Research Article

Plastic Waste as Threat to Environmental Sustainability in Smart Cities: A Systematic Review of Extant Literature

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Abstract

The objective of review of literature is to place a research project in an historical perspective so that unnecessary duplication can be avoided. In the present study, the concept of smart city has been first of all discovered as defined in the extant literature. Then the environmental concerns in smart cities as discussed in extant literature have been enumerated. Further, the importance of solid waste management as elaborated in extant literature has been reviewed. Finally, plastic waste and its contribution to solid waste in smart cities and socio economic impact of banning plastic bags in smart cities have been discovered. The main question that has arisen out of the review of extant literature on plastic waste as a threat to environmental sustainability in smart cities is: 'what is the perception of population in a smart city towards consumption of polythene bags?' There are however three more related questions which have been identified in the present study. There are a few research questions which have been identified from the extensive review of extant literature on plastic waste as threat to environmental sustainability in smart cities created a scope for further research in the subject. It is however proven from the present study that plastic waste is unquestionably a threat to sustainable environment which is a key characteristic of any smart city.

Keywords: *Sustainability, Sustainable Environment, Smart City, Solid Waste Management*

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Introduction

Before we go for understanding the concept of smart city, let us first of all know what is meant by a 'city'. The word city has always been an urban concept and the word village has always been a rural concept. A city is generally referred to a system of systems which should have a history that is unique in itself. A city is always set in not only a specific social context but also an environmental perpective. It is a system because in order to maket the city prosper all the components of the city are needed to be operated systematically in a particular order and sequence. A city gains 'smartness' as it increases its ability to bring all its resources together. Through it the city can operate with highest efficiency and maximum effectiveness. It results in minimum implementtion and operation costs with maximum long-term sustainability. Smart cities are more faster, more friendlier, more safer and unquestionably more greener than traditional cities. In order to achieve smartness, a city requires smart transportation, smart infrastructure, smart healthcare, smart technology and above all smart energy (Mohanty *et. al.*, 2011). Researches done on public management reveals that one of the crucial factors in urban development is urban planning. In this connection, if cities will be loaded with proper institutions, adequate intellectual resources and developed infrastructures then their efficiency and effectiveness in functioning will be exponentially improved to upgrade for a smart city. Proper local spatial plans for urban development are definitely required to be implemented on traditional city formats to convert them into smart cities. There are certain key components of these plans including industrial complexes, technology transfer centres, research and development (R&D) companies, technology parks and business incubators. There is a practical robust methodology to measure the performance of smart cities across the world and that is ISO 37120 standard. Level of investment pressure is the factor that determines whether special management is required or not. The city does not require local spatial plans for urban development if the level of investment pressure is declining. Additionally there is a strong relationship between investment pressure, coverage planning and green areas (Hajduk, 2016). Hence, green areas have come up to be one of the key components of smart cities. Without managing the natural environment, no city can be upgraded to a smart city. For a sustainable environment in smart cities, there needs to be a proper solid waste management system and the present research is an attempt to review the extant literature in this context.

Objectives of the Study

In the present study, the concept of smart city has been first of all discovered as defined in the extant literature. Then the environmental concerns in smart cities as discussed in extant literature have been enumerated. Further, the importance of solid waste management as elaborated in extant literature has been reviewed. Finally, plastic waste and its contribution to solid waste in smart cities and socio economic impact of banning plastic bags in smart cities have been discovered.

Methodology of the Study

The objective of review of literature is to place a research project in an historical perspective so that unnecessary duplication can be avoided. Additionally, a proper review of literature helps evaluate methodologies used by past researchers and also relate the key findings with the research study in hand. For this purpose only the present study has been undertaken so that first of all the extant literature indirectly and directly related to plastic waste as a threat to environmental sustainability in smart cities can be identified. Secondly, extant literature identified to be indirectly or directly related to plastic waste as a threat to environmental sustainability in smart cities can be reviewed and lastly, research questions can be developed for enabling future researches. Hence, a review of extant literature has been chosen as the first step to initiate research in the present context.

