Making a Metropolitan City Smarter in Developing Countries

Biruk B. Seyoum

University of Trento, Trento, Italy

birukbelay.seyoum@studenti.unitn.it

Abstract. **Metropolitan cities existed long before the conception of the notion of smart cities. "Smartifying" such cities brings with it specific opportunities and challenges. This paper explores the features of a smart metropolitan city and logical steps that are needed to be taken to make a metropolitan city smarter. It then assesses the "smartness" of Addis Ababa, the capital of Ethiopia, in terms of the smart public housing and smart mobility.**

Keywords. Smart Cities; smart mobility; smart housing; Addis Ababa.

I. Why Smart Cities

Cities have a major impact on the economic and social development of nations. They are also centers of resource consumption as they are platforms where numerous people live and have businesses at. According to [1] cities consume 75% of the energy resources and generate 80% of greenhouse gases while occupying only 2% of world's territory. Based on a UN report, in July 2007, the urban population has surpassed the rural population in the world. By 2050, it is estimated that 70% of the world population will be living in cities [2]. This has caused an evolution in the demand for resources in the cities and hence has led for a major reconsideration of the management models of cities. One of the adopted strategies for accommodating a boom of the demand in a sustainable manner is the expansion of the existing infrastructure along with the construction of new ones. The building of new infrastructure also includes the development of new and improved services. This strategy also incorporates enhancing the function and value of the infrastructures by integrating different features of digital technology. This feature effectively transforms cities into being smart.

The need for an economic, social and environmental sustainability can also be the motivation for creating smart cities. More efficient and better integrated services are the basis for sustainable economic conditions in a city. A socially sustainable and socially inclusive city tends to be secure and stable and consequently attracts business and capital. A city might face challenges related to environmental sustainability. These challenges may have natural causes such as weather or geological events or they can be caused by human activities incidents. An environmentally sustainable city is resilient to challenges posed by the environment.

II. What is a smart city?

One way of defining a smart city is as a city that uses digital technology to enhance the quality and standard of life for its inhabitants [2]. The Internet of things (IoT) is a main feature to achieve this goal. It is based on the integration of information and communication technologies, and intelligent business management systems with the existing infrastructure for an improved function [3]. Data is massively collected and analyzed to address daily challenges such as rerouting traffic, effective resource deployment and management etc. Information technology (IT) enables transparent governance, efficient utility management, improved management of infrastructure, improved security and reduced crime rate are some of the outcomes of a smart city. In addition, resources are efficiently consumed with the added advantage of efficient asset allocation and situation management in case of state emergency. The efficiency of different services and systems of a city is improved when transitioning to a smart city. Some of them are:

a) *Energy management* including smart grid, smart metering, urban waste collection.

b) *Urban mobility* including smart real-time traffic management, management of transportation and city resources such as parking lots, efficient alternative means of transportation like shared bicycles and shared car services, tracking applications and logistics.

c) *City infrastructure* management, including public buildings and urban facilities

d) *Health services* such as telemonitoring, telemedicine, telecare, social health services

e) *Public safety* including video surveillance and security of citizens, fire prevention and management of public emergency services.

Improving government responsiveness is also an additional goal. All in all, a smart city ventures to create a community that is efficient, livable and sustainable. But these goals of a smart city may sometimes be at odds with each other. For example, livability can be at odds with efficiency. This implies that the choice of the IoT technology must be made

in accordance with the chosen smart city goal. Another key issue to note is that, despite its benefits, the technology that is employed in a smart city is not able to fix inherent urban problems such as poor neighborhood design, uncontrolled population growth.
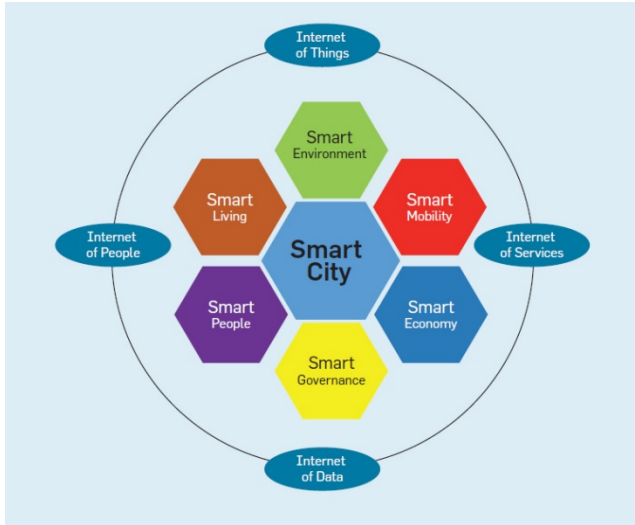

Fig. 1. Categories of a smart city [4]

III. How to transition to smart city?

The right technology is a corner stone of smart cities and when it comes to the implementation it is easier to deploy and test a technology in smaller and mid-sized cities than in large ones. This goes hand in hand with the fact that small and mid-sized cities are more interested in investing in technology to increase economic growth and investment [5]. But the challenge of adding the smart city features to larger metropolitan cities still stands.

