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Application and Prospect of Smart Technologies in Urban Planning

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Abstract:
It is against the background of the compounding challenges of urban planning and the opportunities inherent in their management that are provided by smart technologies that this paper examines the application and prospect of smart technology in urban planning. Drawing from different literature, the paper utilizes a desktop approach to cast light on the areas of application of smart technologies in urban planning. It argues that city managers are exposed to these technologies to achieve instant and accurate city management.

Keywords: Urban Planning, Smart Technology, Artificial Intelligence, Geographic Information System

1.0 Introduction

Urban planning is a complex and challenging endeavour. This is due to thedynamic and complex nature of cities,the intricacies and connectedness of their challenges, and the cyclical nature of their approach. With an expected increase in global urban population by 2050 as well as the expansion of urban areas and its fringes (Samih, 2019), the challenges of managing urban areas will become more laborious in the coming years. The implication of this for urban planners is the need to adopt a system response to the emerging urban challenges.Thankfully, the evolution of smart technologies including Information Technology (IT), Internet of Things (IoT), and Artificial Intelligence (Al)) presents this platform. Smart technologiespossess the ability to address the complex urban challenges throughrepresentation, modelling and projection.

Developments in Information and Communication Technology (ICT) have led to the emergence of new urban activities as well as greater cultural diversity inside cities. It has also redefined the urban space as well as brought to the fore new unprecedented urban linkages. Therefore, as ICT improves, city planners must integrate the physical and virtual worlds to demonstrate their flexibility in comprehending the dynamic complex interactions that are taking place in them (Shiode, 2000; Cohen, 2001; Hamilton et al., 2005). This prompts the need formore learning and adapting these news technologies to achieve a flexible and change-responsive design interventions.

Smart technologies are emerging technologies that aid the connectivity and immediate response between elements and systems. Smart technology is evolving and its application in urban planning – including the achievement and driving of smart cities – is not only growing but becoming more popular. Hence as new areas are popping out for exploration, there is a need to bring its knowledge and application options to city planners. It is against this background that this paper explores the application and prospect of smart technologies in urban planning.

2.0 Methodology

This paper utilizes a systemic literature review approach. A desktop review of review of the literature related to the subject matter was done. First, the keywords of the subject matter were keyed into the google scholar and all related documents were harvested. Thereafter, the harvested documents were pruned considering relevancy in urban planning.

3.0 Smart Technologies in Urban Planning

Prior to the seventeenth century, the major focus of urban planning was the physical organization of activities within urban areas. The urban areas were not only a few, they are small and their activities are

relatively simple. There were little or no challenges associated with their management. As a result, the science of planning was not really emphasized.However, this planning methodology soon became outdated with the emergence of more urban areas and the complexity of activities taking place within them. The need for scientific diagnosis of cities which involves critical assessment, analysis and projection led to the paradigm shift in the planning approach first from idiographic to positivist, and later to structuralist -inthe twentieth century. The emergence of technology and its adaptation in different urban climes has seen the merger of structuralist and technology techniques (Li, 2019; Yeh, 2020). This era which can be revered to as a simulated-technology era utilizes technology to identify planning problems early enough and accurately diagnose the same within a short time.

Significant improvements in the field of information technology have aided the expansion of contemporary urban planning. Smart technologieshave been utilized to achieve various forms of urban planning for more than fifty years. However, when the Information and Communication Technology (ICT) age began, the vast majority of systems, gadgets, and tools were created with the primary objective of achieving a certain goal, with little regard for interaction. In 1990, the introduction of the internet and online services accelerated the creation of a graphically enhanced cyberspace. IT and Al are now inextricably linked to every aspect of life, and they are continually enhancing the effectiveness of urban planning systems (Shiode, 2000; Firmino et al., 2008) and, throughout the last three decades, computers have always supported urban planning and administration. Over time usage and integration of ICT and Al in urban planning are empirically demonstrated in Figure 1.

