify that all these conditions have been met, including a certificate that all the conditions relating to establishment, structure, functions and operations of the SPV as given in para 10 and Annexure 5 are complied with.

13. Mission Monitoring

13.1 National Level

An Apex Committee (AC), headed by the Secretary, MoUD and comprising representatives of related Ministries and organisations will approve the Proposals for Smart Cities Mission, monitor their progress and release funds. This Committee will meet periodically, as considered necessary. The AC will consist of the following indicative members:

i.	Secretary, Housing and Poverty Alleviation	Member
ii.	Secretary (Expenditure)	Member
iii.	Joint Secretary, Finance, MoUD	Member
iv.	Director, NIUA	Member
v.	Chief Planner, Town and Country Planning	Member
vi.	Select Principal Secretaries of States	Member
vii.	Select CEOs of SPVs	Member
viii.	Mission Director	Member Secretary

13.1.1 The Representatives of stakeholders like UN Habitat, World Bank, TERI, Centre for Development of Advanced Computing (C-DAC), Centre for Smart Cities (CSC), Bangalore or other bilateral and multilateral agencies and urban planning experts may be invited with the approval of the Chair.

13.1.2 The AC will provide overall guidance and play an advisory role to the Mission and its key responsibilities are given below.

i. Review the list of the names of Cities sent by the State Governments after Stage 1.

ii. Review the proposals evaluated by panel of experts after Stage 2.

iii. Approve the release of funds based on progress in implementation.

iv. Recommend mid-course correction in the implementation tools as and when required.

v. Undertake quarterly review of activities of the scheme including budget, implementation and co-ordination with other missions/ schemes and activities of various ministries.

13.1.3 There will be a National Mission Director, not below the rank of Joint Secretary to Government of India who will be the overall in-charge of all activities related to the Mission. A Mission Directorate will take support from subject matter experts and such staff as considered necessary. The key responsibilities of the Mission Directorate are given below.

i. Develop strategic blueprint and detailed implementation roadmap of the Smart Cities Mission, including the detailed design of the City Challenge.

ii. Coordinate across Centre, States, ULBs and external stakeholders in order to ensure that external agencies are efficiently used for preparation of SCP, DPRs, sharing of best practices, developing Smart Solution, etc.

iii. Oversee Capacity building and assisting in handholding of SPVs, State and ULBs. This includes developing and retaining a best practice repository (Model RFP documents, Draft DPRs, Financial models, land monetization ideas, best practices in SPV formation, use of financial instruments and risk mitigation techniques) and mechanism for knowledge sharing across States and ULBs (through publications, workshops, seminars).

13.2 State Level

There shall be a State level High Powered Steering Committee (HPSC) chaired by the Chief Secretary, which would steer the Mission Programme in its entirety. The HPSC will have representatives of State Government departments. The Mayor and Municipal Commissioner of the ULB relating to the Smart City would be represented in the HPSC. There would also be a State Mission Director who will be an officer not below the rank of Secretary to the State Government, nominated by the State Government. The State Mission Director will function as the Member-Secretary of the State HPSC. The indicative composition of HPSC is given below:

i. Principal Secretary, Finance,

ii. Principal Secretary, Planning,

iii. Principal Secretary/Director, Town & Country Planning Department, State/UT Governments,

iv. Representative of MoUD,

v. Select CEO of SPV in the State,*

vi. Select Mayors and Municipal Commissioners /Chief Executive of the ULBs, and Heads of the concerned State Line Departments,

vii. Secretary/Engineer-in-Chief or equivalent, Public Health Engineering Department,

viii. Principal Secretary, Urban Development – Member Secretary.

*As and when it is formed.

The key responsibilities of the HPSC are given below.

i. Provide guidance to the Mission and provide State level platform for exchange of ideas pertaining to development of Smart Cities.

ii. Oversee the process of first stage intra-State competition on the basis of Stage 1 criteria.

iii. Review the SCPs and send to the MoUD for participation in the Challenge.

13.3 City Level

A Smart City Advisory Forum will be established at the city level for all 100 Smart Cities to advise and enable collaboration among various stakeholders and will include the District Collector, MP, MLA, Mayor, CEO of SPV, local youths, technical experts, and at least one member from the area who is a,

i. President / secretary representing registered Residents Welfare Association,

ii. Member of registered Tax Payers Association / Rate Payers Association,

iii. President / Secretary of slum level federation, and

iv. Members of a Non-Governmental Organization (NGO) or Mahila Mandali / Chamber of Commerce / Youth Associations.