Despite the challenges, there are several ways in which existing metropolitan cities can become smart. Some infrequent opportunities such as hosting a national or global event leads to the incorporation of the smart city features into a metropolitan city in a short period of time. As an example, hosting the football world cup or Olympic games may effectively be a trigger for the transformation. Some cities may also host lots of startup companies and they can actualize their transformation to a smart city from the innovative projects tested by the local companies. As these are rare events the most common strategy for transforming a city into a smart city entails a clearly defined vision and a road map laid out by the stakeholders to achieve it. The stakeholders include:

- political leaders, managers and operators of local government;
- investors such as banks and venture capitalists;
- private or public service operators such as gas, electricity, communication and transport;
- technology providers;
- inhabitants and local business owners.

The stakeholders play a central role for the successful implementation of smart cities. A shared vision is crucial for its success and it is also one of the biggest challenge in creating smart cities. A pragmatic plan which aims to create value in the long term should be developed. The plan must create different initiatives over the years. It should also identify the fundamental problems. A carefully designed plan leads to a sequential implementation of a road-map based on the plan. To effectively create smart cities public governance must be coordinated with both the private sector and the community [6]. As an example, the installation of cables and some other elements of new technology is usually very difficult in old buildings due to design and construction constraints. In this case the city administration might update the construction code of the city to incorporate a special directive which dictates that the renovations and construction of new buildings must be suitable for the deployment of current and anticipated technology. This point also demonstrates the importance of a dynamic and coherent leadership to achieve the goals. It is also vitally important if the leadership is headed by the city administration as this will facilitate the organization of the activities of the different stakeholders.

The second logical step in creating smart cities is bringing the right technology. This step is very important as the number of technology related to smart cities is overwhelming. The technology that is chosen for implementation must be scalable, reliable and cost effective. As coordination between different sections of city infrastructures is mandatory, the choice of the technology must ensure integration. The fundamental technology for smart cities includes wired or wireless sensors, communication networks and facilities for data processing and management. Technology allows a city's infrastructure to create a critical mass of data that allows for continuous improvement of the systems themselves. Improving and connecting systems delivers a tremendous volume of information that can be used to deliver better, more effective, and efficient public services [6].

The technology to be deployed in smart cities usually comes from different vendors hence it is very important to ensure integration and interoperability. Integration has both vertical and horizontal dimensions. Combining the functions of sensors, communication protocols and real-time control results in a vertical integration while horizontal integration incorporates the orchestration of different services. Interoperability can only be guaranteed through the existence of international standards ensuring that components from different suppliers and technologies can interact seamlessly. Consequently, suppliers who comply with these standards should be preferred.

Fig.2. Constituents of a city infrastructure [7]

Standards must also include a specification on the various assets of the city. For example, the construction code can enforce the addition of performance monitoring and early failure detecting sensors into newly built buildings. Cities should also build a regulatory framework to address liability, security and privacy issues. They should also revise older regulations based on their effect on existing technology. The extended efficiency gains from integration and interoperability can only be realized if stakeholders collaborate effectively and agree to share information. Smart services and infrastructures cannot be developed without proper collaboration.

Local innovation supported by the city administration also plays a key role in fostering smart cities. The administration can contribute to innovation by investing in technology, education and establishing start-up incubators in partnership with private sector [7]. Different start-ups can be motivated to work on innovative solutions to address different urban challenges and the city administration can support such companies with different incentives such as tax breaks and other mechanisms.

IV. The case of Addis Ababa

Addis Ababa, the capital of Ethiopia and home of the African Union (AU), is one of the largest cities in Africa with over 4 million inhabitants. The city is 126 years old and is currently in the middle of a construction boom with projects ranging from skyscrapers to condominiums and roads. The city administration recently built and commissioned a light railway system which expanded the mobility domain in the city. In its pace for modernity, besides the development of new infrastructure and services, the city is facing challenges of gracefully upgrading old infrastructure according to current standards and integrating the services they offer with new services

In this paper the smartness of the transport and the public housing sectors, currently under heavy development, are analyzed.

4.1 Smart Housing

The rapid increase in population has forced the Addis Ababa city administration to massively invest in urban housing since the early 2000's. Every year thousands of condominiums are built and distributed for residents. These buildings comprise four floors with 4 apartments on each floor with different sizes. The primary cost of construction is covered by the government and later paid back when the houses are delivered to inhabitants.

Despite being better in quality than most of the existing housing in Addis Ababa, the new houses need to incorporate more elements to be categorized as smart houses.