A growing reliance on high-level IT and Al technologies not only complements contemporary city components but also helps provide another dimension to urban planning for managing socio-economic transformation in cities with some tools and methods. The mixing of real and electronic space results in "Augmented Space." Therefore, traditional urban planning approaches, such as how we use, manage, and plan physical locations in cities, have been altered. It is impossible to overestimate the relevance of augmented spaces in socioeconomic, political, and cultural activities (Cohen, 2001). This is because electronic and physical aspects are intertwined in this scenario, and urban planners should think about new modes and instruments that will fit into the transformed cities. "This is problematic not just because modern cities have reached unparalleled levels of complexity, but also because the idea of 'city' is undergoing a crisis never previously encountered," (Firmino et al., 2008).

4.0 ICT-Urban Planning Interaction and Core Challenges

According to Han & Kim (1989), urban information systems and artificial intelligence (Al) have primarily focused on providing essential information for decision-making as well as more intelligent and effective solutions to urban problems by combining data from various sources using emerging and promising technology. New urban infrastructure known as "Cyberspace" has emerged as a result of increased internet use, bringing unique design and management issues. New planning ideas such as E-city (electronic city), ICT city, information city, and others are on the increase as the ICT industry continues to expand and engage in urban planning. All of these concepts emphasize the interconnected nature of IT and cities. The Artificial Intelligence and Information Technology sectors will largely drive and manage these urban environments.

Urban strategies that include ICT in urban planning are commonly regarded as useful instruments for long-term urban management. A healthy urban environment is a requirement for effective urban development in general, and the ICT industry now plays a critical role in ensuring environmentally balanced economic growth. Furthermore, it is claimed that the exponential growth of ICT in this modern era has had a considerable influence on urban activities. Urban planners should be aware of the situation and how these changes affect urban infrastructure, as well as how to incorporate new methods of Internet planning. Spatial distortion has come from the blending of cultures in today's highly populated cities, as well as modern transportation and information network expansion. Modem urban planners have also responded to the rising concern by establishing and upgrading a variety of supportive technologies, including Geographic Information Systems (GIS), web-based public engagement platforms like E-participation, and so on. These cutting-edge technologies enable a bottom-up participatory planning approach, reducing work and time spent on planning activities, urban infrastructure management, and big data analysis, among other things.

