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Technology and Innovations: Empowering Citizens for Future Liveable Cities

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Abstract*: According to the UN State of the World Population 2007 report, by 2030, 40.76% of India's population is expected to reside in urban areas. This urbanization causing for demands of new housing, industries, commercial establishment and civic infrastructure is putting high pressure on the existing inner-city areas. To solve these issues apart from good planning and design, good governance system, public engagement and empowering citizens play an important role for better city management. To understand the city level issues information about the urban systems to information at a lower scale need to be propelled to the citizens where technology and innovations are the strings linking different sectors. We planners and urban designers are utilizing technology to address the daily works and needs of the people to effectively predict and respond to chronic urban issues to create liveable communities and improving the overall quality of life. Not only provision of good infrastructure and continuous energy supply can make a city liveable but people need to be aware of the facts and the conditions and engage themselves in governance system by giving inputs, ideas and feedback during all the stages of the planning process. The paper will discuss different attributes and components of technology and innovations around the world that has empowered citizens in various sectors for making of better liveable place. This paper is based on the information available in the secondary sources about the application of various citizen engagement platforms such as mobile applications, online mapping tools, tech-enabled solutions, online services, websites, telecommunication system, location-based services and information, etc to enhance urban governance. Through a review of the current relevant literature, observational investigation of publicly opened web portals, applications and tools, this paper systematically highlights some significant findings. The present study suggests technology innovations empowers citizens that enables the entire urban planning process in a more straightforward way for attaining future liveable cities.

Keywords: Citizen engagements; City planning and management; Citizen Science; Information and Communication technology; Urban Governance

I. INTRODUCTION

Indian cities are growing exponentially to meet the ever-growing requirement of its urban population. About 377 million people live in 7935 towns/cities across the country which constitutes about **31.2 %** of the total population **[1].** According to the UN State of the World Population 2007 report, by 2030, **40.76%** of India's population is expected to reside in urban areas. This urbanization causing for demands of new housing, industries, commercial establishment and civic infrastructure is putting high pressures on the existing urban areas. To solve these issues apart from good planning and design, good governance system, public engagement and empowering citizens play an important role for better city management and for future sustainable planning.

Public participation is required at any stage to attain sustainable urban strategies such as improved urban living conditions, for cohesive and inclusive societies but this participation is hindered by the systemic complexity of data, which places several challenges for people's understanding **[2].** To understand the city level issues along with their local community problems, information about the urban systems to information at a lower scale need to be propelled to the citizens where technology and innovations are the strings linking different sectors. Participatory planning involves the entire community in the strategic and management processes of urban planning; or, community-level planning processes for community development. Digital tools have helped to build a bridge between the citizens, researchers, planners, city managers by promoting the participation and collaboration of citizens. Technology innovations are helping to share people's experiences and behavior with the built environment. Innovation is a continuous process and there are infinite citizen engagement tools such as mobile applications, online mapping tools, tech enabled solutions, online services, websites, telecommunication system, location based services and information, software etc. evolving every now and then to interact, gather data, analyse and solve the issues in various sectors for making of better liveable place. All these technology and innovations are run by a government entity or by a private entity which directly or indirectly acts as a helping hand and a support system in governance. All these might not be working in a single window system but they are functioning independently at different platforms, empowering citizens and transforming the urban life. Michael Batty states "By the year 2050, everything around us will be some form of computer. As planners we are accustomed to using computers to advance our science and art but it would appear that the city itself is turning into a constellation of computers" **[3].** The population density of Indian cities is going to increase proportionately in the next decades. To enhance the governance system, the local bodies must adapt appropriate strategies to empower citizens and involve people in the city's planning process to achieve more sustainable communities.

The paper will discuss different attributes and components of technology and innovations around the world that has empowered citizens in various sectors for making of better liveable place. The article summarizes the framework of the relationship between citizens and different stakeholders.

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This paper is based on the information available in the secondary sources about the application of various citizen engagement platforms such as mobile applications, online mapping tools, tech-enabled solutions, online services, websites, telecommunication system, location-based services and information, etc to enhance urban governance.