Fig 3. A newly built housing site in Addis Ababa [8]

A smart housing is a connected, efficient and cost-effective building [9]. This results from the optimization of structure, systems, services and management of buildings and their interrelationship. For this work, 14 housing sites which comprised more than 2000 buildings have been assessed by the author. In terms of maximizing the effectiveness and guaranteeing the safety of the building occupants, the current housing scheme in Addis Ababa lacks a few elements. For example, all the housing buildings, by design, do not have elevators. They also lack the proper facilities that are necessary to handle emergency situations. For example, there is only one stairway and hence no fire exit. The buildings are not equipped with technology that is used to monitor structural health that is required for early risk assessment of structural failure. This feature i.e. monitoring the structural integrity of the buildings, is necessary since the houses are built using low cost materials to make them affordable. The technology that is used for automation and control of building functions is absent or poorly implemented. The systems aimed at the distribution of electricity and water on the buildings do not leverage digital technology and hence the implementation of a building wide protocol for energy efficiency is very difficult. The buildings are also not subject to higher level energy saving techniques such as smart lighting. A smart garbage collection is also not implemented in these housings. Trash is not separated in Addis Ababa therefore all solid waste is garbled together. All in all, the houses with their current form and state cannot be categorized as houses in a smart city.

4.2 Smart Mobility

Efficient transportation is the pillar for the quality of life of citizens in a city. In Addis Ababa, public transport is a major

mode for mobility. With the rising population size and with the existing modes of transportation becoming obsolete by the day, this sector had been facing problems such as low quality and unsafe public transportation, roads under poor condition which are unsafe and overcrowded, poor traffic management, lack of parking spaces. To alleviate some of these problems, the government of Ethiopia had heavily invested in new transport infrastructure ranging from bicycle lanes to roads and had also recently commissioned light rail transit (LRT). To improve the service, the city administration also started different bus services making a high-quality transport service available for the public. Various private companies that provide taxi and bus services had also been established. An adaptive traffic management system had also been deployed on most of the roads in the city. Mobility had significantly been improved and traffic congestion had been reduced with the work done so far. The improved transportation service has benefited about 80% of working adults in Addis Ababa whose work is not within walking distance from their home [5].

Addis Ababa has also introduced Africa's first smart parking system to solve the lack of parking space that was becoming a severe problem in the city [10]. The parking system uses an automated lift system to park vehicles in a steel structured building. The city administration has now deployed this technology in lots of places across the city.

Fig. 4. The light rail way in Addis Ababa [16]

V. Conclusion

Due to rising population size and expansion of cities, the need for smart and sustainable cities has become inevitable. Cities across the world are spending billions of US dollars in smart city technologies to improve their efficiency, livability, and sustainability. The creation of a smart city requires the collaboration of different stakeholders which include government, private sector and the citizens. In smart cities, urban infrastructures need to be updated and improved to tackle challenges such as energy and water scarcity, pollution, traffic congestion, crime, waste disposal and safety risks. Beyond the environmental benefits the improvement of city wide systems contributes to social equality through universal access to public services.

Addis Ababa is currently going through a massive construction boom which includes the construction of lots of condominium apartments. The administration is also working to improve transport and road conditions across the city. Although, alleviating the problems of housing for residents, the massively built condominium housings lack the proper integration of digital technology to make them sustainable and comfortable dwellings in a smart city. On the contrary the transport sector is showing improvements because of the choices of the administration of building new infrastructures and implementing better traffic management system along with increased mobility options.

REFERENCES

[1] https://www.telefonica.com/en/web/public-policy/blog/article/-/blogs/why-do-we-need-smart-cities-

[2] I. Zaman "*White paper in smart citie*s" daywatcher.com 2015

[3] C.H. Aoun, *The Smart City Cornerstone:Urban Efficiency. Published by Schneider electric,* 2013

[4] https://cacm.acm.org/magazines/2016/8/205032-smart-cities/abstract

[5] http://www.theigc.org/blog/urban-experimentation-how-housing-transport-and-infrastructure-projects-are-revolutionising-addis-ababa/

[6] Ericsson white paper "*Laying the foundation for a smart sustainable city,*" Jan. 2016

[7] "Orchestrating infrastructure for sustainable Smart Cities", IEC white paper, http://www.iec.ch/whitepaper/smartcities

[8] https://www.esetube.com/2080-condominium-housing-winners-list-2016/

[9] www.commscope.com/Blog/Defining-Todays-Intelligent-Building/

[10] https://eblnews.com/video/ethiopia-introduces-first-smart-parking-system-africa-126212

[11] http://www.ebc.et/web/ennews/-/addis-ababa-1st-in-east-africa-with-bus-rapid-transit

[12] R.E. Hall, *"The vision of a smart city", 2nd International Life Extention Technology Workshop, Paris, France,* 2000

[13] L. Leydesdorff, M. Deakin, "The triple-helix model of smart cities: a neo evolutionary perspective,*"* Journal of Urban Technology, 18 (2). pp. 53-63, 2000. ISSN 1063 0732

[14] T. Nam, T.A. Pardo, "Conceptualizing smart city with dimensions of technology, people, and institutions", Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times. ACM, pp. 282–291, 2011.

[15] https://gcn.com/articles/2017/01/30/smart-small-cities.aspx

[16] https://www.weforum.org/agenda/2015/10/5-ways-to-make-our-cities-smarter/

[17] "Orchestrating infrastructure for sustainable Smart Cities", IEC white paper, http://www.iec.ch/whitepaper/smartcities