Building up Environment Sustainable City through IT Lens

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Abstract-Global urbanization trends and pressing issues around sustainability pose great challenges for cities. The smart city concept has been developed as a strategy for working with cities as they become systematically more complex through interconnected frameworks, and increasingly rely on the use of Information and Communication Technology to meet the needs of their citizens. The paper describes the main attributes of a smart sustainable city (SSC) and provides readers with a wider understanding of composition of sustainable smart city. The primary characteristics of the city along with its attributes are clubbed into four primary pillars viz. economy, governance, environment and society. It identifies and highlights the role and potential of information and communication technologies (ICTs) in SSC.

Keywords— Environment, Information & Communication Technology

I. INTRODUCTION

The emergency to devise smarter way of managing the global urbanization trend is challenging [1]. The urban development is looked upon as parallel to the development of sustainable cities. A mixed of traditional and modern approach incorporating ICT practices and indigenous knowledge through usage of natural resource is the emphasis laid as the foundation of the concept of development of smart cities [2]. The smart cities emphasize upon the various facets of sustainability such as responsible resource management, efficient energy management and the overarching citizen management Nevertheless it must be always borne in mind that the sustainability of a smart city is functional only under the realms of natural boundaries. The model of smart cities is very complex as it endows a lot of interconnections and interdependence. The urban area have been synonymous to hopes, aspirations and prosperity of millions of people banking on them, this is leading to generation of a congested urban spaces and several challenges. Intrepid explosion of population, burgeoning demand of energy, water security, public services and sanitation challenges, health sector and education is pressuring the resource base. The interconnection of the three pillars of sustainable development i.e. social, economic and environment issues. The cities account for 70% of global greenhouse gas emissions as well as 60-80% of global energy consumption [3]. ICT is seen as a tool which would help in enabling a smart sustainable city.

The visualisation of smart sustainable city would be truly utopian in absentia of infrastructure. Broad categorization of infrastructure includes two types of infrastructure: physical infrastructure comprising buildings, roads, transportation, and power plants and digital infrastructure *viz.* information technology (IT) and communications infrastructure. Infrastructure services with values addition also exist which provide the physical infrastructure (e.g. Education, health care, e-government, and mass transit). The optimum and efficient operation of a smart and sustainable city has a requisite of digital infrastructure enablers. Smart energy, smart buildings, smart transportation smart water, smart waste and smart health care are the basic components of basic physical and service infrastructure.

ICT plays a crucial role in achieving SSC as it provides a platform to collate the information and data, which would further help in enabling the functioning of the city in terms of resource management, provisioning of services, and lifestyles. Thus, a smart sustainable city has an overall mandate to provide and achieve an end goal of an economically sustainable urban environment without sacrificing the comfort and convenience/quality

of life of citizenry. It endeavors to create a sustainable living environment for all its citizens through the use of information and communication technologies (ICTs).

II. C I T Y DIMENSION AND ATTRIBUTES

The following three dimensions are identifies as key attribute of a city:

(1) Environment and sustainability
(2) City level services
(3) Quality of life

A number of important attributes are associated with each of the dimension. With the overlap of attributes in few cases a 360^0 lens is required to view the same. The four core pillars namely Economy, Governance, Environment and society of a Smart sustainable city represent the further reclassification of the above dimension and their attributes. Each dimension has specialised characteristic feature of their own. The first overarching d i m e n s i o n o f e n v i r o n m e n t a n d s u s t a i n a b i l i t y represents the soul of urban landscape as cities consume over 75% of energy and produce 80% of global emissions. The priority players of this dimension are infrastructure and governance, energy and climate change, pollution, waste, social, economic and health aspects. The city level services, the key attributes include technology and infrastructure (e.g. transportation, buildings, healthcare),sustainability (e.g. water, air, waste), governance (e.g. organization, administration and leadership) and economy (e.g. financial, human capital, economic strength).The quality of life of the citizens is the reflects the perception of the inhabitants of the city and their self-sense of well- being and cognizance to the fact that they are constantly striving towards betterment in different spheres of health , wealth and education. All the above mentioned dimensions are a pre requisite ingredients for the recipe for a successful smart and sustainable city.

