ANALYSING THE POTENTIALS AND CHALLENGES IN MAKING GAYA A SMART CITY

Poonam Kumria[1] , Krishna Kumar[2] and Manjit Singh[3]
[1]Associate Professor, Department of Geography, Miranda House, University of Delhi, New Delhi.
[2]Assistant Professor, Department of Geography, Shaheed Bhagat Singh Evening College,
University of Delhi, New Delhi.
[3]Assistant Professor, Department of Geography, Miranda House, University of Delhi, New Delhi.

ABSTRACT:
Many developing countries of Asia and Africa are facing the challenges in meeting the needs of their growing urban populations, including for housing, transportation, energy systems and other physical infrastructure, as well as for employment and basic services such as health care, education, environment, air and potable water. In this context, integrated policies to manage urban growth that guarantee access to physical infrastructure and social services for all are becoming a top priority for the government of the respective countries. In order to achieve the correct administration and projection of the improvements in the cities, it is necessary to have an overview of what is happening there and in their surroundings. In this context, as the cities and humanity are on the lookout for the way to proceed, the concept of "Smart City" is gaining popularity as it is successfully covers all the key issues, such as, sustainable urban development, sustainable infrastructure, sustainable transportation, sustainable circular economy, smart networks infrastructure, provision of urban services to its citizens and government.

KEYWORDS: *growing urban populations , physical infrastructure and social services.*

1.INTRODUCTION :
Across the globe, Governments have created strategic and innovative approaches for smart city transformation to improve operational efficiencies, maximize environmental sustainability efforts, and create new citizen services. There is an urge to create smart cities all over the world to surpass challenges posed by traditional and conventional cities. Overcoming these critical challenges in a systematic manner is crucial for cities inspired to shift towards more sustainable measures among all stakeholders: citizens, businesses and governments (PricewaterhouseCoopers, 2015). The Current situation and trends of urbanization is more miserable and challenging in a developing country like India. With rapid and unplanned urbanization, Indian cities are characterized by dense population, traffic jams, high level of pollution, unaffordable housing resulting in urban sprawl and slums, high cost of livings, corruption, irresponsible governance, low level of health care and educational facilities and strained infrastructure in terms of frequent power cuts, and water shortages. Most of the cities have already stretched beyond its carrying capacity limit and have become unsustainable. Continued Increase in flow of migrants to urban areas is only worsening the problem. Despite all the problem Indian cities are facing now a days, these are like powerful engine for the fast developing economy like India. Currently, 31 percent of India's population lives in urban areas and contributes 63 percent of India's Gross Domestic Product (Census of India, 2011). With increasing urbanization, 40 percent of India's population

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is projected to dwell urban areas and contribute 75 percent of India's GDP by 2030 (Smart City Guidelines, 2015). In the current scenario, development of physical, institutional, social and economic infrastructure of cities is the need of the hour. These are significant in terms of improving quality of life and to draw attention of people and investment towards the city. India's smart city mission for transforming urban areas is a step in that direction.

The Indian government took a major policy initiative to create 100 smart cities across the country. The purpose behind the mission to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes (Smart City Guidelines, 2015). This ambitious plan will transform the structure of existing cities and take it to the global level. To make this mission successful, Indian government has collaborated with many developed countries including United States of America, France, Germany, United Kingdom, Japan and Singapore. These countries will provide necessary know how and technologies so that quick implementation and time bound delivery of the project could become possible.

In August 2014, Government of Bihar has proposed the name of its 4 cities in which Gaya was also included but the centre government has refused to consider the name of Gaya in its ambitious project of smart city in the first phase but government of Bihar is taking all possible to transform Gaya into a smart city as it hold important place on domestic and international tourist place. Gaya has all possibilities to become a smart city as it has international and national tourist spot which attract tourists all round the year. It has also a central university and state university and lively township.