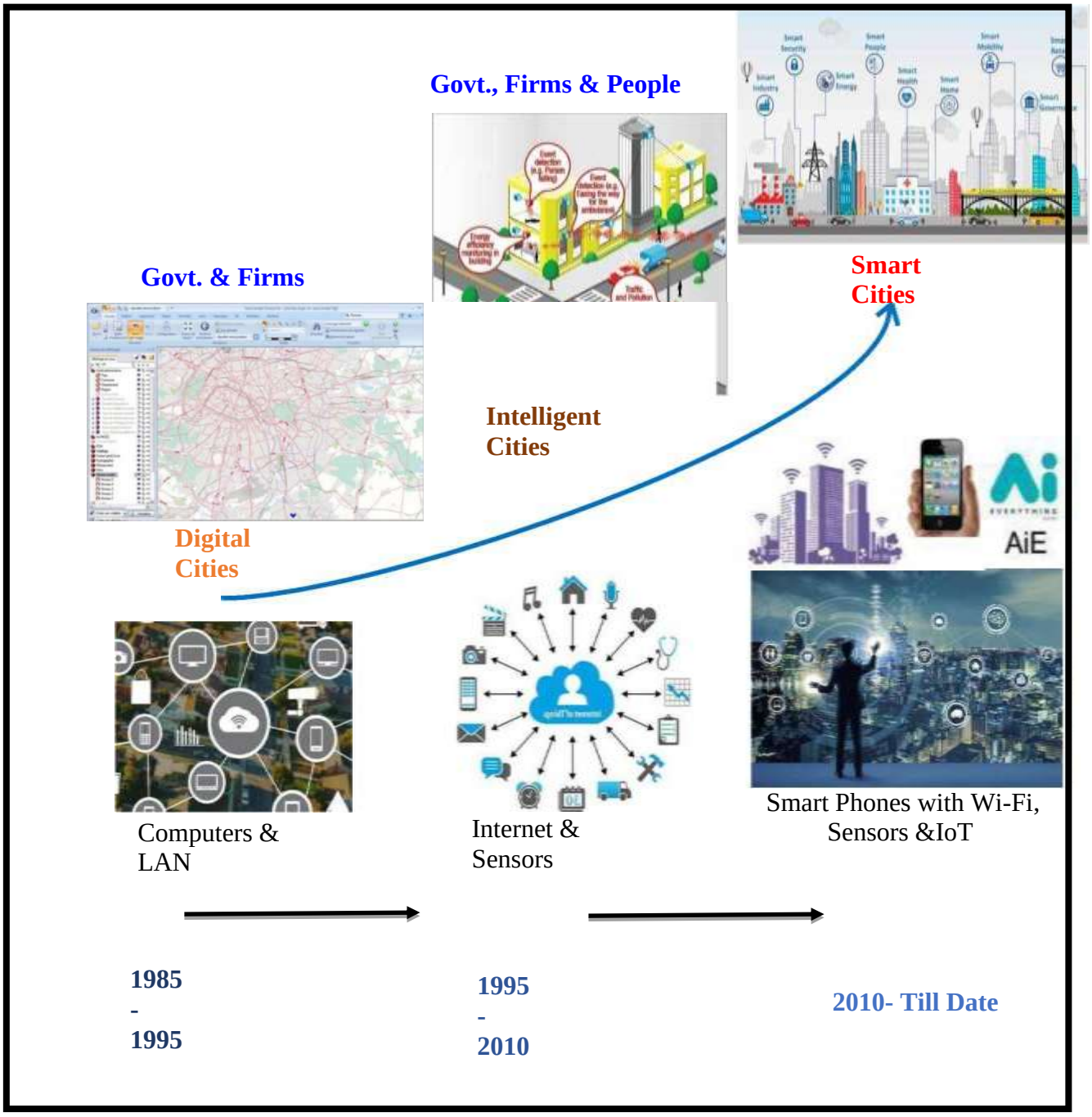

Figure 1: ICT & AI in Urban Planning
Source: Adapted from Yeh, 2020

5.0 Smart Cities: New Sphere of Urban Planning

The purpose of smart cities is to provide solutions that are both efficient and cost-effective. Several governments and private-sector Smart City (SC) projects have resulted in the use of Information and Communication Technologies (ICT) to provide long-term, efficient, and effective solutions to cities' expanding list of issues (Caragliu, Del Bo, & Nijkamp, 2011; Su, Jie, &Hongbo, 2011). Education, health, traffic, energy, trash, unemployment, and crime prevention are just a few of the urgent issues that need to be addressed (Chourabi et al., 2012).The different types of cities play an important role in recognizing and comprehending smart cities. Each city is unique in terms of its size, geographical environment, financial resources, and other things. Such variations have an impact on cities' capacity to handle smart technologies and attract smart city investment. Different physical conditions may also have an impact on the applicability of specific digital technologies (Organization for economic cooperation and development [OECD], 2020).

