

A review on smart cities: impact of technology and social factors

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Abstract:

With the application of various smart technologies, industrial changes have taken place. This paper presents how improvements in technology widely change cities with special analysis of its effect on communication, infrastructure, networking, transportation, education and populace, It is proposed that research work in the future should investigate new strategies and policies that can bring about successful implementation of smart city technologies, putting into consideration the human factor, governance and technology required to create a positive change in making a city smart compliant.

Keywords: Smart, Cities, Technology

Full Text:

1.0. INTRODUCTION

Technology is and has become a global trend. The terms "smart" and "intelligent" are used as tools to market new products, nonetheless much thought is not always given as to what these really mean. A city where available public functions are networked by means of cutting-edge information and communication technologies is termed a smart city. Functions necessary for the realization of ICT-based smart city include concepts of sensor-based global environment and intelligence (Seong-Hoon and Dong-Woo, 2015). Smart city started as Internet-based virtual city in computers and has progressed to the present status. The framework of smart city consists of the six elements: smart government, smart building, smart mobility, smart energy, environment and smart service. Various products might include the topmost of great technology as available today but the defining question is, are they really capable of bringing to the fore a consciousness of their position and do they possess the required ability of responding to this awareness? Attributes like these are significant and required for an existing technology to be categorized as truly smart.

Smart people, smart governance, smart economies, smart homes, smart environments and smart devices are a few of the numerous component dimensions that are often associated with the concept of a smart city as outlined by Madakam et.al (2014). These know-hows are orchestrated by intelligent inventions which possess capabilities that allow for the sensing of variations in their environments with abilities to implement measures that improve their functionalities with respect to a change in these circumstances and according to Worden et.al (2003) these inventions massively aid proficiency, performance, productivity and the economics of operations.

Arising from the need to understand the depth and breadth of the concept of smart cities development and acceptance, it has become necessary to gain a significant appreciation of the elements that combine to make such urban developments. It is also equally important to understand the roles played by these individual elements with the aim of extracting appreciation on the subject matter.

Smart technologies are intended to be engrafted into every aspect of our lives as human beings since these technologies are aimed to make structures like sanitation, social amenities,

transportation, housing, land use and land reclamation better monitored, more maintained and more economical. The Internet of Things (IoT) was concerted to enable structural entities with individual responsibilities out of the most mundane things and enable humans to access these data and take decisions from the comfort of their smart gadgets without necessarily visiting the control centre as the case was in the recent past. Amazingly, SMART is an acronym which means Self-Monitoring Analysis and Reporting Technology. What this really means is object embedded with the ability to record data, analyze them, and make a decision based on either a programmed response, or the most preferably used options from its database of actions. The smartness of these devices could also be applied to the ability to make intelligent decisions from the information that has been imputed into them by the user or from the information gotten from the internet. These devices are capable of anticipating occurrences before they happen and take the predetermined precautions. The history of smart technology could be traced back to IBM, when they created software that helped predict when their hard drives were going to fail. The capability of smart devices has since transcended to possess high level capacities ranging from simple tasks such as lighting bulbs at specified times, to keeping space craft in orbit of intended travel.

Smart City: There are various ways a smart city can be defined. It could mean a city that has smart and user-friendly technology entrenched through all city functions; a city where all sectors are being driven by technology.

Smart city could also suggest sustainability of a population in the areas of economic activities and employment, irrespective of their education, abilities or revenue levels.

Source: <http://blog.ideas4all.com/es/files/2013/01/Smartcityjpg>

The concept of a smart city is active and on-going, not static. Smart cities can be described as a process by which cities become better places to live in with favourable and user-friendly conditions. It can also be described as a city that identifies the physical restrictions to its advancement without affecting the value of life of the present-day and upcoming generations.

