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Urban Transformation, Sustainable Environment and Smart Cities: Case Study of Allahabad City, India

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Abstract

Humanity will thrive in urban areas in the future. Trends and the current state of urbanization have made life more difficult and unpleasant for people everywhere, but especially in emerging countries like India. Considerations like climate resilience, disaster risk management, low-carbon urban energy systems, ecosystem-based adaptation, basic public health measures, diversification of livelihoods, early warning systems (for things like cyclones and coastal flooding), integrated water resources management, and improved sanitation facilities would make a smart city environmentally sustainable. This study makes an effort to take stock of where environmental sustainability stands in the context of planned smart cities, focusing in particular on Allahabad, and to examine the part environmental sustainability plays in the evolution of Allahabad into a smart city. The research draws on both primary and secondary sources. The parameters are evaluated using multi-criteria decision analysis, which results in a single score for the whole. The overall score helps shed light on the state of Allahabad's sewage systems and their potential role in transforming the city into a "smart city." Allahabad city received a combined 4.94 out of 10 on a scale measuring environmental sustainability. Due to ineffective mechanisms and tactics, the city's results in the areas of disaster management, climate resilience, pollution control, water recycling, and solid waste management have been subpar. Allahabad has a long way to go in terms of technological involvement. City authorities must immediately address significant deficiencies in appropriate functioning and administration. The research will provide future plans for transforming Allahabad into a "smart city" complete with high-tech infrastructure.

Keywords: *We'll talk about Allahabad in the context of smart environments, smart cities, technological interventions, and multi-criteria decision analysis.*

Introduction

1. As the world's population rises, so does the need for improved access to essential services like reliable power and clean living conditions. The United Nations (UN) approved 17 sustainable development goals (SDGs), six of which deal with water and sanitation, and another eleven with sustainable cities and communities. Space, social and physical infrastructure in cities are all feeling the strain of the increasing rate of urbanization. In developing countries like India, the present state and patterns of urbanization have gotten increasingly difficult and unhappy. Pollution, urban sprawl and

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slums, dense population, traffic jams, high cost of living, corruption, irresponsible governance, poor health care and educational facilities, frequent power cuts, water shortages, and inadequate sanitation facilities are just some of the problems plaguing proposed smart cities in India as a result of the country's rapid and unplanned urbanization.

2. The majority of Indian cities are no longer viable since they have depleted their resources to dangerously low levels. The situation is becoming worse as more people migrate to cities every year (Owen, 2009). The urban population of India accounts for 31% of the total population and produces 63% of the country's GDP (Census of India, 2011). The Ministry of Urban Development (2015) estimates that by 2030, 40% of India's population would live in urban regions, and that this group will be responsible for producing 75% of India's gross domestic product. Degradation of the natural beauty of the environment has had a negative effect on the health of city residents as a consequence of urbanization and the following growth of built-up regions at the urban city center (Singh et al., 2016). Current conditions call for progress in three areas: infrastructure, society, and government.Cities need Arun Pratap Mishra's infrastructure now more than ever. These are essential for enhancing the city's quality of life and luring new residents and businesses to the area. The Indian government's "smart city mission" represents a giant stride toward this goal of modernizing India's metropolitan centers.

3. The notion of a "smart city" is still being defined and conceptualized (Boulton et al., 2011; Hollands., 2008). The Ministry of Urban Development (2015) notes that "the definition and concept of smart city varies from one people to another, city to city, and nation to nation" due to differences in development levels, resource availability, readiness for change, and the hopes and dreams of city residents. "A city well performing in a forward-looking way in people, governance, economy, transportation, environment, and living, built on the smart blend of endowments and activities of independent, aware, and self-decisive citizens" (Giffinger et al., 2007).

4. The projected 100 smart city program relies heavily on environmental sustainability. Considerations like climate resilience, disaster risk management, low-carbon urban energy systems, ecosystem-based adaptation, basic public health measures, diversification of livelihoods, early warning systems (for things like cyclones and coastal flooding), integrated water resources management, and improved sanitation facilities would make a smart city environmentally sustainable. Improved quality of life and environmental circumstances are attainable via the promotion of a sustainable environment. Smarter resource and energy management made possible by today's technology helps cities evolve with the times (Jones, 2015). Sustaining the EnvironmentChange in the City, Environment That Can Last...

