Smart City Public Transport Remodel Urban Biodiversity Management

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Abstract. This study seeks to analyse peer reviewed literature focusing on sustainable smart cities and smart transport concepts, and their influence on urban biodiversity. This paper extensively searched databases frequently used by researchers, limiting to articles published between 2016 and 2021, focusing on sustainable smart cities, smart mobility, and urban biodiversity. This study adopts a qualitative methodology and uses systematic review of the literature to explore smart city concepts aimed at conserving biodiversity and positively contributing to urban biodiversity management. A key reason why smart public transport concepts and smart cities have been unable to fully materialize, especially in developing countries, is the obscured definition of these concepts by various studies. This paper’s findings will help urban managers understand smart concept trends that help to conserve urban biodiversity, and this information can be used for practical implementation in smart cities.

1. INTRODUCTION

At the beginning of 2021, cities were home to over half of the global population with an expected addition of 2.5 billion new residents by 2050 (Leeson, 2018). Cities face increased environmental pressures as a result of increased urban population leading to a heightened demand for new infrastructures. Healthy living in cities is reliant on the richness of biodiversity – the myriad organisms in our environment. All our ecosystem services are a consequence of an abundant biodiversity and the former are vital elements for the continued health and well-being of a city and its inhabitants. Sustainability in cities is viewed from social, economic and environmental dimensions, though latter has an overarching influence on the other two. The city can improve on its health and well-being through provision of smart public transport systems that enhance ecosystem services. Public transport is a critical element impacting on urban health. Cities have multiple transport networks, under different management firms and it is important for a coordinated effort to align services with residents’ health. In post Covid-19, smart cities are innovating to thrive in the ‘new normal’, more so in public transportation. Previously, smart city concepts were viewed as intrusive and disruptive to ‘desirable’ urban lifestyles. The 2020 pandemic changed all that and people are embracing smart concepts that mitigate threats of disease infection. Innovative systems are being developed to create liveable environments that promote citizen mental and physical health while still maintaining their connection to nature. Transport nodes in smart cities feature an intersection of numerous providers and there is need to consider how commuters will interact with these services that support a convenient and accessible dynamic transport system (Carnis, 2018). This paper identifies new concepts enhancing biodiversity, and who benefits from the implementation within a smart public transportation system.

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To understand how smart city concepts are impacting on the environment, requires analysis of how urban biodiversity management is occurring in the present.

This research adopts qualitative methodology through a systematic review of the literature, explores sustainable smart cities and smart transport concepts’ and their influence on urban biodiversity management. This study accessed literature from peer reviewed journals published between 2016 and 2021. This paper seeks to build on existing knowledge on building sustainable smart cities.

**Aim and research questions**

This research aims to improve understanding on how smart public transport concepts influence urban biodiversity management. Specifically, the research seeks:

- To explore the relationship between sustainable smart cities and sustainable biodiversity; and
- To identify and interrogate the various smart mobility concepts and their impacts on urban biodiversity.

These specific objectives have been subsequently crystallised into the following research questions:

- What is the relationship between sustainable smart cities and sustainable biodiversity?
- What are the various smart mobility concepts and how do they impact urban biodiversity?

**Rationale**

This paper will offer a new perspective for smart city managers seeking to discover new concepts that improve on health and well-being of citizens. Smart cities are home to intelligent networks, myriad sensors and millions of people accessing services through smart phones. The findings of this paper will help city managers to design urban spaces that regenerate biodiversity.