The goal of this paper is to give field experts and professionals a sight of how digitals tools are used to bridge the gap between citizens and stakeholders for better city management and to encourage them to come up with new ideas and innovations. This article further reveals the interdisciplinary relationship between urban planning and information technology field where there is considerable scope for further research in future. It gives an insight into the gaps and challenges that Indian cities are facing currently and what could be done with the help of technology innovations to improve the urban services.

II. DATA AS INFRASTRUCTURE

Any kind of scientific theory or research needs a little more use of data to give it a concrete base to produce and to sustain it to results. Example even if we look in the history, we can see Greek philosophers Aristotle, Galileo, Aryabhatta collected data based on their observations **[4].** Considering Data as an infrastructure, it needs to processed and analysed to produce it as a collective information to lead it further to be used as knowledge and wisdom (DIKW Pyramid). The standardisation of data and information has had a significant impact on human society until now. Through urban design, the limit of data is expanding faster, where derived information, used to build design knowledge, which at a larger scale we call it information cities through information architecture. Today data is gathered not only from internet but also from the super market receipts, mobile phones, cars, planes and even from electronic devices. Technically data are generated through sensor systems; user generated content, administrative organization, private sectors, arts and humanities, and hybrid sources **[4].**

Data is a symbol in its simplest form, such as words, numbers, codes or tables, when linked together to form sentences, paragraphs, equation, it gives birth to information. Data needs to be protected, stored and its access control is necessary so that information enables us to make decisions to adapt strategies or to better manage risks. All these data when comes to give some information it expresses us about the demand and the usage pattern, the activity and the changes. Data interpretation can be long term and short term to give valid information. Open data is accessible to everyone in order to create knowledgeable, engage creative citizen while also bringing about accountability and transparency. Open data initiatives have the prospective to lead innovations and to address the needs of the disadvantage. On the other hand, we are in an era of putting multiple data to produce it as information. Though the role and the use of it are differently done in different context or cities but it has emerged throughout the world and its spreading within a while. If all the stages are processed in planned way, it can bring a huge positive change in the different sectors of city management by empowering the citizens. Data has now become a city infrastructure and local bodies should maintain proper urban information system which should be analysed at every stage of planning. Data are generated in a large amount everywhere all around us but in a very complex and unorganized way. Digital tools and platforms have the potential to shape and structure the raw data in an organized manner to process it further to produce meaningful information. Yet there is a great challenge due to digital illiteracy, poor infrastructure, lack of coordination among different organisations and all the planning attempts fails when there is a non-availability of data and by the difficulties to process it.

III. DATA, TECHNOLOGY, INTERNET AND CITIZEN ENGAGEMENT

Data, Technology and Internet are all interconnected to each other, when combined together it can change the scenario in the field of urban and spatial planning and city management. The unique nature of ICT is it helps from the scratch level of administration to ground level execution. Now we planners and urban designers are utilizing technology to address the daily works and needs of the people to effectively predict and respond to chronic urban issues to create liveable communities and improving the overall quality of life while protecting the environment. It has its infinite use in today's life starting from management system, transportation system, and better use of infrastructure, energy and urban resources. What we are thinking of smart city, e city, intelligent city or digital cities, they all need data which can be processed to give information with help of service-oriented computing system to take real time decisions in order to maximize the problem-solving capability of the city. New technologies have facilitated new opportunities of involving people in the design process. The combination of crowdsourcing ideas and co-design strategies is called distributed participatory design or mass-participatory design **[5].** In fact, if the information has the capability to empower citizens, we can place ourselves in a better liveable city from an information city, where we are able to see the invisible thus helping to understand the functioning of an interaction between components of the city, and to design new cities **[6]**. There is a dramatic change in the spatial organization of activities within cities and large metropolitan regions as information systems are permitting new combinations of people, equipment and places **[7]**. Citizens tend to engage more when they see that governments are open to interacting and integrating their point of view when formulating decisions and when they have access to useful, relevant, and a complete set of information from the government **[8]**.

IV. CITIZEN ENGAGEMENT AND CITY MANAGEMENT

The impact of technology has brought a tremendous change in the city management. With a start from engaging the citizens in sustainable urban planning, it has made people to adapt technology for a better understanding of the city. People are engaging themselves in more detail, from urban design, architecture and building construction.