III. I C T INFRASTRUCTURE AND DISASTERS IN SSC

The essential duty of a city is to facilitate the pollution free, safe and secure life to its citizens. The city may host a number of problems such as population explosion, weather manifestations, unprecedented disasters, unemployment, and poverty claiming to be potential threat to the stability of the city. Different technological innovations are being employed by the Government machinery to induce a paradigm-shift to tackle the above challenges .For this to happen an increasing amount of data needs to be garnered so as to have a more pronounced and informed decision making. Performance related smart quotient has high relevance of implementable technical solutions. ICT services act as conduits which act as enabler or purveyor to allow “smartness” to flow through them.

The physical infrastructure supported by physical buildings, roads, transportation and power plants and digital infrastructure consisting of IT and communication are the two lifelines of any city. Integration of the above two coupled with smart management and linkages of the infrastructure would facilitate in provisioning of an enhanced multiplier effect. This coupling and integration are the main ingredients of a smart sustainable city. The design of a smart city would be incomplete without the reflection of Disaster management. Recent experiences from the recent Fukushima, Katrina and 9-11 incidents have evidenced. In the case of the 9-11 tragedy, it has been suggested that the lack of interoperability between the first respondents and other corresponding civic agencies significantly hampered rescue efforts. Thus, the exploration of the use and potential o f ICT in the area of disaster management has come to light [4]. ICT plays a very crucial role in SSCs, by performing the niche role of digital platform which acts as a pedestal to generate information and knowledge. Thus this forms the basis of a well-informed network. Such an informed network not only allows aggregation of information but also strengthens the city’s functioning in terms of resource consumption, services, and lifestyles. Such digital platforms generate amiable information which is dispensed and act as guidelines for the policy makers to make informed policy decisions and generate policy directions. Eventually these well thought over policy inputs aid in improving the quality of life of citizens and society as a whole.

IV. A HOLISTIC APPROACH TO SSC

The most critical limitation of urban development which acts as a major barrier in making the city "smart" is the work culture across government departments and civil societies. The temperament of non- sharing of information and working in *silos* has resulted in a major setback. This has proved detrimental for informed decisions during emergency situations and also for optimum resource utilization. The amalgamation of ICT with ICT tools helps in integration which helps in the foundation of smart sustainable city. For example, optimization of traffic flow and energy usage of electric vehicles could be achieved through dissemination of information on location of electric vehicle charging stations.

- ICT-enabled information and knowledge sharing: Traditionally due to inefficiency on sharing of information, a city may not be ready to solve a problem even if it is well equipped to respond. With immediate and accurate information, cities can gain an insight on the problem and take action before it escalates.
- ICT-enabled forecasts: A considerable amount of reliable data is required to generate study patterns which is used for preparing for stressors like natural disasters, identify trends, recognize vulnerable area, and predict potential problems. ICT provides and manages the information efficiently, which helps in enhancing the cities to improve its preparedness, response and resilience.
- ICT-enabled integration: Access to timely and relevant information (e.g. ICT-based early warning systems) need to be ensured in order to better understand the city's vulnerabilities and strengths.

With the synchronization of all services provided to an individual, the city can have executable smarter provisions. Another feather in the cap of smart city is its prediction, specific events and scenarios can be well anticipated which facilitate a better quality of life substantiating its citizenry with more informed and educated design. [5] Where specific incidents, events or scenarios can be anticipated, the end result being an improved quality of life, or allowing citizens to make more informed and educated decisions on what actions to take next. Predictive analysis essentially applies modern statistical techniques of modelling, machine learning, data mining facts (current and historical) to make predictions about future events. Predictive analytics has become an essential tool in business modelling.

For example, constant data sharing would be able to provide immediate warning for any fragile water pipelines to relevant government departments before it bursts, mobile applications, predict which trains will be fully occupied at a given time and modelling people flows or workflows with real-time feedback loops.

