

Smart Cities

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Abstract—In the twenty-first century, growth, economic value and competitive differentiation of cities will increasingly be derived from people and their skills, creativity and knowledge, as well as the capacity of the economy to create and absorb innovation. To compete in this new economic environment, cities will need to better apply advanced information technology, analytics and systems thinking to develop a more citizen-centric approach and services. By doing so, they can better attract, create, enable and retain their citizens' skills, knowledge and creativity.

I. INTRODUCTION

Cities, as hubs of the global economy, are the focal points for this transformation. In the immediate future, three interconnected factors will place even more emphasis on the role of cities in talent-based economic development:

- The world is at an unprecedented level of urbanization. Every week, one million people move from rural areas into urban areas, driven by the economic opportunities that the cities of the world offer see Figure 1 and Figure 2. In fact, close to 4 billion of the world's current population of 7 billion now live in urban areas. The number is expected to increase to 6 billion people by 2050, most of whom will live in developing and less-developed countries see Figure 1. As the cities continue to grow, so too will the focus on smart and sustainable solutions within them

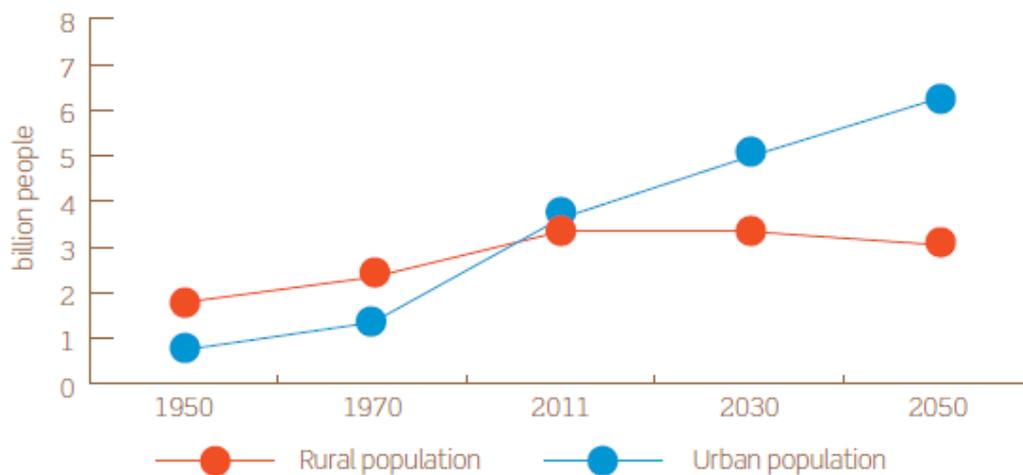


Fig 1: World Urbanisation Prospects
Source: United Nations. World Urbanisation Prospects: 2011

- Cities contain an increasingly large share of the world's highly skilled, educated, creative and entrepreneurial population, giving rise to highly concentrated and diverse pools of knowledge and knowledge-creation networks.

- Cities can support large-scale business and investment networks that create economies of scale in absorbing and extending innovation. As growing economic activity has historically gone hand in hand with increased greenhouse gas emissions, cities have become major contributors to the climate problem which the world is currently facing. Around 70% of global CO₂ emissions derive from cities, which are also facilitating unprecedented consumption levels among their inhabitants. This means that cities consume as much as 80 percent of total global energy production.

Besides the benefits of urban density, the city provides an excellent opportunity to integrate the many systems and networks it contains into one another (e.g. transportation, business, education, communication, infrastructure), thus creating more sustainable living.

However, in order to make the growing importance of the world's cities a positive force in the quest to develop sustainable living, smart and innovative solutions for cities are needed. The concept of the 'Smart City' has been developed as a natural response to the process of urbanization, the economic importance of cities, and the increasing demand for sustainable living.