The CEO of the SPV will be the convener of the Smart City Advisory Forum.

14. Convergence with Other Government Schemes

14.1 Comprehensive development occurs in areas by integrating the physical, institutional, social and economic infrastructure. Many of the sectoral schemes of the Government converge in this goal, although the path is different. There is a strong complementarity between the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Smart Cities Mission in achieving urban transformation. While AMRUT follows a project-based approach, the Smart Cities Mission follows an area-based strategy.

14.2 Similarly, great benefit can be derived by seeking convergence of other Central and State Government Programs/Schemes with the Smart Cities Mission. At the planning stage itself, cities must seek convergence in the SCP with AMRUT, Swachh Bharat Mission (SBM), National Heritage City Development and Augmentation Yojana (HRIDAY), Digital India, Skill development, Housing for All, construction of Museums funded by the Culture Department and other programs connected to social infrastructure such as Health, Education and Culture. (Annexure 1).

15. Challenges

15.1 This is the first time, a MoUD programme is using the 'Challenge' or competition method to select cities for funding and using a strategy of area-based development. This captures the spirit of 'competitive and cooperative federalism'.

15.2 States and ULBs will play a key supportive role in the development of Smart Cities. Smart leadership and vision at this level and ability to act decisively will be important factors determining the success of the Mission.

15.3 Understanding the concepts of retrofitting, redevelopment and greenfield development by the policy makers, implementers and other stakeholders at different levels will require capacity assistance.

15.4 Major investments in time and resources will have to be made during the planning phase prior to participation in the Challenge. This is different from the conventional DPR-driven approach.

15.5 The Smart Cities Mission requires smart people who actively participate in governance and reforms. Citizen involvement is much more than a ceremonial participation in governance. Smart people involve themselves in the definition of the Smart City, decisions on deploying Smart Solutions, implementing reforms, doing more with less and oversight during implementing and designing post-project structures in order to make the Smart City developments sustainable. The participation of smart people will be enabled by the SPV through increasing use of ICT, especially mobile-based tools.

Annexure 3

SMART CITY INITIATIVES

GO ON, MANCHESTER (UK)

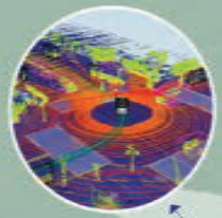
'OYSTER' SMART TICKETING CARDS AND LONDON DATA STORE, LONDON (UK)

LOW2NO, HELSINKI (FINLAND)

NYC HYPER-LOCAL SMART SCREENS, NEW YORK (USA)

URBAN ECOMAP, AMSTERDAM (NETHERLANDS)

DRIVERLESS VEHICLES, LAS VEGAS (USA)



BICING, BARCELONA (SPAIN)

WALKFIRST, SF*park* AND URBAN ECOMAP SAN FRANCISCO, (USA)

YOKOHAMA SMART CITY PROJECT, YOKOHAMA (JAPAN)

FIX MY STREET (UK)

BIG DATA AND DA NANG (VIETNAM)

SUSTAINABLE CITY MANAGEMENT, CURITIBA (BRAZIL)

RIO OPERATIONS CENTRE, RIO DE JANEIRO, (BRAZIL)

SOLAR-POWERED SUPERTREES, (SINGAPORE)

BARANGAROO, SYDNEY (AUSTRALIA)

SMART CITY CASE STUDIES

The London suburb of Hackbridge (UK)

Climate Smart Hyllie, Malmo (Sweden)

Oulu Arctic City (Finland)

Stockholm Royal Seaport (Sweden)

Nordhavn in Copenhagen (Denmark)

Hafencity in Hamburg (Germany)

Barcelona's 22@ Barcelona (Spain)

Aspern in Vienna (Austria)

Boston Innovation District, Boston, (USA)

New Songdo City, Incheon (South Korea)

Lyon Smart Community (France)

Smart City Malta (Malta)

Masdar City (UAE)

Smart City Kochi (India)

Sino-Singapore Guangzhou Knowledge City (China)

Tianjin Eco-city (China)

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