2.STUDY AREA

The study was carried out for Gaya district which was a part of ancient Magadha region of Bihar. Located between 84° 4' to 85° 5' E longitudes and 24° 5' to 25° 1' N latitudes, it is 100 kilometers south of Patna. The surrounding physical features give the region a unique identity. The region is surrounded by a series of low rocky hills (Mangala-Gauri, Shringa-Sthan, Ram-Shila and Brahmayoni) on three sides, and River Falgu flowing on the fourth western-side, thus gets a separate identity from its surrounding area. The region has an area of 4,856 sq. km. and a population of 3,473,428 in 2001. It is bounded on the east, north and west respectively by Nawada, Jehanabad and Aurangabad districts of Bihar, and south by Chatra district of Jharkhand. A dominant majority of the population is engaged in agricultural activities.
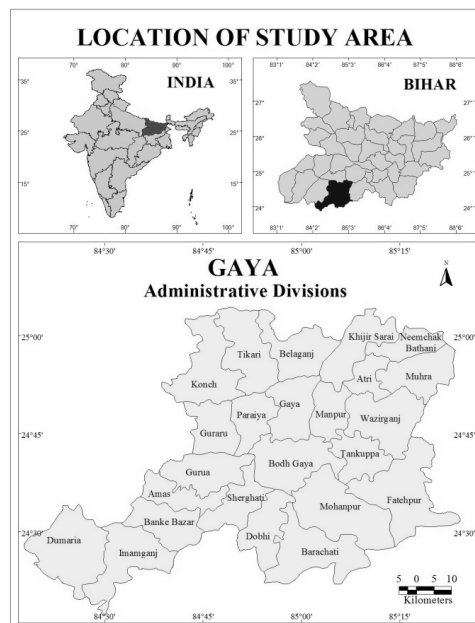

Figure 1: Study Area

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3.CONCEPTUALIZING SMART CITY

The idea of smart city has become more prevalent now a days and its growing interest among policy makers and academicians is visible across the globe. More people and governments are embracing this idea. Not only developed countries of Europe and North America but developing nations like China and India are planning their cities for smart city transformation. Although the term 'smart city' is frequently being used now, still there is not clear and common understanding of the concept among the practitioners and academia. The idea of smart city is still in its primary phase and the process of defining and conceptualizing is in progress (Boulton et al, 2011, Hollands, 2008). The concept and definition of smart city varies from people to people, city to city, nation to nation, depending upon the level of development, resource availability, zeal for transformation and aspirations of city residents (Smart City Guidelines, 2015). Through the help of literature review several working definitions of smart city is listed out which is of great practical and academic use.

"A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens" (Hall, 2000).

"A city that gives inspiration, shares culture, knowledge, and life, a city that motivates its "A city where The ICT strengthen the freedom of speech and the accessibility to public information and services" (Partridge, 2004).

"A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens" (Giffinger et al., 2007).

"The use of Smart Computing technologies to make the critical infrastructure components and services of a city––which include city administration, education, healthcare, public safety, real estate, transportation, and utilities––more intelligent, interconnected, and efficient" (Washburn et al.,2010).

A city "combining ICT and Web 2.0 technology with other organizational, design and planning efforts to dematerialize and speed up bureaucratic processes and help to identify new, innovative solutions to city management complexity, in order to improve sustainability and livability" (Toppeta, 2010).

According to the Ministry of Housing and Urban Affairs, Government of India (2019), some of the core infrastructure elements in a Smart City would include adequate water supply, assured electricity supply, sanitation, including solid waste management, efficient urban mobility and public transport, affordable housing, especially for the poor, robust IT connectivity and digitalization, good governance, especially e-Governance and citizen participation, sustainable environment, safety and security of citizens, particularly women, children and the elderly and health and education.

3.1 Dimensions and Conceptual Relatives of a Smart City

The concept of smart city is not clearly expressed in various literatures. It is consisted of various characteristics and dimensions. Nam and Pardo (2011) has discussed about variety of conceptual relatives of smart city. Those conceptual variants can be largely categorized according to the technological, human and institutional dimensions (Table 1).

Table 1: Conceptual Relatives of a Smart City

| Dimensions	Concepts
Technological	Digital City, Intelligent City, Ubiquitous City, Wired City, Hybrid City, Information City
Human	Creative city, Learning city, Humane City, Knowledge City
Institutional	Smart Community, Smart Growth

Source: Nam et al., 2011

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Technology dimension plays a greater role in defining and conceptual understanding of smart city. High quality urban information and communication technology (ICT) is the most basic requirement of a smart city. Smart city model has been put forward by various private corporations active in the field of software, informatics, telecommunication and power energy. Various literatures have consistently emphasized the importance of ICT in overall performance of the city. However, despite this, the concept of smart city is much broader (Caragliu et al., 2011). Human dimension is also a key element of a smart city. It focuses on educated and skilled population and workforce, which are not only "new engine" for economic growth of cities but also a key component for the conceptualization of smart city (Campbell, 2012). Smart communities with the use of ICT technologies, people's innovation capabilities and government support represent institutional dimension, which help cities to grow positively (Lindskog, 2004).