II. SMART CITY

'Smart cities' is the latest concept when it comes to building the cities of the future. Smart cities are expected to be the key to combining a sustainable future with continued economic growth and job creation. Apart from employment, it is also important for a Smart City to offer decent living options to every resident. This would mean that it will have to provide a very high quality of life i.e. good quality but affordable housing, cost efficient physical, social and institutional infrastructure such as adequate and quality water supply, sanitation, 24 x 7 electric supply, clean air, quality education, cost efficient health care, dependable security, entertainment, sports, robust and high speed interconnectivity, fast & efficient urban mobility etc.

Cities can improve their current service delivery capabilities (as well as lay the foundation for new and expanded services) by making their core systems -transport, public safety, government services, education and health "smarter." This can be achieved through the application of advanced information technology, analytics and systems thinking to improve how a city works and how it stimulates a thriving, knowledge-driven economy. Investments in making a city's core systems smarter will create cost savings and increased efficiencies while positioning it for long-term economic growth.

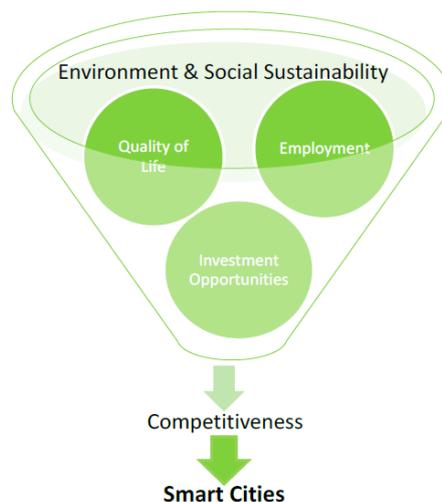


Fig 2. Smart City

2.1 How is Smart City Developed?

Cities are made up of vast networks of people, businesses, technologies, infrastructure, consumption, energy and spaces. In a Smart City, these networks are linked together; supporting and feeding off each other. As every city is unique, so too will be their transition towards becoming a Smart City. For instance, becoming a Smart City does not mean the same thing in Mumbai as it does in Copenhagen, as the barriers and opportunities are not the same in the two cities. Furthermore, the development towards becoming a Smart City can take many forms. In certain places, whole new cities are built from scratch. This means that there is a need and a possibility to think holistically from the very beginning. In most cities, however, the development towards becoming a Smart City will happen in stages. The process of linking the many different networks of the city together in a system presents a number of technological as well as governance-related and social challenges

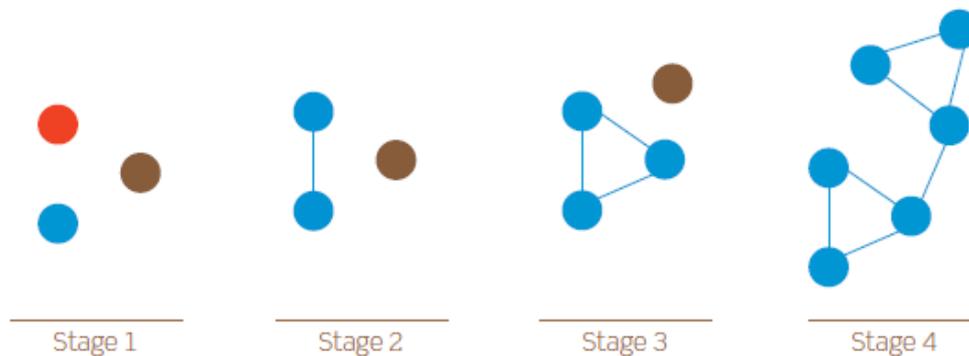


Fig 3: Smart City Development

Source: Information Market places. The new economics of cities.2011

A. Digitalization

Starting with the technological challenges, most of the solutions which are needed in a Smart City have already been developed. Solar panels, electric vehicles, wind turbines, smart grids, building management systems, etc. all have the potential to become part of the Smart City. Being a smart technology, however, is not just about using less energy or being made of smart and reusable materials. It is about being able to function as an integral part of a larger system. The problem therefore lies not so much in the individual technology, but in the fact that the Smart Cities demand that this technology should be integrated into a system, an internet of things. There are at least three main technological challenges to overcome before this can be realized:

Enabling the technology to gather data

First of all, being a type of Smart City technology means being able to constantly gather information about the city which can be used by the technology itself in order to adapt to the most sustainable and smart behaviour. An example of this is a Smart Building System, which constantly gathers data about the performance of a building, which it then uses to optimize energy use.