Now if we consider the use of technology, it has brought a tremendous change on human behavior with respect to time. Starting from public transport to private vehicles it has come to the detail of a smart watch.

There are multiple factors responsible for the change in the mode of transport. It can be the way it was planned like the people's office, the places he loves to visit, a cafeteria or a public park or it will vary with different age group. For example, the introduction of 'Ola' and 'Uber' services, if seen in details with a range of five-year period a change in the pattern of their route and mode can be seen. Evolution of electric cars and merging it with technology are now our future for the next ten years. The most interesting part is how they would react to it. Transportation is just one area of city life that digital technology is transforming. Technology has now become a part of e-government services, emergency and crime prevention, social services, pollution reduction and environmental sustainability. According to the EIU survey, 36% of respondents cite telecoms services as the digital technology that has impacted their life over the past three years, followed by transportation (cited by 31%), crime prevention (21%) and social services such as healthcare and education (21%) **[9].**

With the initiative of various smart cities mission, there has been a tremendous boost in urban planning and information technology sector. Technology has now started making people concerned and growing interests of their built environment and the surroundings. Not only provision of good infrastructure and continuous energy supply can make a city liveable but people need to be aware of the facts and the conditions and to engage themselves in governance system by giving inputs, ideas and feedback during all the stages of a planning process **[10]**.

A. Conceptual framework

There are various layers for end-user involvement in design processes. These include user-centered design, human-centered design, collaborative-design, participatory design, co-design, co-production, and co-creation. User-centered design and human- centered design generally reflect the consideration of a user without necessarily invoking their involvement **[11].** Local people can understand the problem better and can solve the issue in an appropriate way. For a better responsive city and to reach the city vision it must adopt smart solutions but while engaging the citizens with the professionals, urban designers, urban planners, and city manager it has become a challenge to understand each other's language. In a user-centered approach, design researchers serve as communicator between user and designer **[12].** They interpret the information of the user, often in form of design criteria, and the designer interprets the criteria which are done in the language of sketches or scenarios.

With the inclusion of technology in the urban planning process and city management, rapid urban transformation is going to take place in the coming few years. To make citizen-centric planning successful, the government should look into new alternatives and techniques to involve people in all the process.

The newly developed hardware and software has made advancement in urban spatial planning and city management. As shown in figure 1, technology and innovations have several components such as the Internet(3g,4g,5g), software and applications (mobile applications, websites, online tools, social media), hardware (smartphones, computer, gadgets and devices) that are acting as a mediator between citizens and other stakeholders. Citizens are coproducers of urban information. They transfer data through different platforms such as websites or web portal, mobile applications, online mapping tools, telecommunications to various stakeholders. The data and information shared between the citizen and the stakeholders (government bodies such as development authorities, municipal corporations, private agencies and offices, educational institutions) are helping to cope up different urban issues and effectively managing the municipal services. Software innovation, hardware innovation, high-speed Internet are continuously being upgraded and updated for public services. These data, as received as information to the stakeholders, are used in the urban planning process for making future decisions.

