

# A Survey: Smart Cities for Sustainable Future

Shafana, A.R.F., Abdul Haleem, S.L.

Department of Information and Communication Technology  
Faculty of Technology, South Eastern University of Sri Lanka University Park  
Oluvil, Sri Lanka

**Abstract:-** The concept of “Smart Cities” have gained wide attention in the technology community. Smart Cities could be envisioned as the one that is strongly backed by Information and Communication Technologies to make the services and monitoring of cities more aware, interactive and efficient. The growing population and its migration towards cities have in fact made this concept to gain wide outreach and acceptance by various stakeholders. This paper in particular reviews the concept of smart cities in various aspects. At first, the potential technologies employed to achieve smart cities are discussed which is followed by the review on several case studies that have deployed smart city concepts globally. This paper concludes that the realization of smart city concept, if well established, could help in the sectors of energy management, weather forecasting, smart parking, waste management, street repairing, smart lighting, traffic control, instant notifications to local authorities which are indeed the impending issues related to the growing population.

**Keywords:-** Smart Cities, Information and Communication Technology, Sustainable, Internet of Things.

## I. INTRODUCTION

Food and Agriculture Organization of the United Nations quotes that the current global population is expected to grow by 70% by the year 2050 [1] During that phase, it is believed that nearly 70% of the world’s population that accounts to more than 6 billion people would perhaps live in cities and its suburbs, reported by Belissent (as cited in [2]). Rather than an incremental upgrading with respect to a city’s organization, infrastructure and services provided, the cities need to be smart to enable a sustainable living in terms of economic, social and environmental wellbeing.

Smart city could be perceived as the one that uses Information and Communication Technologies to make the city services and monitoring more aware, interactive and efficient. At this juncture, the successful employment of multitude of recent technologies relevant to the various disciplines can be considered as a sustainable solution to overcome this situation. Application of various technological tools for the mapping of future could give rise to a socio-technologically competent cities, so called the “smart-cities”.

Urged by the necessity outraged by the growing population and its migration towards cities, the concept of smart city has gained wide outreach and acceptance by various stakeholders. The smart city market is estimated to be of three-digit billion dollars by 2020, with an annual spending reaching nearly which proves the necessity,

usefulness and business case of smart cities, business around Smart Cities [3].

This particular paper reviews the concepts of smart cities, various instances of smart city, potential technologies used and identified the key areas touched by the smart city paradigm.

## II. LITERATURE REVIEW

### A. Smart Cities

A smart city could be perceived as a system that is aimed at providing value-added services for the extremely complicated cities and its administration by exploiting the advanced communication technologies. The particular paradigm can be exploited in various domains such as industrial automation, home automation, medical aids, mobile healthcare, elderly assistance, smart grids and intelligent energy management, automotive, traffic management, and many others [4].

An urban environment that provides a new outlook for environment surveillance, energy distribution, transportation, health care services, business ventures and many other socio-economical activities could be termed as a Smart City [5]. The integration of various heterogeneous distributed devices into a common environment backed by software can be viewed as a “Smart City”. The particular research further emphasizes Smart Cities share a number of common elements where they are sensible, connectable, accessible, ubiquitous, sociable, sharable and visible or augmented.

Multitude of ICT solutions could be integrated to manage a city’s assets with the aim of creating a sustainable environment, improving the quality of life and enhancing the economic value and efficiency. The future city planning need to incorporate Internet of Things (IoT) concepts which grows exponentially in the recent days. [6]

The instrumented, interconnected and intelligent city could be defined as a smart city. A smart city could be characterized and measured by the following characteristics but not limited to: Smart Energy; Smart Data; Smart Transport; Smart Infrastructure; Connected Devices and Connected Mobility [7]. The backend of all these features is IoT, where it contributes to better network management, optimization of production and energy distribution.

### B. Backend Technologies for Smart Cities

Zanella, Bui, Castellani, Vangelista & Zorzi [6] have forwarded an architecture that utilizes Internet of Things (IoT) as a technical solution that is capable of satisfying the requirements of all complex application scenarios in the developing cities. The particular research has suggested the incorporation of wide variety of devices such as sensors,

actuators for monitoring and regulating cities could provide plethora of digital services.

The domain of wireless sensor networks (WSNs) have relatively a great impact in connecting objects over a certain distance. This connectivity is crucial for the planning and implementation of smart city. However, it could be noted that WSNs have its popularity among the academic circles rather than industry for over a decade. Thus, it could be noted that the incorporation of various findings from the expertise of academic community with the industrial standards could better bring potential insights to the smart city paradigm. Another positive approach, which standardized the architecture, protocols and functionality of the IoT by various standardization bodies such as IEEE, IETF, HART, ISA have geared the use of IoT for facilitating smart city services [3].

Wireless Multi-hop Infrastructures (WMIs) is another technology that can be employed on Smart City infrastructures. As smart city is highly reliant on communication infrastructures, WMIs could provide homogeneous and easily deployable wireless routers in order to enable disaster resilient network access for smart cities. The particular technology further provides sustainability to the Smart City paradigm by providing infrastructures with high resilience [8].