Enabling the technology to communicate

Secondly, technology should also be able to share that data with people or other technologies or borrow relevant data from elsewhere. In this sense, smart technology should be able to communicate with the rest of a Smart City system. Furthermore, it needs to be connected to a common communicative platform where information can be shared and interoperability can be promoted (e.g. a smart grid).

Making the technology multi-functional

Thirdly, although technology which is able to gather data and communicate with other technologies is indeed smart, truly smart technologies are multi-functional. This means that they provide solutions

to multiple problems. One example could be the electric vehicle. This not only leads to less congestion; in connection with a smart grid it can also serve as an energy buffer, which would help level out the energy supply and demand curve.

It is of course impossible to link all the devices of the city together overnight, and the process must be regarded as a step-by-step development.

B. Integrating smart technologies in the city's infrastructure

The infrastructure of a city is crucial for the way that city operates as it supports the movement of people, energy, money, goods, ideas etc. within the city. In a Smart City, the physical infrastructure of the city is integrated into the digital. Sensors and smart meters deployed throughout the city can provide digital information about traffic flows, vacant parking spaces, energy use, car crashes, weather conditions etc. This information can then be accessed by the city's inhabitants via smart phones or other smart devices and thereby inform them about the smartest options for moving around the city. This makes the physical infrastructure much more flexible and customized.

Besides the integration of the physical and digital infrastructure, the communicative infrastructure needs to be integrated as well. In order for the Smart City system to work, all people and devices have to be able to communicate with each other via the same language. When the physical infrastructure is integrated into the digital and the communications infrastructures, the mobility of the city will be far greater. This will not only lead to huge efficiency gains, it will also spur creativity and innovation among the city's many stakeholders.

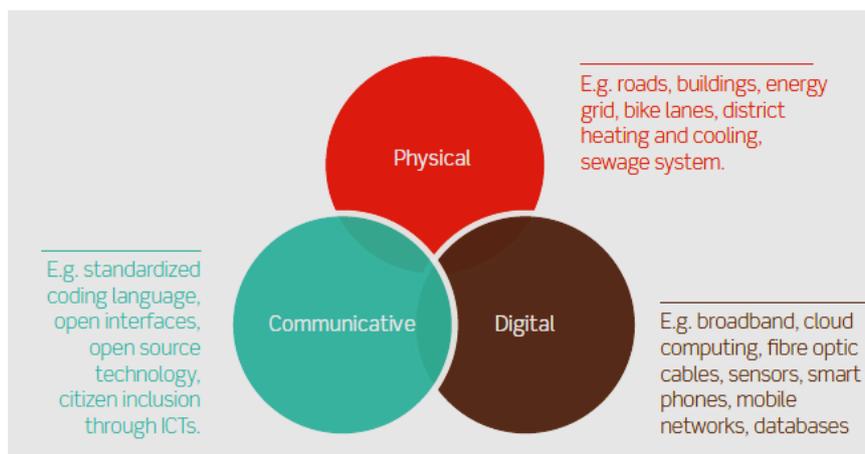
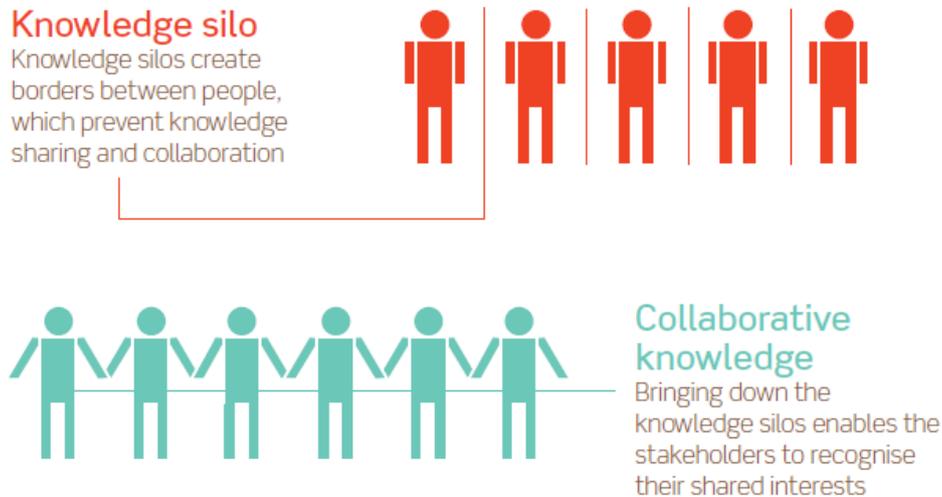