V. DATA ACCESSIBILITY AND MANAGEMENT

Smart solution require the availability of data and information for flawless functioning. Access to data must be possible under all circumstances, thus enabling corresponding actions to be taken by city officials. Cross-scale information sharing using ICTs as platforms allows policy makers and officials from different sectors to base their decisions on common information, and undertake coordinated courses of action. The following are some of the key components that ensure data accessibility and management in SSC:

a. Accessibility to data: Policy interventions need to promote an open and easy access to data. While there will always be a concern in terms of "privacy" and the proprietary nature of data, most 'sensitive' data can perhaps be made anonymous before being made accessible. The act of balancing between privacy and accessibility is still a question mark with reference to legal and regulatory framwework.it has been felt that this needs to be advanced separately.
b. Open data: It is recommended that data on energy, utilities, transportation, and other basic datasets are to be made public. This is vital in facilitating the cross-scale information sharing component of a smart city that was suggested above. Information sharing allows better operational decisions to be made and implemented. It is equally important to note that all data should be presented in a consistent and standardized

manner. It is only when all data is based on the same parameters that it allows for meaningful exchanges and decision making, such as in the case of open application programming interfaces (APIs).

c. Massive data management: The associated parcels of information are of various sizes and shapes just as the cities are. To ensure the reliability of data from various sources the features such as accuracy, analytical capability, data storage and data security should be well guarded. Therefore, data needs to be managed using highly efficient database constructs.
d. High performance: Massive data inputs generating new insights are complemented with digital infrastructure has high capability performance index. The operational capacity of existing devise infrastructure mounts enormous pressure for task optimization, the ICT system must be dependable, with minimized downtime, precise data transmission. In cases of failure, the solution should be ready to handle and recover from error.
e. Maximum efficiency: Swift dissemination of information from one corner to another requires operation at peak efficiency at all points of time. Improving quality and flexibility while minimizing capital and operational cost is crucial for both maximizing and maintaining the role of ICTs over time.

VI. PHYSICAL AND SERVICE INFRASTRUCTURE ELEMENTS

Smart energy, smart buildings, smart transportation, smart water, smart water, smart physical safety and security, smart health care and smart education are the physical and service infrastructure as key indicators of a smart sustainable city. These infrastructures are traditional and very physical in nature. The convergence with digital (ICT) infrastructures leads them to become "smart".

The concept of smart energy rises from various notions such as rising energy prices, energy security and theft, depleting energy sources and the global warming. There is a global water deficit which is a result of the tripling of water demand over the last half-century. Water shortage could quickly translate into food shortages, consequently contributing to the rising food prices. Studies suggest that between early 2007 and 2008, the prices of wheat, rice, corn and soybeans have roughly tripled around the globe [5]. Cities are looking to solve these problems with the development of new technologies to collect information and control energy in order to maximize urban energy consumption levels.

Smart energy management systems use sensors, advanced meters, digital controls and analytic tools to automate, monitor, and control the two-way flow of energy [6]. These systems optimize grid operation and usage by keeping consumers, the producers and providers up to date with the latest technology advancements to deliver energy efficient solutions thus enabling the translation of real time data into action. Smart buildings are an urban necessity. However, buildings are also the main contributors to greenhouse gas emissions. 36% of total energy use and 65% of electricity consumption generating 30% of greenhouse gas emissions, 30% of raw materials use, 30% of waste output (136 million tons annually), 12% of potable water consumption. Smart building management systems with up-to-date information can make intelligent modifications to improve building energy efficiency, reduce wastage, and make optimum usage of water with operational effectiveness and occupant satisfaction. Moreover, these modifications are also effective in old buildings through simple retrofit programmes saving up to 50% of energy [7].