A smart city is an all-encompassing urban management model that improves control and efficiency, allows participation, and promotes inclusion for all citizens by leveraging and exploiting modern technologies (Adaku& Peter, 2021). A limited perspective of the smart city is to consider it solely in terms of technology and connectivity. In practice and in principle, the smart city is about leveraging technology to help government, citizens, and businesses make better decisions and improve society's functioning and sustainability (Ponting and Yimin 2017).In today's world, smart city technology has been recognized as playing a critical part in attaining sustainable development (Kutty et al. 2020). Many cities throughout the world have used smart technology to improve urban services and infrastructure in order to improve economic and social circumstances, improve the environment, and boost their worldwide competitiveness and attraction (Trindade et al. 2017).Three layers form the foundation of the smart city. These are:

i. IoT (Internet of things)

These are the networked devices and sensors that form the backbone and technical foundation. It's a networked system of physically interconnected devices and products that can communicate and share data. Electronics, firmware, software, sensors, and other components are used to build the foundation. Interconnection, intelligence, and instrumentation are three key features of the Internet of Things (IoT) (Mohanty, Choppali, and Kougianos 2016). IoT devices include things like wearables, smartphones, smart gadgets, and smart home devices.

ii. Analytics

Intelligent applications and data analytics capabilities that turn raw data into actionable insights, signals, and information for end users are referred to as this. Analytics include data mining, modification, analysis, organization, and decision-making. The IoT and governance components are interwoven at this level.

iii. Governance

This is about how data is controlled, accepted, and used to help people live better lives and make better decisions (Ray, 2018). Governance demands making efficient use of data obtained in order to enhance how people work, live, and travel. The city's capacity to bring the two components together and establish regulations to ensure smooth operations is referred to as governance (Mohanty, Choppali, and Kougianos 2016). Smart city governance is described by Meijer and Bolvar (2016) as "creating new kinds of cooperation via the use of ICT to provide better results and more transparent governing procedures." Digital technology and networking form the foundation of the infrastructure. This information is then used to concerns like as urbanization and sustainable development, as well as living, working, and learning environments. One of the smart city's main objectives is to reduce pollution.

The six aspects in which a city should be smart are smart mobility, smart economy, smart environment, smart living, and smart government (Semiz, 2016; Routley, 2018). It covers almost every aspect of local government involvement in urban planning, such as amenities and service supply, energy crisis resolution, urban transportation, democratic transparency, and so on. As shown in Figure 2, sensors, information technology (IT), and artificial intelligence (Al) are at the centre of the transformational process that allows traditional cities to become smart (Almirall et al., 2016; Yeh, 2020)

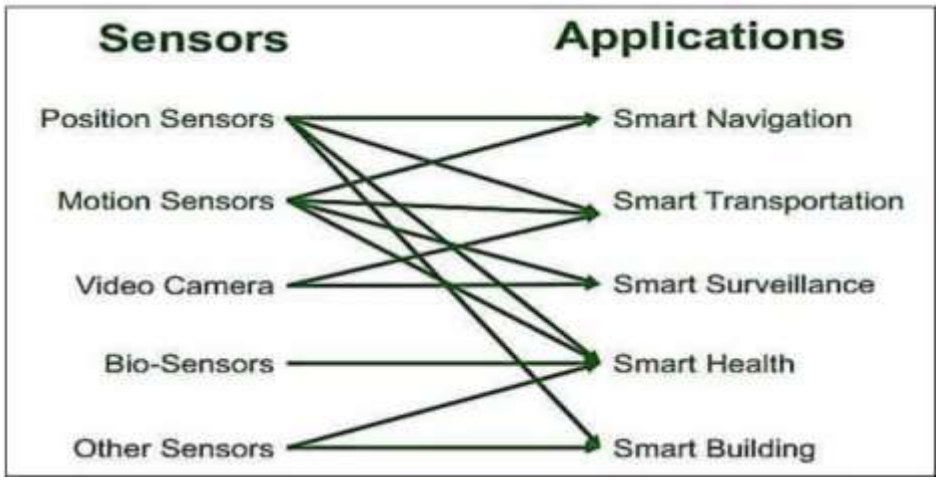

Figure 2: Sensors & Related IT services in the Heart of Smart Cities
Source: Yeh, 2020