Fig 4: Integrated Infrastructure of Smart City:Source: Copenhagen Cleantech Cluster 2012

C. Breaking down the silos of knowledge

Besides the development and integration of new and smart technologies in a Smart City system, the Smart City requires new modes of governance to be developed. These must be less 'top-down' than traditional governance policies and instead focus on more horizontal governance solutions which spur collaboration and networking between different actors across society. At present, much of the knowledge needed to create Smart City solutions is clustered in different 'silos of knowledge' which are often separated from each other, so that the knowledge of one does not benefit that of the other. This is one of the reasons why many of the individual technologies are unable to function in sync with other.

In order for future, multi-functional Smart City solutions to be developed, these silos of knowledge need to be opened up and integrated into one another. In other words, smart cities require different stakeholders to collaborate.



Source: Copenhagen Cleantech Cluster 2012

D. Harvesting the collective knowledge of citizens

For technological and political ambitions of Smart Cities to be implemented successfully, citizen acceptance and inclusion is vital. Citizens are the primary reason for the existence of the city and its policies. A key element in the development of smarter cities, therefore, is the inclusion of citizens in the Smart City vision. In this regard ICTs like smart phones and social media can be used to create feedback systems between the town hall and the citizens, allowing input from citizens to be collected and assessed.

III. APPLICATION AREAS IN SMART CITY

Smart Cities solution portfolio is expansive. Prioritized industries are as below

Transportation: More efficient and effective transport systems can reduce the costs of congestion on cities. Intelligent transport systems can improve quality of life. Smarter transport can also help improve safety, reduce delays and cut maintenance costs. Accidents and congestion can also be reduced by balancing traffic across routes or modes

Energy: Energy systems around the world are seeing increased demand as populations rise and energy consumption per head increases. Energy systems in developed economies are facing increasing maintenance and upgrade costs to keep up with demand and ageing infrastructure, whilst those in developing countries are racing to keep up with exploding energy demand. These factors drive the need to improve energy management to drive up energy efficiency and resilience.

Smart energy management technology is defined here as technology that makes use of data or information to improve the management of energy Smart energy management technologies can help utilities and distributors to forecast and manage loads better, reduce the need for costly infrastructure expansion, and improve service quality and customer satisfaction

Water: The United Nations predicts that global water demand will rise by 40% between now and 2020 and that this will be 50% higher in developing countries. A smart water system is one in which technology manages the distribution and management of water resources, where advanced water treatment is present, where demand-side efficiency is enabled and where products improve water efficiency. A smart water network is a fully integrated system where products and systems are integrated to enable water utilities and customers to:

- Remotely and continuously monitor and diagnose problems, to take pre-emptive measures to manage maintenance
- Use remote sensors to optimise performance
- Comply with waste water regulation and conserve water
- Reduce supply disruptions and improve customer service
- Manage water consumption more proactively and maintain price stability
- Provide users with intelligent information which enables them to make choices about their water usage.