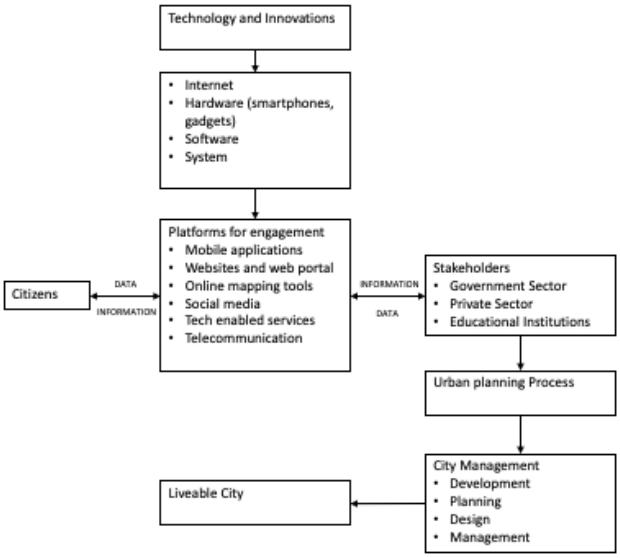

Fig. 1. Citizen engagement and City management ***(Source-Author)***

B. Initiatives and Applications

Whatever we term it as smart city, digital city, liveable city, future city, happy city, the purpose or vision are the same and are focused particularly on citizens only. Active participation of citizens in urban governance is not only the way to help us in achieving the utopian idea of the liveable city. Technology has also helped in spreading different awareness programs, information and education and communication at a very ground level of the society, which in either way is moving forward our cities to reach our goals and target. Technology has also played an essential role in maintaining transparency at all levels of the developmental process as trust and faith between the people and the government are very crucial.

For proper transportation management in a city, the authority must have real-time data within themselves. In metro cities, the situations are monitored live by collecting real-time data. Cameras installed to capture the real-time data in traffic management centers gives visual message so that necessary actions could be taken such as alteration of the route, accident location, rule violations etc.

High-speed internets, new smartphones, tech-based gadgets, electronic devices, are developing simultaneously to go with the technologies to support without which the entire process would have failed.

Multi-language interfaces have helped people to use devices, tools, and applications very comfortably, which have further contributed to communicate and collect the exact data and information from the source.

Educational institutions are also enacting intensive research on tools for active participation of citizens with the local authorities. "Urban STeP - Smart Toolkit for Participatory Approach in Local Area Planning" developed by School of Planning and Architecture; New Delhi, India has developed this web portal and mobile application which aims to bridge the gap between the citizens and the local stakeholders to enable active participation. It facilitates by communicating the opinions and feedback of citizens to the authorities at all stages of local area planning.

Researchers are now coming with new tools to solve this gap. For example, Quick Urban Analysis Kit (qua-kit) as a design tool that enables non-experts to do simple design tasks **[10].** Several online websites have come to engage people in the planning process and to give information about their built environment and surroundings i.e. Maptionnaire, urban observatory. Another example, 'Maptionnaire' is a powerful mapping tool which makes community engagement effective and effortless using digital participatory platform in different phases of the planning process. It includes survey through social media including info graphics and videos in the survey. It has now become an educational tool for citizens **[13]**.

In a country like India, Swachhta mobile application has played an essential role in maintaining cleanliness and has eased the entire waste management process at various levels.

The Swachhta application fuses a time-tested complaint redressal platform allowing the citizens to work together on civic issues with community-centric features for citizens to vote upon complaints, share them with other concerned citizens and comment on completion of the work.

The simple inclusion of GPS feature in the mobile application has helped to track the exact location of garbage dump areas and other civic issues within the city. The app can point the site of the complaint with accuracy using the geo-location of the image for faster resolution of the complaint.

Social media which includes web-based and mobile technologies, turn communication into interactive conversation and are solving problems during natural disasters. Online social networking services and social media like Facebook, Twitter, Google, etc. stay active while other conventional platforms generally stop functioning. Individuals and social media organizations can mutually collaborate for emergency management: mitigation, preparedness, response and recovery. Kerala in India, flood victims used their smartphones or tablets to generate plus codes and shared their plus code (introduced by google), which works in offline mode also, helped to track their exact location with their friends, relatives or rescuers. The plus code pinpointed the exact location and helped to save the time of those conducting rescue operations and the entire management team. Plus codes could be used over an emergency voice call or SMS.

Technology acts as a catalyst in the process or may facilitate the city's daily governance but people need to be smart to adapt those or better concern about the quality of life and protecting the environment. For example, as stated by Huang, "One of the main objectives of the Taipei Cyber City plan was to bridge the digital divide in Taipei City, which proposed three actions to ensure the accessibility of disadvantaged citizens, including giving three hours of basic skill training in the use of the Internet, improving the accessibility of municipal websites, and providing computers to low- income households and disadvantaged students" **[14]**.