3.2 Characteristics of a Smart City

Giffinger et al., 2007 have described six characteristics of smart city namely smart economy, smart mobility, smart environment, smart people, smart living and smart governance (Figure 2). 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.

Figure 2: Characteristics of a Smart City
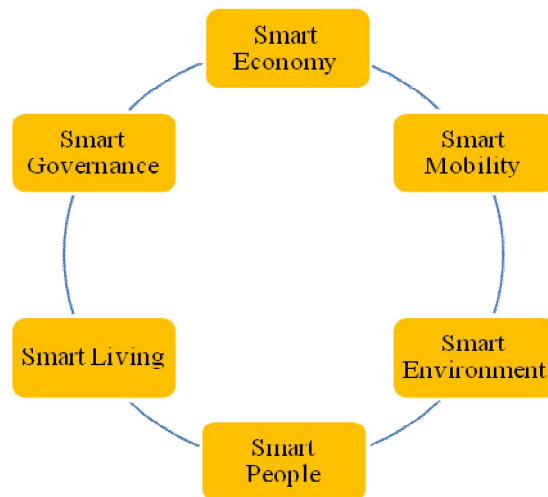
Source: Giffinger et al., 2007

4.DATABASE AND METHODOLOGY

Both the qualitative and quantitative data has been collected from both primary and secondary sources. Primary data is obtained with the help of questionnaire (open and close ended), ground survey and interview of city residents, and officials. Secondary data is taken from city-specific government websites, city-specific department websites, public reports and statistics and surveys done by various analyst organizations. Secondary data are also collected from Gaya District Census Handbook 2011, Gaya Town Directory 2011, Census of India 2011, Jawaharlal Nehru National Urban Renewal Mission reports of Gaya city etc. To fulfill the objective, methodology and indicators developed by PricewaterhouseCoopers, India on Smart city has been adopted with some modification according to the study area. To understand the current situation of Gaya city by analyzing various economic, social, urban components and metrics and its readiness for smart city transformation, a structured approach

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has been adopted, that involves detailed assessment of fundamental and critical parameters for smart city transformation and to take cognizance of city readiness to achieve the smart city vision. In order to develop a comprehensive picture, Gaya city has been assessed on the basis of social, economic and urban characteristics and several parameters as discussed in following sections (Table 2).

Table 2: Major components of Smart city identified for analysis of Gaya as Smart City

Social	Urban	Economic
Health Education Public Safety Disaster management	Power Water Transport	Municipal corporation Sustainability

Source: Based on PricewaterhouseCoopers, 2015

Multi criteria decision analysis is used as a method to analyze each sector in detail. Across each identified sector, metrics were developed of smart city based on benchmarks and target values. Score is given in accordance with and deviation from these benchmarks and target values. Considering the difficulties in data collection and limited resources, 41 components have been identified. PricewaterhouseCoopers report on smart city and Draft Concept Note on Smart City Scheme developed by Ministry of Urban Development have been of great importance in the selection and assessment of components. These components have been assessed and rated across three criteria namely Current status, Technology intervention and Contribution to smart cities (Table 3). Current status refers to the current level of city performance and service delivery across each of the component and is assessed. Technology intervention defines the use and state of technology solutions for city operations and the delivery of various city services and Contribution to smart city implies the vitality index and the contribution made by individual components in city operations. Out of these 41 components, 39 percent depicts an urban overview, 32 percent a social overview and the remaining provides an economic overview of the city. During the assessment, care has been taken to use the most recent data available. These criteria are assessed on a scale of three to one, three being the highest rating and one the lowest. Weights have been assigned to these criteria on the basis of their significance and contribution to help assess the preparedness of the city in reference.