5. also stresses the need of using renewable energy sources and preventing climate change. The effects of climate change may be felt on every scale from the global to the regional to the small. The interdependencies between several aspects of sustainability provide a solution to this problem. There is an energy issue in this century, making renewable energy sources crucial. Slow but steady progress is being made in the field of renewable energy thanks to increased public and governmental interest. Renewable energy is the segment of the energy industry with the brightest

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future. Some examples are nuclear power, hydropower, solar power, tidal power, biofuels, flying wind farms, electricity from the sun in space, human power created through motion, and tidal power (Jones, 2015).

6. The Government of India revealed its list of 98 "smart cities" in August of 2015. In a competition between states held by the Ministry of Urban Development of the Government of India, the city of Allahabad came out on top. According to the Press Information Bureau (2015), it is one of 12 proposed "smart cities" in the Indian state of Uttar Pradesh. To make Allahabad a smart city, the United States Trade and Development Agency has signed a Memorandum of Understanding with the Government of Uttar Pradesh (The Hindu, 2015). Draft Smart City Proposal Allahabad, 2015 specifies that the Katra and Mumfordganj neighborhoods would undergo smart city retrofitting. This study makes an effort to take stock of where environmental sustainability stands in the context of planned smart cities, focusing in particular on Allahabad, and to examine the part environmental sustainability plays in the evolution of Allahabad into a smart city.

7. Characteristics of a Smart City

Giffinger et al., 2007 have described six characteristics of smart city namely smarteconomy, smart people, smart governance, smart mobility, smart environment and smart living (Figure 1). The above mentioned three dimensions such as technology, human capital and institutions result in different blends of smart city characteristics. Several studies related to assessment and ranking of smart cities have been preformed with the help of these characteristics. These characteristics and factors form the framework for the indicators and the following assessment of a city's current situation and its readiness of smart city transformation.

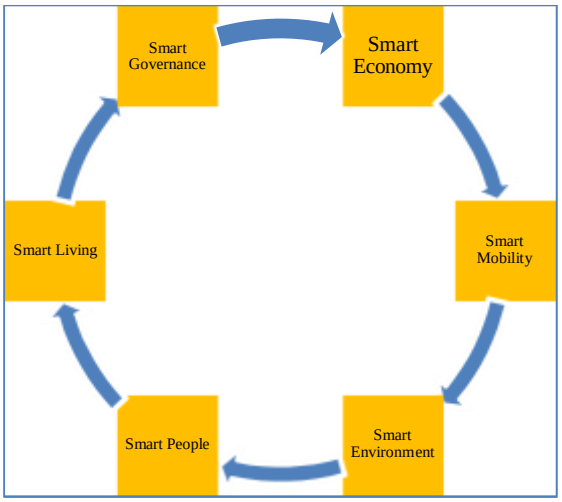

Figure 1: Characteristics of a Smart City

8. Study Area: Allahabad City

Allahabad is one of the largest cities of UP (Uttar Pradesh) in terms of population and area (Figure 2). Allahabad is situated at 25°28'N latitude and 81°54'E longitude. TheCity is well-known worldwide for its magical convergence of religion history and culture. (CDP of Allahabad, 2006). Topography of thecity is mainly plain with some undulations and city may be classified into three physical parts - (i) Trans-Ganga or the *Gangapar* Plain, (ii) Trans-Yamuna or the *Yamunapar* tract and (iii) the Ganga-Yamuna doab (confluence), all three of which are shaped by Ganga and its tributary Yamuna, the latter joining the former at Allahabad,

the confluence is known as *Sangam*. As per Census of India, 2011, total Area of the city is approximately 70 km^2 with population of 1,168,385. Whole city area is divided into 80 wards for administrative ease.

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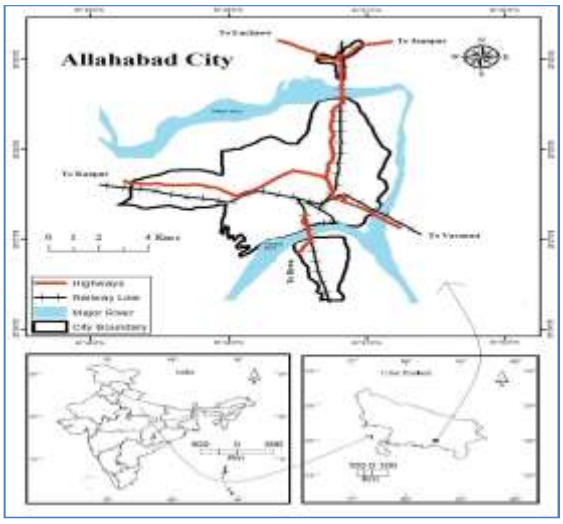

Figure 2: Location of Allahabad City.