6.0 Application of Smart Technology in Urban Planning

The Geographic Information System (GIS) is a contemporary technology that is extensively used in urban planning for managing the geographic position of various places and services, as well as connecting data and information to maps that can be updated on a regular basis (Yousef, 2007). It assists urban planners in accelerating data organization, management, and processing in order to speed up the urban development decision-making process (Aldegheishem&Alqarni, 2012). It has given urban planning a new dimension by contributing to a variety of areas such as identifying different types of land uses, locational distribution of various amenities and services, providing clarity for the city's overall vision to meet future urban needs, and other city management functions. It is a common, quick, and effective method for capturing, assessing, modelling, and displaying geo-referenced information at various stages of urban planning (Criado et al., 2019).

In order to make long-term planning decisions, accurate geographic knowledge is essential. It uses cutting-edge tools and procedures to instantly improve the quality of life and the urban environment. In the face of expanding urbanization, municipal administrations now employ GIS technology to create and distribute spatially integrated information for accurate decision-making. As a result, pushing forward with any type of urban or socioeconomic development without considering the role of GIS in urban planning has become practically impossible. (Al-Humaili, 2005). The applications of smart technologies is further discussed below

I. Democratic E-governance

E-government is a relatively recent notion in urban planning, primarily for the purpose of assisting municipal planning agencies in informing and engaging their citizens. The development of ICTbased e-government tools may improve citizen engagement in the planning process (Healey, 1992; Innes, 1996; Kwan and Weber, 2003). The main goal of this system is to convert traditional file and face-to-face work to a digital platform. Citizens may anticipate benefits from this upgraded egovernance in the form of increased efficiency, greater dissemination of public information, and so on (Kaylor et al., 2001). Urban planners and statutory authorities have both technical and budgetary challenges in implementing e-government technologies (i.e. e-commerce) into the planmaking process (Conroy & Evans, 2006; Lee, 2019).

II. Virtual Reality Technologies (VR)

It's a simulation tool that deviates from reality in unexpected ways. Its contribution to urban development is 3-D modeling of urban environments using computers and advanced visualization techniques, which allows visualizing urban areas in a 3-D graphic environment from various perspectives and approaches; it also allows the prior evaluation of environmental impacts caused to a specific location and aids in urban regional planning decisions. These techniques and solutions improve the task's efficiency and adaptability while reducing the amount of time and effort necessary to do it (Rosindo, 2006).

III. Remote Sensing (RS)Systems

They are technologies that allow for the collection of data from a location or plot without the use of physical touch. Aerial photographs and satellite images are two examples of these systems. They assist in monitoring and managing the disproportionate expansion of cities by detecting changes in the use of soil, identifying the increase of urban sprawl and natural resources, and detecting changes in the use of soil in urban

development.

IV. Transportation

Smart city technology can help relieve traffic congestion and degraded public transportation and road networks. By freeing up time for competent people, ICT has the potential to bring about positive changes and overcome the infrastructural gap, resulting in increased production (Lovitske 2018). In terms of reducing traffic congestion, cities may benefit from intelligent transportation systems. Advanced passenger and traffic management systems, for example, may be able to predict traffic congestion in real-time and suggest other routes to motorists, resulting in greater travel efficiency. A system like this may also provide information to drivers and passengers about the optimal time to leave, traffic problems, weather conditions, and other factors, allowing them to make the best decisions possible. Cities that invest in their transportation infrastructure will reap the benefits of urbanization while also improving their efficiency.

V. Waste Management

The use of IoT for waste management challenges in cities cannot be overemphasised. Waste management is a vital process consisting of different sub-processes such as collection, transportation, processing, disposal, managing, and monitoring of waste materials. Each one consumes a significant amount of time, money and labour. Modern smart cities can optimise waste management processes by integratin a collaborative sensing infrastructure and bear- related costs collectively as suggested in (Perera et al., 2014). Each party can retrieve sensor data in real-time to achieve its own objective. For example, the manufacturing plants can use sensor data to determine the amount of incoming waste so as to optimize their internal processes. Additionally, a city council may use the collected data to efficiently optimize the garbage collection strategies.