Technology: Technology includes products or methods that make life more enjoyable and stress free for the people. A typical smart city has products of technology like: Wi-Fi, video surveillance, traffic control lights, electric street lights, and lots more which distinguish the smart cities from the local countryside. The Smart City Technology impacts on the following aspects of the environment:

- * Communication and Networking
- * Infrastructural Design
- * Economy and businesses
- * Transportation and Landscape
- * Education

2.0 AIM: The purpose of this paper is to investigate how Smart Technologies create a reliable change in the society and how it transforms the health, socio-economic life, business, education, transport, energy, landscape sectors, and other diverse aspects of modern society. It also aims to propose areas for further research.

3.0. THEORY REVIEW

As identified by Frost & Sullivan (2014) there are eight important features of a smart city: smart energy, smart building, smart governance, smart infrastructure, smart healthcare, smart mobility, smart citizen and smart technology.

New technology has impacted businesses in three major ways which are defense, efficiency and winning. In defense, when the advancement in technology is ignored, the impact is that one loses.

It was opined that there are no choices but to carry on. Another factor is that of efficiency. Functionally, technology saves costs, it produces efficiencies, and it delivers better communication.

Technology gives you a head start in dealing with your clients and customers as well as your products and services. The third aspect is winning. You can use technology to distinguish yourself, and make your products better than that of competitors.



Figure 1: An illustration of a typical smart city

The five cities on the verge of achieving the dream of becoming smart cities include: London, Bristol, Manchester, Glasgow and Birmingham. These cities are achieving this by relative interconnectedness of various parts of the cities ranging from door locks to power grids (Doorn, 2014). These cities have become actively engaged in intelligent maneuvers such as collating data that are inputted by the diverse types of sensors that have been embedded inside them. Of the many possible applications that the interaction enabled platforms that smart technology could provide, the most evolved and closest to reality are itemized below:

a). Intelligent Transportation Systems (ITS) includes a wide variety of digital technologies which help to develop better efficiency in the transport sector. The use of ITS on vehicles, public transportation network and roads can surely aid reduction in traffic congestions, improve mobility, save lives, and optimize other existing infrastructures. This innovation is gradually changing our outlook and adding a new dimension to travelling which includes but not limited to:

- * Providing end users with parking space information, real-time traffic locations, transit and navigation info;
- * Improving highway and vehicle safety;
- * Minimizing traffic congestion and incident response times;
- * Reducing energy emissions and use;
- * Improving supply chain efficiency and shipment;
- * Enabling advanced financing substitutes such as dynamic pricing and mileage-based user fees. (smart Transportation Technology Showcased on Capitol Hill held in June 26, 2013)

b) With the outcry by the UN on global warming, many cities are striving hard to transfer their insatiable energy demands from the exhaustible fossil fuels to more environmental and greener sources of energy. Smart technology designed with the goal to study and proffer the most efficient way to achieve this based on the weather data could be engaged to tackle this disturbing challenge as seen in the San Jose Green vision being implemented in California, United States. Intel and San Jose are creating a "sustainability lens" by installing a network of air quality, sound and microclimate sensors. The "sustainability lens" uses IoT (Internet of Things) technology to measure characteristics such as particulates in the air, noise pollution, and traffic flow. With this information,

the city management can work on air quality improvements, noise, efficiency in transportation, health, energy and also environmental sustainability (see www.smartamerica.org).

The goals to be achieved via this program are surmised below:

- * Charging stations for electric vehicles conveniently located just off freeways.
- * Smart Meters in homes and businesses that regulate energy consumption throughout the day
- * Photovoltaic solar panels on every roof allowing owners to independently produce energy.
- * Recycled rain water containers on every roof that provide water for domestic use, ensuring water conversion
- * Personalized digital signs that provide relevant and personalized information for people passing by
- * M2M (motorist-to-motorist) technology that provides drivers with up to the moment information about traffic delays and the most effective routes.
- * Biometric technology that confirms identity and allows users to open buildings, vehicles, computers and other secure areas with a simple touch of their fingertip
- * Super speed train systems offering reliable wireless Long Term Evolution (LTE) 4G access providing users with constant access to networks anywhere
- * Efficient bicycle lanes to assist the growing number of zero-emission vehicle users