New ICT based solutions are developed to track and monitor activities allowing urban quality and wellbeing to be assessed at more fine-grained levels. It is making the invisible acts into visible facts on the scale of a city helping to understand the functioning of an interaction between the components of the city and to design new cities. Citizen science was first used to include both citizen science projects and about user generated content not particularly addressing a scientific process. It's not about collecting data, raising awareness, building capacity and strengthening communities. There are always new challenges to the analytical methods while integrating quantitative and qualitative data from heterogeneous sources. There are various other mediums that help in grass root level of data collection, validating into information and transformed into information and knowledge which either helps in process of better managing the urban system or helps to take the right decisions for solving a particular issue. The implementation of ICT based citizen engagement and participation faces specific challenges in the context of the developing world. **[15].**

Governments across the world are using information technology as a tool for solving urban problems and creating an effective governance mechanism. It has a wide application in different sectors like a) Public service and governance, b) Urban administration, c) Urban infrastructure planning, d) Environment and energy, and e) Public health and safety [**16].**

Table- I: Use of ICT for effective governance

Sectors	***Applications***
Public service and governance	• Delivery of services online • Online building plan approval • Electronic billing • Citizen feedback • Land information system
Urban administration	• Human resource management • Knowledge management • Technology and innovation center • City administration center
Urban infrastructure planning	• Traffic control and management • Safety and security monitoring • Real time maps and guides • Smartcards, road pricing and vehicle monitoring • Electronic billing and payment • Digital metering system • Realtime network condition monitoring
Environment and energy	• Integrated environment measures • Energy networks and grids • Environment resource management • Power quality monitoring • Electric vehicles • Green building, smart meters
Public health and safety	• Real time crime monitoring • GIS health data

(*Sources- ICT in Urban Services, NIUA)*

For example, in Seoul a mobile application named 'Mobile Seoul', where public services are offered on smartphones. It has a feature called 'M-voting', where opinions from the citizens are gathered to facilitate participatory democracy; Other feature includes 'In-formation Open Plaza' where all administrative information is disclosed to citizens **[16].** In Beijing China, Dongcheng District has implemented the pilot program using ICT, such as GPS and GIS technologies for the management of urban infrastructure. Having these types of data available, GIS enables the city to quickly locate where the problems have occurred as well as fix which entity had the charge for resolving each one **[16].** 'Fix my street' in London is a web service to help people report, view and to discuss their local problems with their local council by simply locating them on a map. Citizens can report potholes, broken street lights and similar problems with streets and roads, and see what reports have already been made and also check the status. Later it was transformed into a mobile application for easy access to people **[16].** Open access to London's data is already being used to plan and operate the city. The London Data store which is one of the first platforms to make public data open and accessible, has engaged London's developer community and resulted in numerous apps that help the city to function better **[17]**. The smart London approach aimed at improving the lives of citizens with the principles of openness and transparency, Collaboration and engagement, Technology Innovation and efficiency and resource management.

GIS (Geographic Information System) based mobile application and a web portal could be developed either with crowdsourcing or with the help of the concerned police department to build crime mapping and to mark the hot spot zones that are having the potential threat to the citizens. For example, Users will be provided with a "Suraksha Mobile Application" to provide security measures all over India, which will enable citizens to identify safe and risky zones through Mapping.

- Suraksha Survekshan, a ranking exercise could be taken up by the government to assess their Urban Areas. Based on ranking, strategies to be implemented after analyzing the gaps and weakness. The mission can cover in all cities and towns irrespective of size in area and demography. The task will be assessed after every year with the same indicators and would be marked based on their performance. This mission will reduce the crime rate in the city, which will improve the interaction among people, communication with the police, and a safe pre-plan for any Disasters. This app will enable users to identify the locations and able to map the potential threat through GIS Mapping of Crime Prone Areas and Disaster-Prone Areas. This app will provide quick and accurate location information and dispatch of emergency services. An application, a complaint redressal mobile and web platform to be designed which could help the users to identify RISKY as well as SAFE zones. A mobile app to determine the locations and able to map the potential threat areas within the city.
- GIS mapping of Crime prone Areas.
- Alerts for the user about the criminal prone regions.
- Crime Control
- Quick and accurate location information
- Effective utilization of emergency services
- Immediate dispatch of emergency services
- Real-time locating of Victim's Location
- Handy user Interface to report the incident with location and details attribute.
- Mapping of disaster-prone areas.
- One-stop solution for managing Emergency Services.