Importance of a Sustainable Environment for Smart Cities

There can be a shift from 'ecological modernization' to 'resilient cities' when it comes to environmental issues in a smart city. In this connection, green infrastructure plays a key role in achieving this objective. Trees, grasses areas, water bodies and landscaping include green infrastructures. In other words, green infrastructure refers to all those aspects of a city which are not built rather they are free gifts of nature. These aspects are not manmade but are supposed to be preserved by man. In function, they are perceived as either as aesthetic or ethereal. These aspects of the city are required for preservation of obscure habitat. In many city formats green infrastructure is seen as a luxury but in a smart city format it has to be considered as a necessity. The idea of resilient cities is very frequent when we talk about smart cities. The idea of resilient cities sees green infrastructure in the centre of climate change, adaptation and mitigation. Management of risk in case of calamities like flood and earthquake and securing the biodiversity also is the objective of green infrastructure which rotates principally around resilience of cities (Antrobus, 2011).

There are five major developments that have happened during the past decades all over the world in relation to urbanization. The first of these five developments is 'globalization of environmental problems and sustainable development'. The global character of environmental problems and its day by day increment has been narrated and highlighted by a series of conferences organized by United Nations (UN) during the past four decades. It was the year 1972 after which the whole world has started seeing environmental issues as a global problem and not a local one. In 1972 the conference held at Stockholm shifted the views of policymakers and before this conference people believed that environmental problems are created locally, that is why should local effects. The subsequent conferences on environmental sustainability held at Rio and Cape Town made the issue clear. The popular slogan 'think global, act local' which is a part of Agenda 21 plan of action kept on clearing it that local implementation of policies on environmental problems would abate global environmental issues. Besides environmental problems like climate change, imbalances in cycles of phosphorous and nitrogen, decline in biodiversity, acidification of oceans and changes in land use there are a number of equally important environmental issues which are needed to be taken care of. In a smart city format the environmental issues are needed to be

locally identified, understood and resolved so that global sustainability of environment can be protected (Hozer, 2014).

Initiatives for a Sustainable Environment in Smart Cities

There are several areas for intervention through which the traditional cities can be transformed into smart cities. And among all areas of interventions, the most important are efficiency of energy and efficiency, existence of renewable energy sources and smart mobility plans. These are the most effective areas which can be taken care of for meeting the environmental objectives like reduction of pollution emissions and energy consumption. These steps can also affect favourably achieve the economic goals also like reduction of cost for public administration and management, development of businesses and improvement in employment levels. Additionally, these steps will help achieve social goals like improvement of quality of services and welfare of people (Casini, 2017).

Presently the smart cities are outsourcing social and environmental resilience to the technology sector globally. But, this procedure is not democratic in nature since it increases the power of those people in cities who are already powerful elites. By this the opportunities for all is marginalised and democratic engagements of resources get limited. It is a threat to social and environmental progress of smart cities. Hence, the smart cities deserve attentions in this regard. It has been argued that any city's 'intelligent systems' are basically a digital consumer experience which has biases inherent that leaves a proportion of the city's population unaccountable. This puts the whole concept of smart cities less resilient in the face of social and environmental risks. It is happening because of failures in implementing a smart political economy in smart cities which is generally beyond the scrutiny of any layman living in smart cities. These philosophies have been withdrawn from studies of infrastructures, informatics, urbanisation and society. It seems that using the term 'ecocities' is most appropriate in this connection related to smart cities for defining environmental resilience of people living in them (Viitanen & Kingston, 2014).

Solid Waste Management for a Sustainable Environment in Smart Cities

There are various challenges in solid waste management especially in cities of India that includes aspects like prevailing practices of municipalities for solid waste management, development of an integrated solid waste management system, intricacy of public private partnership mode, rules pertaining to solid waste management in the country and role of rag-pickers (Joshi & Ahmed, 2016). It is extremely important to plan and implement low-cost sustainable solid waste management strategies in countries like India. Inappropriate technical knowledge, lack of awareness, lack of accountability, inadequate funding, improper implementation of policies and legislation are the major causes for the failure of solid waste management mechanism of municipalities in India. If the capacity of the municipalities will be enhanced and procedures as well as training will be improved then issues like adequate financial support, proper site selection, and improper human resource management can be overcome. Not only the central government but also the state governments have to take various actions in order to strengthen the solid waste management mechanisms of

municipalities. The key challenges in this connection are: awareness to enhance segregation, characterization of municipal solid waste, urbanization and lack of appropriate level funding, implementation of rules at ground level, financial auditing and work study, resistance for notification of new landfill site, lack of coordination among central and state governments, appropriate technological solution, outsourcing and management of public private partnership mode, failure of waste to energy projects, involvement of organized sector etc. In developing countries like India, installation of decentralized solid waste processing units in smart cities and metros and development of a formal recycling sector is most needed at this moment.