Table 3: Framework for Rating the Criteria

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

Source: Based on PricewaterhouseCoopers, 2015

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

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

To define the level of importance of criteria, Weighting factors are used for each component. Weights have been assigned from zero to five scales. Zero refers to not important, one is for very low importance, two is for low importance, three is for medium importance, four is for high importance and

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five is for very high importance. Current status and technology intervention have been assigned equal weightage of 4 that is of high importance. Very high weightage of 5 is assigned to "contribution to smart city" to emphasize the critical components that need urgent attention and efforts. Assessment findings have been rationalized by carrying out a ground level analysis and initiative taken by cities in that particular sector by individual departments across all identified components. City development plan of Gaya under JNNURM has been of great importance in these respects. To know the value of current ground level initiatives and mechanisms have been examined in detail to substantiate the findings and ratings. Through the standardization process, consolidated score on a scale of 1 to 10 for each component has been developed. This has helped to gain clear insights of the entire city-wise operations till the last level.

5. RESULTS AND DISCUSSION
5.1 Assessment of current situation of the Gaya city and its readiness for smart city transformation

The component scoring of nine components including the availability of water, power, transport, health, education, public safety, disaster management, Municipal Corporation and sustainability has been derived in the study (Table 4 to Table 13). Each component has been rated against the current state, technology intervention, and contribution towards smart city. Consolidated score is produced from multiplying ratings with weights.

5.1.1 Water

In terms of water supply that comprises 24x7 water supply, metering of water connections, online payment facility and water losses minimization, Gaya has a consolidated score of 6.03 which shows that the city needs more improvement in the level of infrastructure related to water supply in the city. 24×7 water supply still seems a dream for the city. Increasing population is creating more pressure on water supply infrastructure in the city. The city requires more technological input and financial support for water connections with proper meter, online payment facility, and water loses minimization.

Issues related to water distribution, water pricing, water population ratio, water cycling and rainwater harvesting need greater level of financial resources and should be dealt with proper care for the transformation of the city into a smart city (Table 4).

Table 4: Component scoring for water

WATER				
Sub components	Current State	Technology intervention	Contribution towards smart city	Score (considering weights)
24x7 water supply	2	2	3	31
Metering of water connections	1	1	3	23
Online payment facility	1	1	3	23
Water losses minimization	1	1	3	23

Source: Compiled by author

5.1.2 Power

Power is a significant component in terms of livability and sustainability from the citizen and industrial perspective. With respect to power sector that includes 24×7 power supply, energy consumption details, online payment facility, Metering and Grievance redressal for citizens of Gaya city has a consolidated score of 6.55 out of ten for power. Overall Gaya has performed well in power sector, still some areas requires greater attention. Electricity metering and citizen grievances redressal system need greater technological input and government support. The city is yet to achieve 24*7 power supply for domestic and commercial use. To make Gaya a smart city, administrators and residents need

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behavioural changes. Electricity department must ensure the supply 24*7 with time bound redressal of any issues related to electricity supply. Residents must pay bill on time and stop electricity theft which is very common in illegal colonies of the cities (Table 5).

Table 5: Component scoring for power

POWER				
Sub components	Current State	Technology Intervention	Contribution Towards Smart City	Score (Considering Weights)
24*7 Electric Supply	2	2	3	31
Energy Consumption Details	3	3	3	39
Online Payment Facility	2	2	3	31
Metering	1	1	3	23
Grievance Redressal for Citizens	2	1	3	27

Source: Compiled by Author

5.1.3 Transport

Smart transportation is one of the major components for any smart city. To make any city smart, transport facilities should be of world class so citizen feels comfortable in using it without giving any second thought for sustainable environment. The city should have efficient modes of transport including road, rail, water and air. Gaya city has potential to develop all the modes smartly. In terms of transportation which includes transport surveillance for instance traffic violation detection, speed, violation detection, traffic signal violation detection, challan management, traffic management system, parking management, availability and frequency of mass transport, availability of bicycle tracks, unobstructed footpaths of minimum two meter width on either side of all streets, the city has consolidated score of 2.95. Low score is the result of poor current status and lack of technological intervention in transport related infrastructures. The city lacks in modern intra city transport facility due to poor quality private auto rickshaws running on road and very few city buses are plying on city roads. The city needs research and development, capital investment, and public support to make transport smoother and smart (Table 6).