**2. REVIEW OF LITERATURE**

**Sustainable Smart Cities**

The world is obsessed with everything ‘smart’— e.g. smart phones, smart home appliances and ‘smart clothing’ (latter driven by Internet of Things (IoT). There is a proliferation of literature on smart cities largely focusing on use of technology for sustainability. The concept of smart cities is relatively new and its preference is driven by the urgent need to overcome the challenges of rapid urbanization. Most cities are finding it difficult to accommodate a high number of people and also provide them with fulfilling and healthy lifestyles. Smart cities are premised on granting citizens improved health and wealth through smart technology solutions. This paper, drawing lessons from a pandemic that disrupted urban living, seeks to investigate concepts in public transportation that are improving on urban biodiversity. According to Toli & Murtagh (2020) smart cities are often publicized as solutions for sustainable urbanization. In their study that explores the idea of ‘sustainability’ in smart city definitions, Toli & Murtagh (2020) assert that there exists multiple definitions and these obscure clarity of the term, smart city. Rapid population growth due to urbanization has a ripple effect in resource consumption leading to numerous challenges for cities, and there is an urgent need for a paradigm shift so as to achieve sustainability. In urban settings, stabilization encompasses social, economic and environmental dimensions. The context of this paper is interested in the environmental dimension – influence of smart transport concepts on biodiversity. Toli & Murtagh (2020) paper fails to exhaustively delve into relations between sustainable smart cities and sustainable environments. This paper opines that smart cities, in their quest to improve citizen’s quality of life, can be described as sustainable only if they are designed to conserve biodiversity, which is the most important element for effective ecosystem services.
Elgazzar & El-Gazzar (2017) analysis on successes and failures of smart/sustainable cities offers this study greater understanding on key characteristics that enable cities to remain smarter. These include: sensor-based systems providing real-time data from meters, sensors, and cameras; and inputs from these devices are integrated and analyzed to provide credible insights for decision making. A city’s smartness is based on implementing smart technology solutions that must be backed by a reliable ICT infrastructure.

Bibri (2019) asserts that, smart cities across the world are now embracing big data technologies in urban planning as it offers leverage to achieve desirable levels of sustainability while improving on citizen health and well-being. According to Bibri (2019) big data analytics and related applications provide smart cities with tools for improving urban services, operations, designs, and are the basis of good decision making. Though Bibri (2019) study acknowledges there is consensus among urban researchers and applied urban science professionals on efficacy of big data, there still exists numerous challenges related to finance, social, regulatory, political and ethical dimensions. It is incumbent for city managers to take an active role by brokering privacy and security measures to protect citizens through prudent contractual parameters and procedures.

Munhoz, et al. (2020) investigate the main drivers of increased urban mobility to understand which areas need prioritization. Smart cities require intelligent systems to remain sustainable. According to Munhoz, et al. (2020), improving urban mobility must be realized through sustainable mobility concepts that reduce emissions, with state and civil society being active participants. In their paper, Munhoz, et al. (2020) identify various drivers that encourage smart mobility including; public policies that focus on integrating ICT in transportation, use of bicycles, scooters, intelligent parking and lighting systems, walk ways, and data sharing collaboration among stakeholders. The main problem facing smart cities concerning transportation is governance action (Munhoz, et al., 2020). Bakogiannis, et al. (2019) identify walking, cycling, and public transportation as core elements of smart mobility, which can contribute to sustainable smart cities.

**Smart Public Transport**

Researchers continue to explore smart transportation networks and there is copious literature focusing on pros and cons of these mobility enablers. Intelligent transportation systems use diverse applications to monitor, analyze, and manage transportation systems that improve on efficiency and safety. Smart transportation covers public infrastructure and automotive industry. These two components are viewed as ‘smart’ if they have networked sensors fitted within the infrastructure and vehicles, enabling for remote management, control, enhanced safety and efficiency. Brown, King, & Goh (2020) analysis of smart city projects in 26 cities in the UK found that there is a proliferation of electric car (EV) charging options. Institutions in the UK have taken lead researching and testing connected and autonomous cars (CAM) and this presents urban managers with an opportunity for collaboration to develop local solutions.