It is however true that the solid waste generated under any municipality depends on population, urbanization, socio-economic criteria etc. and the overall solid waste management system in India at present in different towns and cities is inadequate (Pamnani & Srinivasarao, 2014). It has been seen that there are a lot of efforts put from the side of the central as well as state governments and public also to improve solid waste management mechanism of municipalities in the major cities of India that includes smart cities but due attention in this regard is lacking when it comes to medium and small towns in the country. The rules related to solid waste management mechanism of municipalities popularly known as MSWM rules, 2000 are extremely stringent but there seem a lot of deficiencies in the implementation of this policy at the grass root level. The major reasons for the non-compliances of these policies largely are: lack of planning, lack of leadership, lack of training and financial constraints. Formulation and implementation of a proper solid waste management policy is not only important for smart cities and metro cities but also it is equally important for medium and small towns and cities of a country like India where around 71% of people leaves outside smart cities and metro cities. The need of the hour is that there should be some optimization studies which are needed to be carried out in order to explore the scope for feasibility of integrated solid waste management mechanisms. There are some evidences from Indian cities where it has been revealed how these towns behave when it comes to solid waste management (Mishra *et. al.*, 2014). The proportion of plastic bags in total solid waste generated by households in these cities is highest and glass, ceramics and metals are nearly equal in proportion to each other. There should be litter bins in every public place of these cities and there should be compulsory segregation in all those sources where these litter bins are implanted. Additionally, the health and safety of workers engaged in this work should also be ensured. For successful implementation of solid waste management mechanism in the municipalities of these towns and cities the requirements are public awareness, public participation and political will. Apart from it proper implementation of legal provisions vis a vis solid waste management system is also an essential part of policy successes.

In a country like India, the administration and regulation of solid waste management by municipalities is governed by the guidelines jointly prescribed by Ministry of Environment and Forests and Climate Change which is popularly known as MoEF, the National Environmental Engineering Research Institute which is popularly known as NEERI, the Ministry of Urban Development which is popularly known as MoUD and the State Pollution Control Boards known SPCBs. And in other developing countries there are various other authorities which take care of the task of managing the solid waste generated in

municipalities. But, the key problems and challenges in doing so seem to be similar to India. In one of the studies, the problems in solid waste management in Vietnam has been identified as the need for a significant increment in existing capacity in relation to the continuing growth of urbanization and industries (Omran & Gavrilescu, 2008). There will be increased health risk and also environmental degradation if necessary measures will not be undertaken that includes effective handling and treatment of the growing quantities of solid waste due to urbanization and industrialization. The challenges that countries like Vietnam are facing are similar to that of India. The challenges include: making a balance of investments and technical appropriateness in solid waste management system of urban areas, ensuring social and financial sustainability of system associated with solid waste management, making a system to address likely problems to be caused by hazardous solid wastes generated by hospitals, industrial units and stockpiled agriculture chemicals etc. The anticipated future challenges can be: ensuring participation of communities in solid waste management, informing public about solid waste management, ensuring adequate investments and operations for solid waste management systems in municipalities etc. In another study conducted in Ghana also similar types of challenges have cropped up for solid waste management in municipalities (Miezah, *et. al.*, 2015). In Ghana, just like other developing countries there is a deficit of complete data on solid wastes. Only for a few selected cities of Ghana the data on composition of solid waste of municipalities are available and that is too only for one decade only. Since a holistic field on generation and composition of solid waste at the household level has not been done, so after carrying out a proper survey in this regard at the grass root level, it has been found that organic components in the total solid waste is ranging from 48% to 69% and it is the highest among all types of other components. Paper is one component of solid waste that can be used as raw material of biological conversion for composting, bioethanol refinery process and biogas. In Ghana, organic composition of solid waste is different among different socio-economic areas though not significantly different. The organic composition of solid waste in Ghana decreases as we move from coastal regions to forest to the savanna in North. Plastic is the second highest component of solid wastes in Ghana and its proportion in the total solid wastes goes on decreasing as we move savanna in North to forests to the coastal regions. The national average of waste generation in Ghana is 0.47 Kg. per person per day. The total generation of solid waste in Ghana is around 12,710 tons per annum out of which 8389 tons are biodegradables while 2754 tons are recyclable. The sorting and separation efficiency at the national level of Ghana is 84% for biodegradables while it is 76% for the other wastes. One way separation system in Ghana has been found to be effective. To add this discussion, if a study undertaken in UK be considered then it reveals that food waste especially when they are avoidable also incurs loss of resources and they have considerable environmental impacts. There are in an aggregate four sectors in the food supply chain in UK where food wastages are generated and they are: retail and wholesale, food processing, food service and households. The bottom-up life cycle assessment method can be implemented to quantify environmental impacts of this avoidable food wastage. Out of the many environmental impacts of food wastage some important are water depletion, global warming, indirect land use changes etc. Preparation of foods for the households and food service sectors are prominent contributors to global warming impacts of