6.0 Conclusion and Recommendations

Modern urban planning has a long and illustrious history that dates back to the early nineteenth century. Meanwhile, in the last three decades, the rapid advancement of information and technology has resulted in substantial changes in the traditional urban planning process. In some ways, it outweighs differences in economic status, geographical context, and cultural context in metropolitan regions. By disrupting spatial hierarchies and bringing distant global cities closer together, a new sort of city has emerged as a result of breakthroughs in information technology and improvements in the transportation network. This paper, therefore, advocates the exposure of urban planners to smart technology applications for utilization in city management.

References

Adaku, J.E. & Peter, C.C. (2021) Smart city technology: a potential solution to Africa's growing population and rapid urbanization? Development Studies Research, 8:1, 82-93, DOI: 10.1080/21665095.2021.1894963.

Alizadeh, T. (2017). An investigation of IBM's Smarter Cities Challenge: What do participate cities want? Cities 2017, 63, 70-80. [CrossRef].

Bakici, T., Almirall, E., & Wareham, J. (2013). A smart city initiative: The case of Barcelona. Journal of the Knowledge Economy, 4(2), 135-148. doi: 10.1007/sl3132-012-0084-9.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, 18(2), 65-82. doi: 10.1080/10630732.2011.601117.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., Scholl, H. J. (2012). Understanding smart cities: An integrative framework. 2012 *45th Hawaii International Conference on System Science* (HICSS), Maui, HI, IEEE, doi: 10.1094/PDIS-l 1-11-0999- PDN

Healey P. (1992), "Planning through debate: the communicative turn in planning theory", Town Planning Review, 63, pp. 143-162.

Hamilton, A., Wang, H., Tanyer, A. M., Arayici, Y., Zhang, X., & Song, Y. (2005), "Urban information model for city planning" Journal of Information Technology in Construction (ITCon), 10(6), pp. 55-67.

Hanzl, M. (2007), "Information technology as a tool for public participation in urban planning: a review of experiments and potentials", Design Studies, 28(3), pp. 289-307. Innes J E. (1996), "Planning through consensus building", Journal of the American Planning Association, Autumn, 62, pp. 460-472.

HUAWEI Enterprise. (2017). UK Smart Cities Index 2017 Assessment of Strategy and Execution for the UK's Leading Smart Cities; Navigant Consulting Inc.: Boulder, CO, USA, 2017; pp. 1-72.

IBM. (2017) Smarter Cities: New Cognitive Approaches to Long-Standing Challenges. Available online: https: //www.ibm.com/smarterplanet/us/en/smarter_cities/overview/ (accessed on 4 May 2019).

Kaylor C, DeshazoR,Van Eck D. (2001), "Gauging e-government: a report on implementing services among American cities" , Government

Information Quarterly, 18, pp. 293-307

Meijer, A., and M. P. R. Bolivar. (2016). "Governing the Smart City: A Review of the Literature on Smart Urban Governance." International Review of Administrative Sciences 82 (2): 392-408.

Mohanty, S. P., U. Choppali, and E. Kougianos (2016). Everything You Wanted to Know about Smart Cities: The Internet of Things Is the Backbone." IEEE Consumer Electronics Magazine 5 (3): 60-70.

Ray, P. P. (2018). "A Survey on Internet of Things Architectures." Journal of King Saud University - Computer and Information Sciences 30 (3): 291-319.

Samih, H. (2019) Smart cities and internet of things. *Journal of Information Technology Case and Application Research*, 21:1, 3-12, DOI: 10.1080/15228053.2019.1587572.

Su, K., Jie, L., &Hongbo, F. (2011). Smart city and the applications. 2011 International Conference on Electronics, Communications and Control (ICECC), Ningbo, China, IEEE