Air pollution is a recurring challenge for city managers and medical professionals, more so as the world faces pandemic threats. Urban transportation is the major contributor of environmental degradation and city authorities are relying on state and international policies to check pollution. Lu, Han, & Zhou (2018) identifies with sustainability through smart urban transit models that reduce traffic congestion, offer different transportation modes, and improve on the quality of urban life. Cities must develop optimal transit service and network to effectively deliver smart services to passengers (Lu, et al., 2018). This must be coupled with a convincing marketing policy that will encourage residents to use smart urban transit systems. Lu, et al. (2018) mention ‘sustainable’ urban transit as a consequence of smart transit system, though the paper fails to tie the ‘sustainable’ to concepts improving the environment. Passenger behavior is another vital component that urban planners must never overlook as it enables mapping of route choice and passenger flow (Lu, et al., 2018).
Ogryzek, Adamska-Kmieć & Anna Klimach (2020) discuss four sustainable transport principles that are responsible for an efficient mobility network in cities. These principals were put forward by a University of Oxford scholar. They emphasize the need for city planners to remain innovative as they apply their technical knowledge in transportation systems, as sustainability depends on meticulous implementation of quality systems that will be readily accepted by the public. City planners need to urgently adopt innovative technology, such as eco-friendly engines and alternative fuels and encourage online shopping to reduce road travel, walk-ways and cycling lanes to cut CO2 emissions (Orgyzek, et al., 2020). Sustainable transportation is also based on a hierarchy; at the top are pedestrians who must be the most privileged, next are cyclists, followed by public transport, and lastly, cars. Ogryzek et al (2020) study, while listing principles of sustainable transport, is vague on the influence of environment on the sustainability and there is a gap of literature on use of smart solutions to preserve the environment. Similar to other literature, Ogryzek et al (2020) assert that public participation during planning ensures social acceptation of the new concepts.

Tomaszewska & Florea (2018) identify challenges of urban smart mobility, suggesting solutions for city managers and other stakeholders who are responsible for implementing smart concepts. Their paper adds on existing knowledge about environmental pollution as a result of motor transportation and need for cities to mitigate challenges through developing intelligent transport systems. It is notable that Tomaszewska & Florea (2018) identifies the main actors responsible for developing and implementing smart solutions: scientific community, these are ideally researchers in institutions of higher learning; technology and transport companies, that offer services for a profit; city managers, who implement policy and design spaces. The researchers provide vital information on where to seek answers for our proposed research questions. Their paper’s emphases is on analyzing scientific literature reporting on smart mobility trends. In developed countries, innovations are helping curb air and noise pollution as well as prevent crowding within cities. An overriding concern for urban transport planners remains to ease congestion in public spaces. Tomaszewska & Florea (2018) recognize need for intelligent green solutions and are concerned cities are yet to comprehend the negative attributes of gas emissions due to transportation.

Urban Biodiversity Conservation

Research on biodiversity-human relations in urban settings is still at a nascent stage. According to Zari (2018), urban biodiversity affects urbanites’ physical, mental, cultural, and economic health. Zari (2018) brings forth the idea of Ecosystem Service Analysis (ESA) – a proven approach for applying ecosystem services in urban spaces. This provides our research with an important tool as it seeks to understand which smart concepts are effective for regenerating urban biodiversity. For city managers, ESA is recommended during planning as it ensures smart concepts are a fit for local environment. Urban biodiversity management requires concepts that increase ecosystem services and eventually support the well-being and health of residents (Zari, 2018).

Kilpatrick, et al. (2017) examine biodiversity conservation and its role in protecting public health and preserving ecosystem health. Conservation can be used for public health intervention but these requires substantial investment in disease ecology studies to establish areas where interventions will be most effective. Urbanization presents new challenges as novel pathogens tend to drift from wildlife and this affects human health, the 2020 Covid-19 pandemic presents a good study case for this observation (Kilpatrick, et al., 2017). Their research calls for novel interventions and strategies to overcome the challenges of human encroachment on natural areas, leading to loss of biodiversity. Smart transport concepts in cities are ‘novel’ interventions and our proposed study intends to discover which smart interventions are regenerating urban biodiversity, to be considered novel.

