Smart Cities are Environmentally Sustainable Cities

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Abstract— Smart cities are environmentally sustainable cities primarily because such cities tend to reduce the environmental impact of urbanization at the scientific, economic and human levels. Smart cities are planned by understanding the advanced science of cities in general and sustainability in the urban setting. The smart cities understand the dynamics and impact of built environment-places where they live, study, work and play and improve the standard of livability of their environment and thereby health of their community gets improved. Smart cities put pressure to design environmental systems to reduce CO2 emissions which is a key to long term success, striving for positive economic and social impacts. In the transport sector by reducing emission from car by favoring urban public transport in the smart cities sustainability can be achieved. ICT play a significant role in reducing the carbon foot print of cities not only but also in the energy sector. Smart cities plan for energy conservation, energy efficiency and renewable energy to minimize the dependence of fossil fuels. Smart water supply system, water distribution system and wastewater management system using smart water grids bring the positive cumulative impact and promote smart cities by becoming environmentally sustainable.

Key words: Smart Cities, Smart Grid system, Environmentally Sustainable, Carbon foot prints

I. INTRODUCTION

The smart cities are environmentally sustainable. That means it should not have any major environmental issues. A smart city should be able to provide cost efficient services to their residents like better employment opportunities, healthcare facilities, and better options for education thereby providing better quality of life. However all these are provided without putting an irreversible burden on the environment and its natural resources. There must be a balance between ecology and economy, production and pollution i.e. the industrial growth in the smart cities must be sustainable. A city can only be smart if it is economically vibrant environmentally friendly and technologically sound.

Generally, developmental experts agree that a sustainable city should meet the needs of the present without sacrificing the ability of future generations to meet their own needs. According to Magilavy, Beryl the ambiguity within this idea leads to a great deal of variation in terms of how cities carry out their attempts to become sustainable. When environmentally sustainability is thought it is the ecology of the city which takes into prime consideration [1]

According to Kennedy et al. (2007), a sustainable city can only be one for which the inflow of material and energy resources, and the disposal of wastes, do not exceed the capacity of the city's surrounding environment. In order to make the city sustainable what is needed is keeping balance between consumption and generation of waste. The pollutants generated on account of using natural resources by human should not be more than its capacity to assimilate.[2]

Smart Cities Council has defined smart city as one that has digital technology embedded across all city functions. According to IEEE, a smart city brings together the technology, Government and society to enable the characteristics such as smart economy, smart mobility, a smart environment, smart people, smart living and smart governance. Key 'smart' sectors include transport, energy, health care, water and waste. The British Government considers the concept of Smart City as not static, there is no absolute definition of a smart city, no end point but rather a process or series of steps, by which cities become more 'livable' and resilient and hence able to respond quicker to new challenges.

According to Indian Government, Smart City offers sustainability in terms of economic activities and employment opportunities to a wider section of its residents regardless of their level of education, skills or income levels". For example, according to European Commission, economic productivity depends on healthy, happy citizens, who need easy access to education, healthcare, security, food, water, transport, clean air and electricity. Such an ideal situation can be created when cities build efficient waste disposal systems, green spaces and green buildings, public transport and attract employers producing green products from local resources for regional markets. Here, the behaviors and lifestyle of city-dwellers plays a role.

The Smart Cities strategies include "Sustainability Mandate" of 21st century. The regulatory bodies and the citizens put pressure on the municipalities to design the environmental systems to reduce CO2 emissions which is a key to long term success, striving for positive economic, environmental and social impacts. The smart cities must be planned for ensuring positive cumulative impacts on the environment. This can be done by reducing energy consumption, increasing the use of renewable energy, reducing emissions from car by favoring urban public transport and thereby promoting sustainable development. [3]

II. TRANSPORT SECTOR

Transport sector is one of the greatest sources of greenhouse gases (GHG) emissions. Transport is responsible for 22% of energy related greenhouse gas emissions worldwide and these emissions are rising faster than those for any other sector. Cities

contribute 70% of energy related GHG emission. Efficient and customer- friendly public transport can help reducing emissions and the living conditions of the cities/urban dwellers can be improved. In smart cities the aspect of transport planning and implementation are addressed. The individual personal transport is largely met with the improved public transportation by linking the passengers and personal data across the sectors in the smart cities.

Idea to create low carbon society represents most important challenges for the smart cities. In Delhi, Battery operated EV rickshaws are operated. Smart cities should restrict the access of any vehicle except Electric vehicles to reduce the congestion and local pollution. Further smart cities should implement the system for sharing electric vehicles and for providing charging stations at public places to facilitate users' thereby stimulating economy of the smart city. Only selected gasoline power cars should have access in smart cities. There is a need to change life style. The sharing and renting of vehicle arrangement enables people to enjoy the utility without ownership. This allows users to use vehicles whenever and wherever required.

Bike and bicycle sharing and walk ways form a big part of smart cities. At PDPU, two young students have started such facilities – renting cycle at nominal cost. This concept has been successfully implemented in Barcelona smart city as bicycle is most innocent vehicle with zero pollution.