avoidable food wastages. Hence, it is recommended that the avoidable food wastages should also be counted while making policies regarding solid waste management in municipalities.

Financial sustainability is another dimension on which an effective solid waste management system of municipalities depends (Tonini, *et. al.*, 2018). This is a typical situation in almost every city of the developing world that the solid waste management systems are not financially sustainable and the solid waste management system existing in these cities are hardly analyzed using a cost-revenue accounting system. The main reason behind this is that the solid waste management system is always seen as a service in developing countries that ideally should be 'public financed' and that is why it is independent of any costs. In a study undertaken in Ethiopia, it has been seen that though the companies engaged in solid waste management of municipalities are able to secure some new grants for covering some of the running costs, still these funds are found not to be earmarked in this purpose. Hence, financial monitoring and continuous analyses of data related to financial management of enterprises engaged in solid waste management of municipalities is extremely essential. It has got two benefits. First of all through the analysis of financial data the nature of financial flows can be understood properly and secondly it facilitates to react when financial sustainability is threatened in these types of organizations. It is recommended to the organizations in developing countries whether public or private who are engaged in the solid waste management of municipalities that they should go for a cost revenue analysis in a detailed manner. In this way they can make financial monitoring and also avoid surprises of financial deficit in the organization for carrying out operations. If there seems a tendency of revenue crunch to meet the costs, there are two fundamental options in the hands of such organizations. First, the organization can initiate to reduce costs or else it can go for arrangements to increase revenues. Further, whenever there will be a calculation for future revenue streams, it is extremely important to consider realistic assumptions and reliable data. There should be a precise business plan for these types of calculations. There is however some factors like for example road infrastructure or tariff changes which are generally in the hands of government authorities and not controlled by the organizations indulged in solid waste management of municipalities. Hence, these factors should be taken into account carefully while making the cost revenue analyses. Additionally, on behalf of the municipalities, the organizations engaged in solid waste management of these municipalities need to play the client function. Last but not the least, a sound alliance between the municipalities and organizations engaged in solid waste management is crucial.

Conclusions

The main question that has arisen out of the review of extant literature on plastic waste as a threat to environmental sustainability in smart cities is: 'what is the perception of population in a smart city towards consumption of polythene bags?' There are however three more related questions which have been identified in the present study. Firstly; is the population in the smart cities aware of the environmental impact of polythene bags? Secondly; is the population in the smart cities willing to reduce the consumption of polythene bags? Thirdly; do people in smart cities support the Government regulation on banning plastic bags in the state? These three questions which have been identified from the extensive review of extant

literature on plastic waste as threat to environmental sustainability in smart cities created a scope for further research in the subject. It is however proven from the present study that plastic waste is unquestionably a threat to sustainable environment which is a key characteristic of any smart city.

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