Table 6: Component scoring for transport

TRANSPORT				
Sub components	Current State	Technology intervention	Contribution towards smart city	Score (considering weights)
Transport surveillance: Traffic violation detection, speed violation detection, traffic signal violation detection	1	1	1	13
Challan management	1	1	1	13
Traffic management system	1	1	1	13
Parking management	1	1	1	13
Availability and frequency of mass Transport	1	1	1	13
Availability of bicycle tracks	1	1	1	13
Unobstructed footpaths of minimum 2m width on either side of all streets	1	1	1	13

Source: Compiled by author

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5.1.4 Health

Health is an important component to measure the smartness of people and living style. A smart city should have smart healthcare facilities combined with state of the art technology and 24 hour unobstructed emergency service. With respect to health sector that includes, number of hospitals with doctors as per population density, healthcare facilities and emergency response facilities (ambulances, emergency wards, etc), the city has consolidated score of 4.58. The city reflects poor performance in terms of current status in healthcare facilities. More hospitals equipped with modern facilities in ratio to the population density of the city are needed and emergency facilities require urgent attention (Table 7).

Table 7: Component scoring for Health

HEALTH				
Sub components	Current State	Technology intervention	Contribution towards smart city	Score (considering weights)
No of hospitals against population Density	1	1	3	23
Healthcare facilities	1	2	3	27
Emergency response facilities (ambulances, emergency wards, etc)	1	2	3	27

Source: Compiled by author

5.1.5 Education

Education plays important role in creating smart people who are interested in more use of information and communication technology. Education makes citizens more responsible, creative and flexible to enjoy the social and ethnic plurality. In terms of education that includes total number of schools, school for the specially-able, colleges against population density, technological colleges against population density, the city has consolidated score of 5.99 only. Moderate score is attributed to availability of large number of schools, and colleges. Gaya city acts like an educational hub of Magadh Region of Bihar. Large numbers of students come from surrounding areas to prepare for higher education and preparing for competitive examinations (Table 8).

Table 8: Component scoring for education

EDUCATION				
Sub components	Current State	Technology intervention	Contribution towards smart city	Score (considering weights)
Total number of schools	3	1	3	31
School for the specially abled	1	1	2	18
Colleges against population density	3	2	2	30
Professional colleges against population density	3	2	2	30

Source: Compiled by author

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5.1.6 Public Safety

Public safety is another critical component to assess smart city readiness. With regard to Public Safety that includes safe and secure environment for all citizens irrespective of any time period. It also includes city surveillance through CCTV cameras, police mobile vans, police checking points, online FIR, complaints registration, and complaint response time. Gaya has a consolidated score of 5.08 out of ten. The city needs more emphasis in utilization of technology and components for city surveillance. More mobile vehicles with advanced technology and CCTV cameras should be provided to police department and for all public places. Various securities related projects are in pipeline and the city administration needs to align its current project objectives with smart city vision to further enhance public safety (Table 9).

Table 9: Component Scoring for Public Safety

PUBLIC SAFETY				
Sub components	Current State	Technology intervention	Contribution towards smart city	Score (considering weights)
City surveillance	1	1	3	23
Online FIR, complaints registration	1	1	2	18
Complaint response time	2	1	2	22

Source: Compiled by author

5.1.7 Disaster Management

Expanding population and urbanization has made city more vulnerable in terms fire, flood, earthquake, epidemics etc. with respect to disaster management that includes disaster prediction

System, early warning system, disaster alarm and response system and fire stations basis population density, Gaya has a consolidated score of 3.91. The moderate score is attributable to the absence of infrastructure related to disaster prediction management. To make Gaya smart city, more emphasis should be given on capital investment, policy support and public awareness program related to disaster management. The city needs District Disaster Management force, more fire stations and advance equipment for fire fighting to meet any unforeseen events (Table 10).

Table 10: Component scoring for disaster management

DISASTER MANAGEMENT				
Sub components	Current State	Technology intervention	Contribution towards smart city	Score (considering weights)
Disaster prediction system, early warning system	1	1	2	18
Disaster alarm and response system	1	1	2	18
Fire stations basis population density	1	1	3	23

Source: Compiled by author

5.1.8 Municipal Corporation

Municipal Corporation plays a great role in making a city smart. Whole things depend on the perception of corporation officials towards the city. Awareness program should be run to sensitize officials to make people oriented programs and assimilate communities. It's the duty of Municipal Corporation to maintain the cleanliness of roads and sewerage as well as managing solid waste for

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providing a clean environment. With regard to Municipal Corporation which comprises property tax payment, complaint registration, birth and death registration, and online building plan sanction, the city has consolidated score of 6.18. High score refers to efforts taken by corporation in areas related to online birth and death registration and online complaint registration, still city needs to take more steps in municipal governance such as online building plan sanction and online complaint redressal (Table 12). Municipal corporation of Gaya city has to still work hard to provide all its services for a better and smart Gaya City.