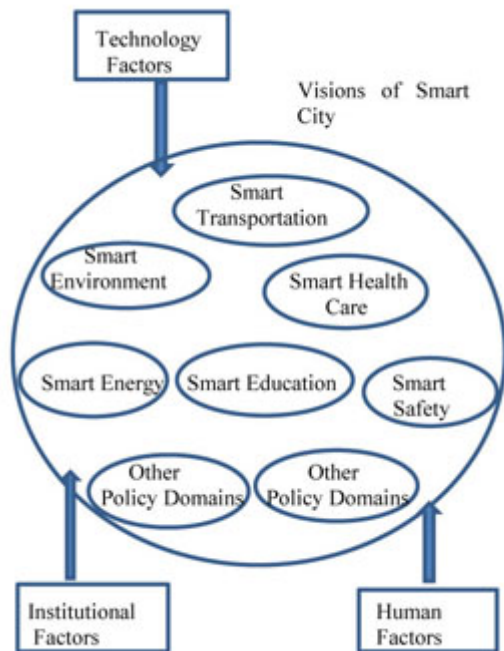
c) The ever growing abuse of weapons and gun-related violence in major cities has risen to catastrophic heights in recent times. A way to curb this resulted in an innovation in Europe by Armatix, a German company which created a line of smart guns which can only be fired by authorized personnel whose biometric data are accessed before the security protocols of the gun could be unlocked. Another innovation is the use of unmanned drones by the US government in military expenditures as a tool for reconnaissance which performed well without the unnecessary loss of human life. This ever evolving and highly secretive technology are programmed to make cities safer. The civilian end of this smart security technology includes:

- * Burglary protection, which uses smart alarms and auto-call features.
- * Home automation technology, which uses individual living patterns to detect suspicious developments.
- * Fire and carbon monoxide monitors which look out for rise in the level of smoke and CO₂ gas before they rise to toxic proportions.
- * In case of accidents, at home or the road, the cars or the house would make emergency calls to the necessary authorities (Smart home services, 2014).

d) The use of smart technology in health care cannot be over emphasized. The devices such as pacemakers and dialysis machine have been very efficient in their jobs. The use of technology has helped to reduce the number of human-related dangers posed in many of these disciplines. There are no limitations to possibilities which eventually encompass food production in agriculture and production lines.

4.0. THEORETICAL FRAMEWORK

4.1 INFRASTRUCTURE DESIGN



The way cities are designed and operated have always been bordered on the transformative effect of technology. Spreading suburban areas were stimulated by the invention of automobiles; the invention of elevator resulted in multistory and skyscraper developments; a global economy nurtured in municipal clusters is possible due to shipping and affordable air travel; also infrastructural developments including networks of public transport and systems managing waste collection and furnished mega cities of huge populations with the motivation to continue growing.

In times past, local constructions have been driven by issues such as sanitation, fire or flooding. The reaction has been to engineer systems (under the powers of centralized, state-led planning and public funding) that solve a single problem at a particular time. Not much consideration has been given to future conditions. Nowadays, and especially with the advent of Information and Communication Technology (ICT), a major wave of development with respect to technology is sweeping through cities resulting in developmental changes, inspiring new city experiences and stimulating their functionality.

4.2 TRANSPORTATION AND LANDSCAPE

A city cannot be called a smart technology city if it does not have digitalized road networks with street lights, Wi-Fi cameras, surveillance video and the like.

Movement supports all we do individually; as groups and global economies.

Individuals want to move about to achieve simple social necessities, but movement is an amenity, adding to value of life by allowing study, relaxation and reformation. High value movement in the city is essential for the realization of other municipal sectors and the establishment of jobs, and acts a key part in refining a good-looking environ for inhabitants and businesses.