9. Data Base and Methodology

Data for this study has been taken from both primary and secondary sources. Primary data is obtained by interviewing city inhabitants and officials. Secondary data is collected from various Indian government information portals, Uttar Pradesh government websites, Allahabad city department websites, research papers available in public domain, public reports and statistics and surveys done by various research organizations. Various reports and publications such as District Census Handbook 2001, 2011 of Allahabad city, Town Directory 2011, Jawaharlal Nehru National Urban Renewal Mission reports of Allahabad city etc have been referred. The

data for the smart city components is collected from different departments of UP
i.e. Municipal Corporation of Allahabad, JalKal Vibhag, Department of Medical Health and Family Welfare, Development Authority of Allahabad city, etc.
I have adopted the methodology and indicators used by PricewaterhouseCoopers India Private Limited on Smart city with some adjustment according to the study area. I have used Multi criteria decision analysis as a method to analyze each parameter in detail. Across each identified parameter, metrics were created of smart city based on target values and benchmarks. Individual score is assigned in accordance with and deviation from these benchmarks and target values. These parameters have been evaluated and rated across three criteria namely Current status, Technology intervention and Contribution to smart cities (Table 1). Assessment has been carried out with the help of the most recent data available. I have assessed these criteria on a scale of three to one, three shows the highest rating and one refers to the lowest. I have also assigned weights to these criteria on the basis of their importance and contribution towards assessment of the preparedness of the city

Table 1: Framework for rating the criteria.

Criteria / Rating	Rating 3	Rating 2	Rating 1
Current status	High service	Medium service	Low service

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	delivery	delivery	delivery
Technology Intervention	High technology involvement (for city monitoring and control points)	Medium technology involvement (limited to city monitoring only)	Low technology Involvement
Contribution to smart city	Essential to a smart city, fundamental requirement	Significant to a smart city	Least significant for a smart city

parameters. City development plan (CDP) of Allahabad under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) has been of great significance in these analysis. I have also thoroughly examined the current ground level initiatives and mechanisms to validate the findings and ratings. By the help of standardization process, consolidated score has been developed on a scale of one to ten for each parameter. This has led me to gain clear insights of the entire city operations till the last level. ArcGis 10.2 has been used for cartographic representation.

Results and Discussion

Current situation of environmental components and the role of sustainable environment for smart city transformation

(Source: Based on Price water house Coopers, 2015)

The final score has been derived as per the following formula:

Final score = (Current status × 4) + (technology intervention × 4) + (contributionto smart city × 5)

I have used weighting factors to define the level of significance of criteria. I have also assigned weights from 0 to 5 scales. Zero means not significant, 1 reefers to very low importance, 2 reefers to low importance, 3 is for medium importance, 4 refers to high importance and last 5 shows very high importance. I have assigned equal weightage of 4 showing high importance to technology intervention and current status. I have assigned very high weightage of 5 to "contribution to smart city" to stress the critical components that need urgent attention and efforts. I have rationalized assessment findings by carrying out a ground level analysis and Allahabad city's initiative in that particular sector by individual departments across all identified Environmental sustainability is the core characteristic of smart city. A smart city should be sustainable on each parameter such as economy, environment, transport, and livelihood. A smart city is that city which not only cares its present generation but future generation too. Carrying capacity of the city must be taken into consideration to make a city smart and sustainable. In terms of environmental sustainability that comprises noise, air, and water

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SUSTAINABLE ENVIRONMENT				
Sub components	Current State	Technology intervention	Contribution towards smart city	Score (considering weights)
Noise pollution control	1	1	2	18
Air pollution control	1	1	2	18
Adherence to building Norms	1	1	3	23
Water pollution control	1	1	2	18
Households connected to waste water, sewerage network	1	1	3	23
Waste water treatment	1	1	2	18
Population with regular solid waste collection (residential)	1	1	2	18
Recycling of solid waste	1	1	2	18

pollution control, green building norms, households connected to the wastewater, sewerage network, waste water treatment, population with regular solid waste collection (residential), and recycling of solid waste, the city has consolidated score of 4.94. Allahabad city has not performed well, due to sub-standard level of mechanism and policies related to pollution control, recycling of waste water, and solid waste management (Figure 3 to Figure 8). City management officials should deal with these issues without delay. To make Allahabad city smart and sustainable, there is a need of more focus on the use of information and

communication technology in generating environmental awareness (Table 2).