Shri Shankar Aggarwal, Secretary of Urban Development had stated "with nearly 31% of Indian living in cities the transportation sector needs to undergo huge change. We have to go in for public transport. We need to create cities that are designed for citizens, not cars" this statement was given by him at the annual conference on 'Transforming Transportation" in Washington DC on 15-16 Jan, 2015.

Ministry of Urban Development, Government of India (June 2015) in Smart Cities Mission under core infrastructure elements in a smart city has included efficient urban mobility and public transport. The important components that city planners should consider are smart roads-road safety and sustainable traffic management, parking and e mobility, urban traffic control at intersections and public transport fleet management and smart ticketing solutions. As a matter of fact, vision on what a Smart City could and should be from a transport perspective is an important key factor. [4]

Pex Langenberg, Vice Mayor of Rotterdam noted that it was important to involve the private sector in bringing these urban changes. There should be zero emission from inner logistics which is far difficult for Indian logistics. The urban roads need to be rerouted so that the traffic can be diverted via ring roads. It is possible to relieve the urban living area from harmful emissions and unhealthy air in doing so. It will be appropriate not to take the traffic to destinations which are not at all in the core city.[5]

Tata Consultancy Services (TCS) as reported in The Financial Express has designed and implemented intelligent transport systems for Karnataka Road Transport Corporation in Mysore. In the present project the critical issue of customer service through real time dissemination of Information of arrival of bus to all its users is solved. The information is obtained through satellite based GPS and SMS messages. Intelligent transport system can also be designed for multi-modal travel journey. Single tickets and seamless exchange is the requirement of public transport system today.[6]

National common mobility card standard allows seamless travel between metro, taxi, bus and train apart from parking and troll. Globally, there is no nationwide common card except in Singapore where in inter-operability is confined to city only. Some of the other models examined include Closed Loop Solution like the Octopus cards in Hong Kong which is limited to using for travel only. The other model of EMV Open Loop Account based model suffers from the limitations of not supporting weekly, monthly, student passes etc., and not facilitating checking for ticketless travel, collection of fines etc., besides increased costs of robust backend systems required for operation. The Urban Development Ministry has decided to task the National Payments Corporation of India with indigenous development and management of Clearing and Settlement of payments, Simulating Cards, Terminals and network, a support base of vendors for providing certified tools, cards, terminals and other services. This is in line with the 'Make in India' initiative.[7]

As contained in Press Information Bureau, Government of India, C-DAC will develop the standards and hardware for Metro gates/validations along with related ecosystems. Funding of Rs.4.47 Crore also has been approved in this regard. Certification and authentication mechanism will be developed by NPCI or any other government agency.[7]

Porous paving system using pervious concrete is also important smart method used for parking lot. The pervious concrete mix contains very little or practically no fine aggregate. It is a mixture of cement paste which forms a thick coating on coarse aggregates. Pervious concrete if adopted for construction of pavements, walkways, it can become a component of rainwater harvesting schemes being prepared by the Government of India on a priority basis. It may help us in reducing the run off thereby decreasing the load on drainage system. [9]

III. ENERGY SECTOR

Smart cities should use sustainable energy concept. Technology that controls energy consumption of building and inter-operates devices such as temperature quality sensors, gas quality sensors, and smart meters can be used. Further smart energy management is necessary for large residential complexes, hotels and offices. Such energy management uses smart metering Smart network with high speed measurement capabilities and data mining.

In the smart cities ICT play a significant role in reducing the carbon foot print of cities not only in the transport sector but also in the energy sector. Smart cities must examine the various sources of energy, how it can be used efficiently with a view to reduce the greenhouse gas emissions and the energy costing. Smart cities plan for energy conservation, energy efficiency and renewable energy to minimize the dependence on fossil fuels. The sustainable energy can also be harnessed. The sustainable energy sources are hydroelectric, wind, solar, bio- energy, and geo-thermal energy.

Further the smart grid is the requirement of smart cities to be sustainable. A smart grid is electrical grid that uses analog or digital information and communication technology together and act on information in an automated way to improve the efficiency of production and distribution of electricity. Charging is a major constraint in usage of electric vehicle –however charging station should be created by smart grid for a stable supply of power using renewable energy sources. Electric

The ICT sector has to be included as an integral part of this smart grid. Some of the most important advanced smart grid demonstrations have involved close partnerships between municipalities and local utilities. Engerati (2016) has reported Cities are also encouraging residential and commercial energy generation through programmes to support solar PV and small wind generation, combined heat and power systems, and other community energy schemes.[8]

IV. WATER AND WASTEWATER SECTOR

Smarter water management solution exists for smart cities. In the system, the sensors are placed almost throughout the infrastructure and natural waterways. This sensors feed data to analytics driven technologies which ultimately enable the real time tracking and reporting conditions. This system thus will help in prediction of problems in the system like clogged drain, hazardous sewage overflow. The identification of leakage of pipe will save lots of water. This will also ensure no losses in the pipe.