Aerts, Honnay & Nieuwenhuyse (2018) paper seems to draw parallel with our proposed study as both explore conserving biodiversity for improved well-being and health, albeit the formers focuses on relations within nature and green spaces. The authors postulate that ecosystems with substantial levels
of biodiversity are often more efficient and provide a higher number of multiple ecosystem services. Moreover, diversity provides for more resilience against anthropogenic and natural threats particularly in urban areas. This informs on need for smart cities to invest on diversifying their ecology systems.

**Smart Concepts and Urban Biodiversity**

Pham, et al. (2019) examine smart concepts responsible for preservation of urban biodiversity, listing elements that facilitate smart city solutions – collection of data, analysis, reporting, and control. Cepeliauskaite & Stasiskiene (2020) explore the principles of sustainable urban ecosystems, asserting that the latter require an extended platform for collective design and inclusive decision making to ensure collaboration among all stakeholders. Sustainable ecosystems that preserve urban biodiversity retain the following characteristics; persistence, dynamism and autonomy (Cepeliauskaite & Stasiskiene, 2020). The superseding feature of a sustainable ecosystem is to preserve the existing natural resources while providing nature and human beings with equal rights.

Lytras & Visvizi (2018) explore smart city concepts from a unique perspective; citizen awareness and how smart applications work, including user capacity to adapt to these solutions. The scholars see smart cities research as lacking pragmatism. Their article adds on literature that views smart research as suffering from ‘normative bias’, as the provided solutions are never useful or relevant for those they are assigned for. Lytras & Visvizi (2018) study helps to build knowledge on ways of conducting the proposed research. According to Smart cities research must be interdisciplinary for it to remain sustainable.

3. METHODOLOGY

Literature reviews provide the foundation for empirical research. This systematic review makes own contribution to existing academic knowledge. The paper adopts a systematic analysis approach for articles published between 2016 and 2021, focusing on sustainable smart cities, smart mobility, and urban biodiversity. A systematic literature review enhances reliability, quality, and validity of the research. The study uses thematic synthesis to identify themes in the literature, which are clustered then synthesized into analytical themes, latter will be used to answer the three research questions.

4. FINDINGS

Sustainability in smart cities depends on transport systems that conserve the environment. Smart mobility systems are remodelling urban spaces to enhance the biodiversity and this improves on cities’ well-being and human health. The findings of this study are based on analyzing the 16 journal articles published after 2016.

The aim of this study was to improve understanding on how smart public transport concepts influence urban biodiversity managements. A systematic analysis of the literature shows smart cities are using Information Communication Technology; data collection systems, smart traffic lights, flexible pass payment, smart parking, and technological innovation. City managers are using smart concepts to reduce gas emissions and ease congestion in urban spaces.

The study also sought to understand how these smart concepts are remodelling urban biodiversity. Systematic analysis of the literature and there is absence of data showing relation between smart mobility concepts and their influence on biodiversity. A notable trend in the literature is focus on marketing the smart concepts to encourage public participation and also to educate users.
5. DISCUSSION AND CONCLUSION

The emergence of smart cities was occasioned by urgent need for cities to remain sustainable even as population grew exponentially. Various actors in research, business, and policy making are investigating ways that ICT-enabled solutions can be used in cities to enhance ecosystem services through conserving biodiversity. Sustainable smart cities are a popular topic for researchers, urban planners, and residents. The 2020 Covid-19 pandemic came with new realities and city managers must discover ways to reduce emissions and ease crowding by adopting smart mobility concepts. This systematic review reveals that there is absence of literature on use of smart mobility that supports urban biodiversity management. From the findings of this paper, it is important for urban managers, researchers, and tech firms to develop smart mobility concepts that enrich ecosystem services through preserving urban biodiversity.

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