Poor infrastructure amenities together with rapid population growth have led to deteriorating environmental quality of Allahabad city. Used plastic bags, wrappers and other kinds of municipal solid wastes have made the roads and streets dirty. Local residents have been observed of throwing wastes on streets which shows their low environmental awareness leading to a dreadful and unhygienic city ecosystem. Due to these wastes, the problem of sewer

blocking is increasing during heavy rainfall. The sub-standard infrastructure system in the city such as encroachment on roads, erection of electric pole and electric transformers on intersections, insufficient parking spaces, , narrow roads are resulting into traffic jams and poor environmental situation in the city. Location of the old city bus stands area and highways passage give rise several bottlenecks in the city area. The heavy traffic has caused temperatures rise and is responsible for noise and air pollutions.

Table 2: Component scoring for sustainable environment.

(Source: Analysis done by author)

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Figure 3: Katra drain with partial roofing.

Mumfordganj.

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and storm water drainage systems, an efficient potable water

Figure 5: Wide and clean Road Spaces inCivil Lines.

Figure 6: Newly Constructed clean Road with Footpath in Mumfordganj.

Figure

Figure 7: Garbage burning on the street ofMumfordganj.

The overall environment of Allahabad city is not good and needs be improved by providing proper infrastructure amenitieslike roads and parking places, treeplantation, green parks, efficient solid waste management system, separate sewerage

Figure8:PoorlymanagedGarbagecollection in Mumfordganj

(Source: Compiled by author, 2017) **Figure 9:** Status of Smart City componentsalong with environmental sustainability in Allahabad city.

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Figure 9 reveals the current status of environmental sustainability in Allahabad city as a whole with other smart city components such as public safety, power, water, education, health, disaster management, and transport. Out of these nine components, power sector has performed the best. Environmental sustainability has shown lowest level of performance among all components. On most of the parameters, Allahabad city has performed averagely. Greater technology intervention and more focus on basic infrastructural problems by city officials are

needed to improve the current status of all these components. Citizen participation should be given more attention because of its great significance in making a city smart. The higher educational status of Allahabad city inhabitants can help in making successful the process of citizen participation and awareness to make the city smart.

9.1 Assessment of Current Situation of Environmental Sustainability in the Allahabad City at Household Level

Current status of Allahabad city has also been assessed with the help of some significant indicators selected from town directory of census of India. These indicators are selected on the basis of their potential role in making Allahabad a smart city. Theseincludes the households with LPG and PNG used for cooking , households with electricity as main source of lighting, households having facility of tap water from treated source, households having waste water outlet connected to closed drainage, households having flush and pour flush latrine connected to piped sewer system and households having computer with internet facility.

9.1.1 Households with LPG and PNG used forcooking

In terms of and households with LPG and PNG used for cooking, status of Allahabad ismore or less satisfactory. But there are still many areas where more than 50 percent of the household don't use LPG for cooking. Both the old and new city have performedwell in tems of reach to LPG and PNG. This is because of it will be highly inefficient and unpractical to use other things like firewood and kerosene for cooking in the city area. Government has also promoted LPG to curb pollution level in the city. The outer growthareas still lacks in this field because of use of other material like firewood and kerosene for

cooking. This is because of low income andawareness (Figure 10).