The Smart water supply system consists of drinking water supply network from their sources to the overhead drinking water tanks in the city under automated control and monitoring system. The system allows the operators to remotely operate and monitor pumping of water to overhead tanks from collection sump.

Sensors placed throughout the infrastructure and natural waterways, feed data to analytics driven technologies

Through GRPS based system, the corporation can operate as well as control the water distribution system. Similar system exists in Tamilnadu- Tiruchirapalli City Corporation by using Supervisory Control and Data Acquisition (SCADA)
Smart Water Metering is a system that measures water consumption and communicates the information for billing and monitoring in an automated way. The system consists of measurement, communication and software application. System may use 'Automated Meter Reading' (AMR) . AMR allows automated collection of meter reading usually by radio transmission (without the need of physical inspection)

Another method is Advanced Metering Infrastructure (AMI). This system is a two way communication

This system is a two way communication – water consumption information is transmitted to utilities while the utilities can in turn issue commands to water meters to undertake specific functions. Smart metering ensures

- Efficient meter reading of abstraction of water
- Theft or leak detection
- Greater billing accuracy and
- Remotely monitoring resource use

But the investment in addition to meter module includes communication infrastructure, data management applications and additional technology to support the large volume of data, software to handle communications and alerts to and from field devices. The upfront cost is a barrier to usage of smart water meters

Smart water Grids begins at the water source where meters, smart valves, smart pumps smart and flood sensors are installed.

From source, water is conveyed to water treatment with more smart meters, valves and pumps. Within the city water distribution system, there are additional water contaminant sensors. At the end-use-locations i.e. at homes or business offices end use sensing devices, smart irrigation controllers, contaminant sensors and smart meters may be used.

Finally waste water through the sewerage system is taken to wastewater treatment plant and discharged (incl. recovery) to water bodies where the same technologies are used.

This sensing device that collects and transmits data about the water system on a real time basis is the foundation of any smart water grid.

In addition to the intelligent water and waste water system, what we can do is to replicate from Singapore model the water efficient methods employed by them. Singapore is using 30% of water from rainwater storage reservoirs as well as 30% recycled wastewater. Some two-third of Singapore's land surface is now water catchment area. Singapore has more than 17 reservoirs. Smart cities in India can adopt such systems.

Water efficiency measures are critical for smart cities – water efficiency means reducing usage of water and minimizing wastewater. It is responsible use of fresh water and responsible use of water is using water cautiously and conserving for our grandchildren. Conservation of water is the basic principles of sustainability. All the fixtures such as taps, shower heads, urinals etc. should be water efficient. Low flow plumbing fixtures should be used. Self-closing or electronic faucets for lavatories help reducing water usage. Technology employed in low flow faucets use aerator. The aerator has a tendency of breaking down the stream of water into many tiny streams and the air will get mixed with each tiny stream. When the faucet is operated this reduces the space for water and ultimately flow of water gets reduced. This can significantly reduce tap water in hand basins and kitchen sinks. The reduction in flow ranges from 50-75% compared to typical flow rates.

Water efficient appliances – washing machines and dishwashers are used in smart cities. High water efficient cloth-washers and dish washers of different sizes are available which use 33% less water and also save 40% energy. Use of grey water can significantly reduce consumption of domestic water. Water audit will be an efficient measure for all existing buildings for conservation of water.

Smart cities encourage efficient use of water during construction. 20% of the requirement of water by construction industry can be reduced by effective building design construction and management. Using buckets of water to clean the tools rather than running water-water needed using the buckets manually will require significantly less water compared with running water. Sometimes high pressure hoses instead of running water will also reduce water as cleaning becomes faster with less use of water. Concrete mixers containing fly ash generally requires less water 1-10% for a given slump than concrete containing Portland cement. Membrane curing is better and water efficient. Thus moist curing of concrete will prove important curing system in smart cities.

The technology uses real time information concerning operational aspects of their distribution grid. In terms of energy generation technology and management systems, many substitutes and solution exist to improve energy management in terms of efficiency improvement and reduction of emissions and costs. These include renewable energy sources like smart meters, solar road ways, Photo-voltaic system, micro grids and other green technologies which can generate energy and prevent temperature rise of earth and reduce carbon foot print. [10] The objective is to improve the ground table. The roads around the houses in rural and even urban areas could be successfully constructed in pervious concrete and surfacing inside the compound can be made with pervious concrete. For smart cities the use of pervious concrete will be suitable for parking lots, pedestrian ways in the green spaces, morning walkways and in rural areas. Where the traffic is light un-compacted gravel crushed stone porous paving block or pervious concrete block can be used.

V. SUMMARY

It is estimated that by 2050, the cumulative population of Indian cities will reach 843 million and to accommodate such massive urbanization, India needs to find smarter ways to manage complexities, opt for cost effectiveness, increase efficiency and improve the quality of life. The best option to combat the present situation is to provide smart inputs for all the elements in form of best management practices. The major elements include transport sector, energy sector, water and wastewater sector. All these elements should have sustainability. Planners should conceive and focus on technologies which bring sustainability.

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