Smart transportation solutions are needed in order to move people (and goods) in an efficient (time), safe (secure), cost effective (economic), and an environmentally friendly and sustainable fashion. Thus making intelligent transport systems (ITS), demand of the day. Smart transportation management systems uses technology and collect information about mobility patterns ensuring lesser investments, cleaner city, efficient and smarter transportation systems. This method lessens the level of wastage and improves the level of citizen's lifestyle. In addition, ICT can help to reduce the overall need for transportation and travel by offering virtual alternatives to physical movements, for eg. Online purchase portals. Studies suggest that approximately 783 million people lack access to clean water, 2.5 billion lack access to adequate sanitation, and 6 to 8 million are dying per year due to water-related diseases and disasters. ICTs can play a key role in this respect through a number of technologies that contribute to a better distribution, management, and allocation of water resources [8]. The management of water systems is

still nascent, and a growing science in terms of utilizing, adopting and integrating advanced information technology (IT) remains in the developmental stage. Lack of awareness of the problem, inadequate information, and difficulties in the ability to demonstrate investment returns are driving governments across the globe to integrate advanced IT techniques and infrastructure to improve the management of water resources [9]. Smart water management systems use and apply ICT in the development and delivery of solutions to provide access to safe water, manage demand and supply, and develop a pricing mechanism. Examples include: Providing continuous monitoring of water quality and availability via smart sensors. Technologies such as Smart pipes and sensor networks, smart metering, communication modems, geographic information systems (GIS), cloud computing, supervisory control and data acquisition (SCADA), optimization, and decision-support tools. Web-based communication and information system tools are being used to facilitate smart water. With the burgeoning urbanisation, cities are finding it difficult to source, segregate different kinds of waste and make use of a product which can be potentially bought back into consumer life cycle. This challenge can be solved with source reduction, proper identification of the category of waste and development of a proper use for the waste. There may be various forward-looking resolutions for converting waste into a resource and creating closed loop economies, with the help of ICT as an enabler. Smart waste management systems will enable the following areas of action:

- Implementing waste tracking systems to monitor and control the movement of different kinds of waste
- Sorting of waste without the operator coming into contact with it,
- Leveraging technology to collect and share data from source to transportation to disposal of waste,
- Connecting various smart waste management systems with local waste management service providers.
- Smart health care converts health-related data into clinical and business insights.

Productive cities and progressive organizations are working in tandem on their health care data to secure information sharing and communication. Examples of smart health care include the availability of remote alternative diagnoses, remote treatment or tele-assistance, online medical services or the possibility of having a digital record via an electronic health management system, remote home services, alarm systems or even remote patient monitoring systems.

VII. CONCLUSIONS

The end goal for a smart sustainable city is to achieve an economically sustainable urban environment without sacrificing the comfort and convenience/quality of life of citizenry. A smart sustainable city strives to create a sustainable living environment for all its citizens through the use of information and communication technologies (ICTs). The various attributes of a smart sustainable city need to be identified and can be used as part of the metrics and reference points for defining the smartness and the sustainability of a city. This will help contribute to a better, more in-depth understanding of what constitutes a smart sustainable city.

REFERENCES

[1] Nam, Taewoo, and Theresa A. Pardo. "Conceptualizing Smart City with Dimensions of Technology, People, and Institutions", Proceedings of the 12th Annual International Conference on Digital Government Research, 2011.
[2] Caragliu, Andrea, Chiara Del Bo, Peter Nijkamp, "Smart cities in Europe. Amsterdam:", VU University of Amsterdam, 2011, 48: 1-12.
[3] Green Economy Report, United Nation Environment Programme, 2011
[4] Personal Communications, Rob van den Dam, IBM Institute for Business Value, ITU Telecom World 2013
[5] Lester R. Brown, WORLD ON THE EDGE: How to Prevent Environmental and Economic Collapse Earth Policy Institute, 2011
[6] Milan Prodanovic, "Smart Energy Management Algorithm", Madrid, November 201 A Technical Report OECD Green Growth Studies in Cities 2013.
[7] S. Sector, "Standardization activities for smart sustainable cities", ITU-T Focus Group on Smart Sustainable Cities, 2015
[8] Anup Shah, "Water and Development", Global Issues, 2010.