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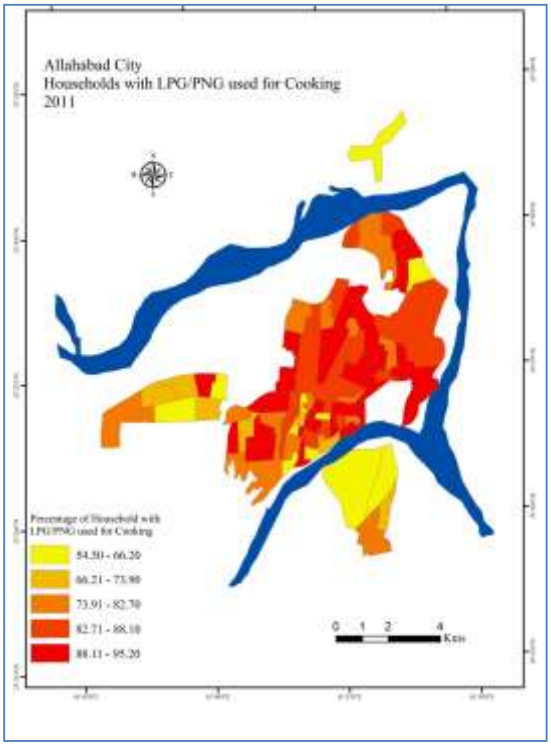
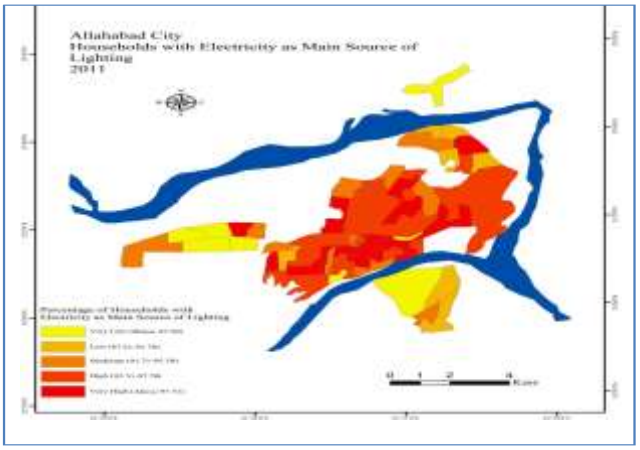


(Source: Prepared by Author based onCensus of India, 2011)

Figure 10: Households with LPG and PNGused for cooking.

9.1.2 Households with Electricity as Main Source of Lighting

With regard to households with electricity as main source of lighting, most of the Allahabad city has performed well except some pockets of outer growth area. Reach of electricity is one of the important indicators of socio-economic development of that particular area. Both old and new city have well established electricity system. High income and commercial importance of this area have made it possible. The outer growth areas are somewhere lacking in terms of high electricity reach. This is because of low income and problems related to electricity like electricity cut, theft etc (Figure 11).



(Source: Town Directory of Allahabad, Census of India, 2011)

Figure 11: Households with Electricity as Main Source of Lighting

9.1.3 Households having wastewater outlet connected to closed drainage

With respect to households having waste water outlet connected to closed drainage, status of Allahabad is also not up to the mark. Overall, only 54.20 per cent households are having wastewater outlet connected to closed drainage in Allahabad city. It can be analyzed that there are still many areas where great overhauling is required to connect waste water outlet to closed. In this case also both the old and the new city have performed well because of well connected wastewater outlet to closed drainage but still there are some places inthese areas where wastewater outlet is connected to open drainage and no drainage and that requires urgent attention. The outer growth areas have very low percentage of households having waste water outlet connected to closed drainage (Figure 12).

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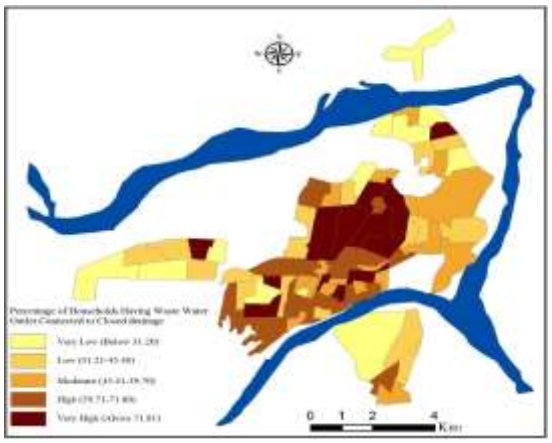


(Source: Prepared by Author based onCensus of India, 2011)

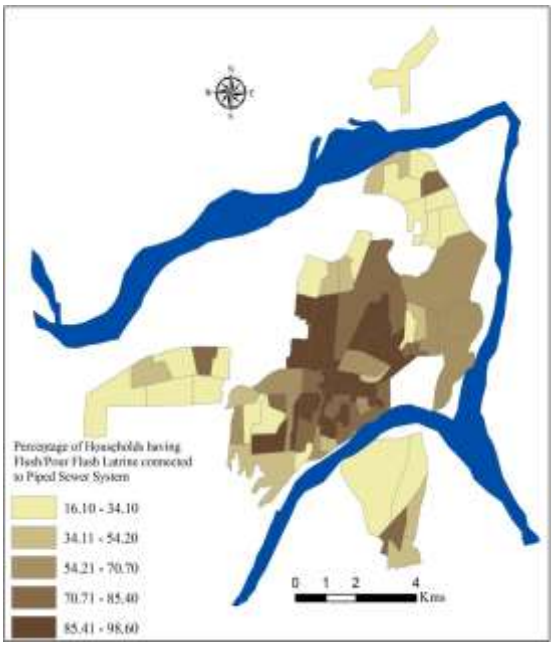
Figure 12: Households Having Wastewater Outlet Connected to Closed Drainage