### III. CASE STUDIES: INSTANCES OF SMART CITY DEPLOYMENT

#### A. *Energy consumption in the Hyllie smart networks of Malmö, Sweden*

Energy consumption is regulated by the use of smart phones and smart meters in Hyllie smart networks of Malmö, Sweden. The particular project has been successful in providing new energy solutions as not only focusing on renewable energy solutions, but also incorporating the active participation of the users in energy consumption. The integrated infrastructure system allows the users to manage challenges with regard to energy production, charging of electric cars and the control of home heating. The users are allowed to be vigilant about their energy usage and to monitor them accordingly. Further, the particular infrastructure notifies the user about the most suitable time for excess power consumption. In addition to the smart grids, the project highlights include viable approaches to transportation, waste management and recycling. [9]

#### B. *Network-enabled LED Street Lighting System – Amsterdam*

The energy consumption and the costs incurred for lighting has been cut down with the use of smart lighting system. The system allows the users to personalize the lighting and temperature by the use of smart phone applications. The system serves as a pathway that is capable of capturing anonymous data on room occupancy, temperature and humidity through built-in sensors, which in turns helps the managers for usage and adjustments. The system allows to make intelligent decisions with exceptional levels of energy and operational efficiency. [10]

#### C. *Fix My Street built by My Society – United Kingdom*

The particular open sourced web service initiated by MySociety has become a role model for several other countries as a crowdsourcing platform that collects information regarding potholes, dangerous pavements, broken street lights etc. The service lets the people to view, report or discuss their problems related to streets to the respective local council.

This service in particular creates a satisfactory relationship between the citizens and the governance that contributes considerably to the smart city planning. Similar systems include CitySourced in United States of America [11], FixEmUp in Tornio [12] and other systems in countries like Australia, Chile, Switzerland, Japan, Malaysia etc. [13]

#### D. *Sfpark: Pricing Parking By Demand – San Francisco, USA*

SFPark is a pilot program implemented in San Francisco, United States of America, that made use of the Smart Parking technology backed by sensors which priced the parking based on occupancy. It is an important instance of smart city that use the data to make smarter decisions and achieve more with the available resources. The initiative was highly efficient and successful as it reduce the traffic congestion while reducing the air pollution. The project installed sensors which reports the occupancy of each curb space in every block that triggers the smart meters on smart pricing. The suite of tools thus used were Garage equipment, Parking sensors, Networked parking meters, Real-time data and mobile applications, Roadway sensors, Data management and reporting tools. [14]

As traffic congestion caused by vehicle is an alarming issue, the use of smart parking is a notion that could save 220,000 gallons of fuels till 2030 and approximately 300,000 gallons of fuels by 2050, says a report [15].

#### E. *Waste Disposal System, Incheon, South Korea*

The particular city itself was planned and built according to green building concepts of LEED-ND principles. The technology vendor CISCO has employed the state of art technologies that connect all the city components. The city has become a pioneer of technological advancement built with the purview of smart city. The smart city has utilized various sensors for temperature monitoring, energy usage, traffic flow and few other smart highlights such as notifying the bus due, informing local authorities of residents' issues etc. The waste disposal system of the project is of highly noteworthy where the wastage collection and disposal is fully automated while the waste is also supposed to be used in the renewable energy production. [16]

#### F. *Rio Operation Centre, Rio De Janeiro, Brazil*

The societal model Rio Operation Centre (ROC) was uprooted in Rio de Janeiro with the flood that hit the city in 2010. Having the fact in mind that disasters are ensued by the mismatches between various constituents that manage the city, the authorities integrated ICT for a collaborative decision making to improve the quality of life, thus bringing the concept of Smart City into real. The particular centre being the first Intelligent Information System that forecasts

weather and helps the city in planning of events, emergency situations, traffic, blackouts and floods in advance. The real time information on weather and traffic allows the users to find alternative paths during special crowded events as well. Thus, ROC has used ICT for risk management to improve the quality of life. The particular initiative was recognized and awarded at the Smart City Expo World Congress, in Barcelona. [17].

#### IV. CONCLUSION AND RECOMMENDATION

Cities have been an important settlement that affect the environmental changes radically. The rate of resource consumption in contemporary cities is high which raises a question on the sustainability of cities in the near future. Smart City could be viewed as an environment of open and technology driven platform that mitigates the existential problems and challenges faced by its citizens for ensuring a better quality of life. This paper reviews the concept of smart city stemmed from the technologies of Information Society as a potential solution to overcome the issues of the future cities. The attempt to incorporate Information and Communication Technology as a key strategy to mitigate the environmental problems while increasing the efficiency and optimizing the cost makes the city smarter i.e. the deployment of connected solutions to create a city is truly smart.



Fig 1:- Key areas of smart city paradigm

The various instances which utilized the concept of smart city have been discussed above and each instance has received its expected outcome in a great deal. Out of various pilot projects backed by the smart city paradigm the following could be identified as the key areas of focus (Fig. 1) including but not limited to energy management, weather forecasting, smart parking, waste management, street repairing, smart lighting, traffic control, instant alert to local authorities which are indeed the potential issues related to the growing population.

Thus, the deployment of smart city concept could be an unprecedented measure that could mitigate the harmful effects of globalization and population growth and while establishing sustainability.

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