For implementation in Indian cities we can empower the citizens through constructing an effective model of science and society. Example, At stage one detailed literature study to be done and will cover several case studies around the world to analyze the detail architecture or different methodologies of technology and Innovations adopted where successful implementation of ICT and citizen science has brought a positive impact in better city planning and thoroughly analyze the interrelation between the components of liveable cities and how technology and innovations has helped in empowering citizens for achieving all the goals. At stage two a comparative analysis between the methodologies and techniques adopted for city management through technology and innovations in Indian context and other successful models used in global cities for citizen engagements and empowerment in sustainable urban planning. At stage three a detailed workflow and architecture to be designed for better data management and providing better urban services covering all the sectors, that can transform the nation through technology powered by digital innovation with the help of government that can benefit the citizens by responding to their different and changing needs, example "Smart nation and digital government Service" of Singapore **[18].** Though it's inherently interdisciplinary theme and will involve inputs from geographers, data scientists, architects, Information technology Engineers, bureaucrats etc. to design the entire architecture and workflow.

There are many software tools used for assessment, performance and analysis in sustainable urban planning projects. ICT tools are often introduced rather late during the planning process and mostly it is used to evaluate the performance with regard to very specific aspects. When used during the project initiation phase, even when the design or use of the area is not yet clear, the tools can be used more to their full potential in the process to formulate the project's ambitions. **[19].** Developments in artificial intelligence, robotics, the Internet of Things, autonomous vehicles, virtual reality, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing are promising a new era of contemporary urban development **[20].**

Where urbanization is at a peak level in India and with failure in 35% of the government projects new initiatives have been taken in 12th fifth year plan 2012-17 which is known as Digital India with an objective to transform India into a digitally empowered society and prepare India for a knowledge future. The three key areas are Digital Infrastructure as a Utility to Every Citizen, Governance & Services on Demand, Digital Empowerment of Citizens **[21].**

Indian cities have also started incorporating ICT based interventions in urban centers under JNNURM reforms., Introduction of system of e-governance using IT applications like, GIS and MIS for various services provided by ULBs. National Informatics Centre (NIC) which was established in 1976, and has since emerged e-Governance applications in government ministries/departments at the Centre, States, Districts and Blocks, up to the grassroots level as well as a promoter of digital opportunities for sustainable development. Different stakeholders from different occupations, service sectors, departments, organizations should be encouraged to work and to take part in implementing citizen-centric approaches to achieve a broader goal.

V. CONCLUSIONS

With the growing population in India and fast urbanization, city management in the coming years is going to be challenging for the city managers and the local administration. Thus, to decentralize the issues we need to empower citizens, for better management in Public service and governance, urban administration, urban infrastructure planning, environment and energy, and Public health and safety, where technology and innovations play an important role in successfully carrying out the entire process of service delivery. We need to focus on capacity building of the professionals, building smart infrastructures, to spread digital literacy for generating a self-consciousness attachment towards the environment they are living in for better sustainable and liveable cities. Better we can interpret the data into information to the citizens, easier it would be to manage. All the process includes citizen involvement or citizen engagement from data collection to final decision-making conclusions but the question arises at how much level these components and attributes of technology and innovations empowers them in taking on the final and right decisions. Tech-based organizations, institutions, startups researching on technology innovations should come across with new ideas and features focusing on empowerment of people to enhance the entire urban planning process and city management. Cities are the most complex objects on earth. The emergence of new instruments with time and the advantage of big data and information technology have helped to simulate and understand these complex systems. For example, crowdsourcing and sensing provide powerful instruments to dynamically influence the design and management of cities. The instalment of sensors has enabled to monitor the day-to-day operations, thus empowering citizens to alert with expected natural or other threats. Though the level varies with different urban system and directly depends on the level of occupancy of the information and the scale it's going to bring the expected positive results. Though India lacks behind in implementing all the tools that have currently used in other developed countries, the best practices could be taken as a model to improve the urban services and further helping to move towards liveable cities. For more organized and substantive participation, participatory e-planning, which is new to way to engage citizens in the planning process should be encouraged more to the general public and to use different digital tools to enhance the urban governance. Imagine if we collect each end every entity's data from the source, we can create a new future.

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