Healthcare: Improving healthcare in cities is an urgent priority. Healthcare demand continues to grow, as urbanisation increases worldwide. Health and wellbeing are not just crucial components of a city's overall survival and attractiveness but they are fundamental to the quality and productivity of a workforce. Smarter healthcare systems integrate various aspects of often disparate healthcare delivery mechanisms, making use of electronic patient records and streamlined processes. These elements of smarter healthcare lead to improved quality of life by reducing risks, provide more patient-centric services tailored to individual needs and improve access to healthcare. Smarter healthcare's optimization around the patient actually increases efficiency, reduces errors, achieves better quality outcomes and saves more lives.

Public Safety: Cities with lower crime and better emergency services find it easier to attract and retain a diverse and higher-quality skilled workforce. Smarter public safety systems can provide centralized and integrated security surveillance and emergency response systems that collect information for analysis in real-time.

Waste Management: Our review of the waste management industry has indicated that there is not a significant amount of smart technology being used in the waste industry at present. Current economic, regulatory and environmental conditions do not appear to be driving key players in the industry towards the adoption of smart technologies. The smart waste management is a nascent market, whose true economic value and wider environmental benefits require further research in order to be fully determined. Smart technology employed within the waste management industry focuses on enhancing the efficiency of collection and separation. The main driver behind these technologies has been cost reduction and the need for many cities to improve their recycling performance. Waste is a by-product of economic activity and the smart management of waste will have economic implications which will influence productivity, government expenditure and the environment.

Government Services: Smart governance is a process of reform in the way government works, and shares information with the public to deliver services. This brings government organizations closer to the public by using technology such as e-services, social media, applications and other platforms. It is about improved governance and transforming the ways that public services are delivered. Government departments will examine excellence in smart services, and will find ways to offer efficient services to the public. Complaints and suggestions cannot be ignored and must be dealt in a timely and professional manner. Feedback is the key to develop, implement and improve government services as it creates a communication channel between the public. The citizens, residents and everyone involved are benefited and it is a win-win situation for everyone.

City mayors or municipal commissioners or city development authorities will play a pivotal role in implementing of reforms in the smart cities.

IV. CONCLUSION

Whereas the previous centuries were dominated first by empires and next by nation states, the 21st century belongs to the cities. The growing economic, social and environmental importance of cities

has led to a global wave of urban development projects. The Smart City is part of this wave, and is defined in this paper as “a city which systematically makes use of ICTs to turn its surplus into resources, promote integrated and multifunctional solutions, and improve its level of mobility and connectedness. It does all this through participatory governance based on collaboration and open source knowledge.” What makes the Smart City differ from ‘Sustainable Cities’ or ‘ECO cities’ is its emphasis on creating connections and systems, not only between the millions of smart devices present in modern day cities, but also between the businesses, the public sector, the knowledge institutions, and the inhabitants of the city. In this sense, the Smart City represents a vision of a future characterized by collaboration, openness, and sharing.

REFERENCES

- [1] <http://indiainsmartcities.in/Site/documents.aspx> as retrieved on 26th January 2014
- [2] <http://www.teleanalysis.com/analysis/top-5-implementation-challenges-in-smart-city-10174.html> as retrieved on 25th January 2014
- [3] Jonas Mortensen, Frederik JonsbakRohde, KlausRovsing Kristiansen, Maria Kanstrup-Clausen, MariannaLubanski; Danish Smart Cities: Sustainable Living in the urban world
- [4] <http://smartcitiescouncil.com/article/new-government-india-wants-build-100-smart-cities> as retrieved on 26th January 2014
- [5] http://indiainsmartcities.in/downloads/CONCEPT_NOTE_3.12.2014__REVISED_AND_LATEST_.pdf as retrieved on 26th January 2014