Hitherto mobility is extensively referred to as one of the greatest inflexible and global challenge tackled by cities worldwide. With an increase in urban populations, present and developing metropolises face the task of meeting growing needs for effective mobility in unfinished physical groundwork capacity. Concurrently, inhabitants' hopes are fluctuating recurrently, due to continuing modernisms around low carbon and proficient means of transportation technologies and developments in infrastructure organization. (Arup 2010). Smart cities now employ more sophisticated technologies in the planning and development of settlements with such

considerations as traffic flow, pedestrian access, and commercial heavy duty trucks and machineries movement in consideration from the basic design stage. This allows for the incorporation of required sensors and aiding devices to be installed as at when due with minimal cost implications.

4.3 EDUCATION

The advent of the Internet brought with it the possibility of expansion on learning from a distance which has been in practice for decades now. Expansion in terms of coverage and better delivery of instruction as a result of Information and Communication Technology (ICT) as compared to the days of old. Texts are now easily combined with audio and video pieces of information for the purpose of maximizing time and getting the best out of education. Teachers and students in smart cities now have the ease of interacting via social media, e-mail and discussion groups. Teachers and students alike readily have access to education audiovisuals online anytime and irrespective of location. A teacher in a smart city can teach a student in another smart city over the internet; this would be impossible with traditional teaching methods.

The essence of distance learning via the Internet is to complete and complement teaching methods that are already existent instead of competing with these traditional methods of learning as existed before ICT.

A smart city is one that would capitalize on the availability of technology and direct it for the betterment of education processes which is the foundation for technology and innovation. Resulting from the advantages of access to internet and the suitability for its use in learning as well as the convenience of learning from a remote location, there is expected to be a rise in the demand for distance learning programs which will subsequently metamorphose to development and advance in the commerce of education.

4.4 POPULACE

Towards advanced smart cities, the starting point should be from human assets, instead of just trusting that IT itself can spontaneously change and develop cities (Hollands, (2008). The serious factor in any efficacious city is its people and how they interrelate. Sturdier approaches to education, responsiveness, and control offer services that are reachable to all, barriers associated with language, culture, education, disabilities, skills and development should be gotten rid of (Coe et al, (2001). For those who might be lagging behind with respect to the use of latest technologies, social learning addresses this concern. Teaching and training activities should improve IT skills, cultivate information workers, enable the environs of social learning, and develop IT training in institutes, societies and businesses (Cairney & Speak, (2000).

4.5 COMMUNICATION AND NETWORKING

Owing to continuous advancements in the smart phone technology which focuses on its unceasing and more reliable connection to the internet, processing and storage functionality improvements, better computing abilities, advancements in sensing and modeling capabilities and the Internet of Things (IoT), the economics of cities and the dynamic nature of urban settlements are being reshaped in a collective fashion. These machineries symbolize an important prospect for cities and their administrations to craft more effective, operational and promising urban settlements.

The ability to converse in ways similar to traditional face to face conversations is made available by computers and associated communication technologies. Smart technologies allow for collaboration between people who do not have to meet in person. This suggests that there are plenty of activities including, but not limited to, conferencing, teaching, learning, attending a function, judging a case, and many more that can be done by smart proxy, instead of in person saving time and resources that might otherwise have been spent.

4.5.1. COMMUNICATION: SMART PHONES IN SMART CITIES

The concept of computing, amalgamated with or infused in communication for consumers who use mobile smart technologies like tablets and mobile phones, is on a progression path, directed towards achieving interoperability with its corresponding influence on functional facilities from each and every industry.

Taking the lead in this union are smart phone devices which play an ever important role as the universal mobile terminal. This process of convergence is made possible by the incorporation of smart phones which can be defined in real sense as a mobile phone that performs many of the functions of a computer due to its advanced operating system and features that enables possibilities beyond traditional functionalities like calling or texting. These devices are a common sight in every smart city and serve as a handy substratum for the interphase with applications, devices and systems within a smart city.