Table 11: Component scoring for Municipal Corporation

MUNICIPAL CORPORATION			
Sub components	Current State	Technology intervention	Contribution towards smart city	Score (considering weights)
Property tax payment	3	3	2	34
Complaint registration	2	2	2	26
Birth and death registration	3	3	2	34
Online building plan sanction	1	1	2	18

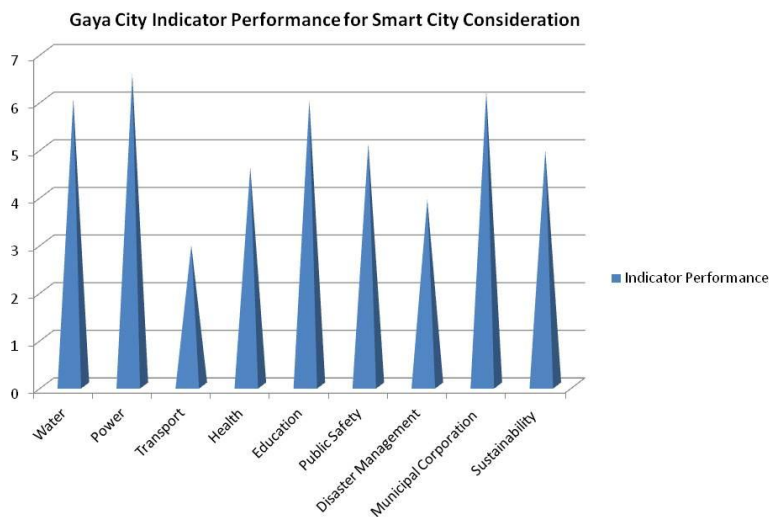Source: Compiled by author

5.1.9 Sustainability

Environmental sustainability is the core feature of any smart city. A smart city should be sustainable in every respect such as transport, livelihood, environment and economy,. A smart city should not only care about its present generation but future generation too.

Table 12: Component scoring for Sustainability

SUSTAINABILITY				
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 the green building Norms	1	1	2	18
Water pollution control	1	1	2	18
Households connected to the 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

Source: Compiled by Author

To make a city sustainable and smart, carrying capacity of the city should be taken into consideration. In terms of sustainability that includes air pollution control, water pollution, soil pollution, solid waste management, adherence to the green building norms, households connected to the wastewater, sewerage network, waste water treatment, the city has consolidated score of 4.94. The city has not performed well, because of poor mechanism and administration related to pollution control, water recycling, and solid waste management. To make Gaya city sustainable, both administration and citizens must come forward and understand their moral responsibility in making their own city a sustainable smart city (Table 12).

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Figure 3: Current status of Smart City components in Gaya City

Source: Compiled by Author

Figure 3 shows the current status of smart city components in Gaya city as a whole in terms of water, power, transport, health, education, public safety, disaster management, Municipal Corporation and sustainability. Out of the nine components, the performance of power sector is best followed by the work of municipal corporation, education facilities and water supply and connection. The performance of transport facilities is lowest among all components. Performance of transport facilities, infrastructure and disaster management is below 5 which is considered not good for a city to which government of Bihar want to be smart city. All the other components have performed only averagely. Current status of all these components needs to be improved by greater technology intervention and focus on root problems by city officials and administration. More attention should be given to citizen participation because of its paramount importance in making a city smart. The higher educational status of Gaya city inhabitants can help in making successful the process of citizen participation and awareness to make the city smart.

6. CONCLUSIONS

The study shows that making smart city in India is not an easy task. Cities like Gaya needs complete overhauling of social, economic, environmental and urban infrastructure. Overall, Gaya has not performed averagely on many components such as power, water and education. In terms of technology intervention, Gaya has to go long way. Some components like power, education, health and Municipal Corporation are showing positive signs, still there are substantial gaps in proper functioning and management and that need urgent attention of city administration. Government of India has launched several schemes to fulfill the gap such as Digital India for electronic empowerment, Swachh Bharat Abhiyan for cleanliness, Integrated Power Development Scheme for power sector, Make in India for boosting investment and manufacturing, and Pradhan Mantri Kaushal Vikas Yojana for skill development of youth. Finally, transformation of Gaya into smart city requires great cooperation among city administrators, private sector, academicians and citizens.

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