9.1.4 Households having Flush and Pour Flush Latrine Connected to Piped Sewer System

With regard to households having flush and pour flush latrine connected to piped sewer system, status of Allahabad is also not satisfactory. There are still many areas where flush latrines are not connected to piped sewer system. Both the old and the new cityhave performed well because of well established piped sewer system but still there are some places where underground sewer line is absent and that needs to be provided. The outer growth areas has also high percentage of livable houses because of recent construction of houses for personal use (Figure 13).

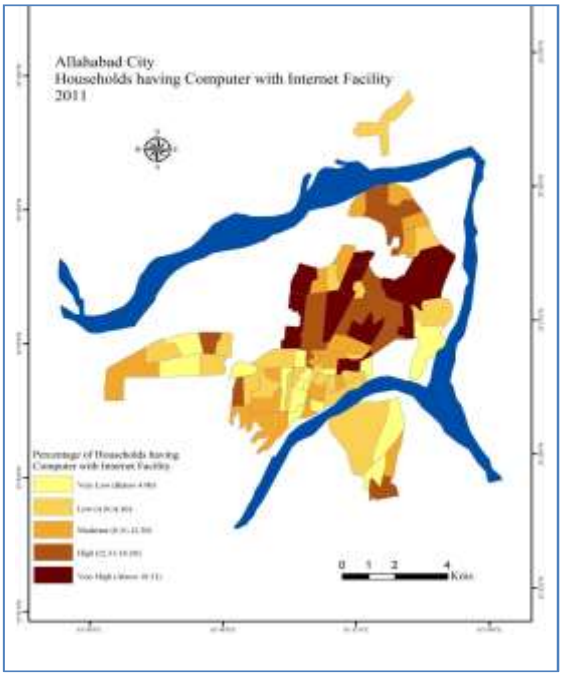
9.1.5 Households having Computer withInternet Facility

With respect to households having computer with internet facility, status of Allahabad is also not satisfactory. There are still many areas which are devoid of internet connection in household. The new city households are more connected to internet connections than the old city.



(Source: Prepared by Author based on Census of India, 2011)

Figure 13: Households Having Flush and Pour Flush Latrine Connected to Piped SewerSystem.



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(Source: Town Directory of Allahabad, Census of India, 2011)

Figure 14: Households having Computer with Internet Facility.

This is because of high socio economic statusof this area and more importance of internet facility. The old city residents are not much concerned with having internet facility in each and every household because of primitive mindset and low awareness about importance of internet. The outer growth areas also lacks internet connection except some industrial area because of low income and low need (Figure 14).

10. Concluding Remarks

The city and its citizens need to adapt to the technology for making a city smarter. Retrofitting of old building, efficient use of the services, self-sufficient building and energy generating devices need to be implemented. The life choices of individuals need to be improved. An aware society can lead to a smarter surrounding. To make a smart city with sustainable environment, carrying capacity of the city must be taken into consideration. In terms of environmental sustainability, the Allahabadcity has consolidated score of 4.94 which is alow score. Allahabad city has not performed well, due to sub-standard level of mechanism and policies related to pollution control, recycling of waste water, and solid waste management. Cities like Allahabad needs complete overhauling infrastructure related to pollution control, sanitation and solid waste management. Overall, Allahabad has not performed well on many parameters of environmental sustainability. In terms of technology intervention, Allahabad has to go long way. There are substantial gaps in proper functioning and management that need urgent attention of city officials. Government of India has launched a scheme to fulfill the gap for cleanliness, which requires proper implementation. Finally, transformation of Allahabad into smart city requires great cooperation and coordination

among various stakeholders like city administrators, private sector, NGOs, academicians and community along with public -private partnership. The accountability of associated responsible people should be fixed in order to achieve sustainable development goal with inclusivity in Allahabad city.

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