There is also the concept of smart phones functioning with existing platforms to enable users to communicate with systems in such a manner as to derive convenience and save costs. Hence the communication between these smart mobile devices and sensors or applications could be helpful for example in avoiding real-time traffic or an overloaded bus. Also smart devices could be used as sensors to share information gathered by the device for the purpose of improving a system. This act of sharing termed as "participatory sensing" ensures communication between the developers of a system and the end users with the information gathered being used for improving city services.

On the flip side, as a marketing strategy, smartphones of various specifications and functions are becoming increasingly affordable. This comes with its corresponding nuisance effect and could be seen by many city dwellers as a distraction. The habitual tendencies associated with the use of smart phones could result in lack of awareness and be detrimental to user's safety. In these circumstances, it is arguable that a smart city can be a dangerous city. Our smart phones, when combined with the infrastructures and technology available within the cities, could have the ability to unquestionably change our world. The big and debatable question is: what is the direction of change?

4.6 BIOROBOTICS

Many claim that the challenge that is faced in urban cities is inadequate investment in robotics. Robotics generally involves the use of a computer aided robot to perform specific tasks as designed. Industrial robots are reputable for repetitive and routine tasks mostly in mass production facilities. Service robot development is an area of robotics yet to be maximized.

With some connectivity and innovation robots are capable of making our cities smarter than they currently are. Unlike robots in the industrial world, service robots are designed to carry out specific tasks that would normally be taking place in an unstructured setting with the likelihood of direct human-robot interface. There is the concept of coworker robots, designed to assist human beings in carrying out a number of different tasks but this has not found full use in numerous countries owing to the expenses associated with owning and operating them and the fear of resulting unemployment due to robots taking human jobs.

Whereas the prospects of having robots assist with routine tasks within the home are very promising, their use in cleaning floors has been the most successful application, especially in Korea.

The lack of a universally accepted standard as well as costs and acceptability in some opinion is responsible for the slow pace of development in these fields.

5.0. CONCLUSION

Smart technologies in cities function to make existing structures more efficient. Since the aim of smart technologies is to eliminate the gargantuan problem and the grotesque odds facing survival in the city life, a city would only be referred to as "smart" if there are technologies in place that amongst other things, help people move around freely, make services and amenities identifiable and reachable, be aware of happenings around with the aim of staying safe and most importantly

be readily accessible. This progress is not without its oddities, the easier it is for the individual to survive in the city, and the quicker it is for such city to be over-populated, which in itself is a challenge not easily managed. With smart cities comes the urge to urbanize indiscriminately which is also another huge challenge for humanity. Smart cities open the possibility to commit smarter crimes by personalities who understand the sophistication required to break many of the security codes. Another pitfall is that a minute computer error could be a devastating moment for residents of such cities. An example was when an American communication satellite went out of orbit rendering pagers useless for a long while. But as with all human achievements that has come to stay, its advantages grossly outweigh the disadvantages.

It is quite easy to see the benefits of smart cities but the question to be answered is: where do we ultimately find ourselves with the adoption of smarter cities and technologies? We imagine that the expounded concept of smart city in this write-up will add to future studies. The idea brings to the fore that there is a linking among technical, social, and institutional factors. Today the use of "smart" captures advanced and transforming changes driven by innovative technologies. Nevertheless, communal issues other than smart tools are central to smart cities. In this regard, a socio-technical opinion on smart city is required. A broad understanding of the connections between social and technical aspects of the environment is important. Research should be carried out on the roles governments, private sectors and policies play in the adoption of smart technologies as it is evident that there must be a complete buy-in for substantial developments to manifest as regards building smart cities. To this close, we will carry on with the study on smart city by concentrating on smart city creativities, bearing in mind the subtleties of several key stakeholders in those initiatives, and conferring policy improvement in urban administrations. Lastly, I would also recommend that an investigation on how smart cities affect control and freedom of citizens be carried out for a richer understanding of the concept.

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