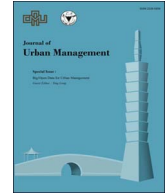


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Journal of Urban Management

journal homepage: www.elsevier.com/locate/jum

Research Article

Assessing smart infrastructure for sustainable urban development in the Lagos metropolis[☆]

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ARTICLE INFO

Keywords:

Smart infrastructure
Urban sprawl
Informal settlement
Sustainable development
Urban regeneration

ABSTRACT

The challenges of sustainable urban development increases daily and the usual planning approaches to ameliorate these challenges are ineffective. This study assesses the applicability of 'smart infrastructure' to achieve sustainable urban development in Lagos metropolis. The study theoretical framework is based on 'smart' principles. The study adopts a mixed method of data collection and analysis with multi-stage sampling techniques of 460 households in six communities of Eti-Osa and Ikeja local government areas of Lagos metropolis. The objectives of the study were to examine the socioeconomic characteristics of the residents and assess the infrastructure, the building uses and the environmental conditions of the study areas in relation to smart principles and smart infrastructure application in the study areas. The data were analyzed using inferential statistics and the findings reflect that the building use is sprawl development in nature with the informal settlement and infrastructure inadequacy as the major challenges. Smart infrastructure approaches are identified as applicable for achieving sustainable development in the study areas with smart interventions in socioeconomic status of the residents, the environment, the building uses and the basic facilities and services in the study areas.

1. Introduction

Sustainable urban development is associated with various challenges, among which infrastructure and urban sprawl developments are significant challenges globally (Soyinka, 2014). Infrastructure challenges are global and it was identified as one of the major determinants or measures of adequate and good urban settlement (Aigbokan, 1999; Otegbulu, 2011; UN-Habitat, 2015a, 2015b). Urban sprawl challenge is the horizontal growth of a city's physical structures with associated growth patterns that present major urban challenges in both developed and developing countries (Adetokunbo & Emeka, 2015).

Wackernagel, Monfreda, Erb, Haberl, and Schulz (2004), states that human deplete their natural resources, biophysical and human potentials more than required and this create environmental degradation. (Zhang, Wu, Skitmore, & Jiang, 2015) also, notes that national development wealth and human resources are depleted, sustainable environment are destroyed daily and the people's standards of living are falling by the day globally, with a diverse threat to life. The global challenges of infrastructures are inadequate and over-utilization of basic facilities and services, abuse and miss-management of infrastructure facilities, and majorly the challenges of urbanization and urban sprawl which creates environmental chaos (Abiodun, 1997; Aigbokan, 1999; FAMILONI,

[☆] Peer review under responsibility of Zhejiang University and Chinese Association of Urban Management.

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<http://dx.doi.org/10.1016/j.jum.2017.01.001>

Received 5 October 2016; Received in revised form 3 January 2017; Accepted 6 January 2017

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2006; Gandy, 2006; Timmermans & Beroggi, 2000).

Adeyeye (2010) also states that the current metropolitan growth in Nigeria is characterized by urban sprawl and informal settlement that encourages haphazard population growth and the available competence is inadequate to ameliorate these challenges. Illegal structures, slum development, and informal settlements are the typical features of the Lagos metropolis and other developing countries. By 2010, it was obvious that the local councils in Lagos metropolis could no longer cope with refuse collection and disposal strategy, flood management, traffic congestion and other environmental responsibilities that arise from urban sprawl and informal settlement in the city. Loss of life and property, urban insecurity, informal settlement and slum developments are the physical features of Lagos metropolis and other kinds of these settlements globally (ARUP, 2014; Solis, 2012).

Considering the severity of these challenges globally and the study area, there is a need for development approaches such as smart concepts, virtual city development, and other intervention mechanisms that can ameliorate the challenges of urban settlement and achieve sustainable development. The quest to provide solutions to this spatial development challenges and achieve sustainable urban development in developed and developing countries has created innovative ‘smart development’ thinking across the globe. Smart development is described as the physical development philosophy and planning activities that create efficient land use development, infrastructure adequacy and sustainable environment that are technologically driven (Howard, 2002).

Thus this study assesses the application of smart infrastructure concept for sustainable urban development in the Lagos metropolis so as to identify a way forward for Nigerian cities and other developing countries that are burdened with the challenges of infrastructure and sprawl development, with the view to identify actions that will ameliorate this challenges and promote integrated sustainable infrastructure development.

2. Literature review

‘Infrastructure’ is a network of interrelated basic facilities and services that provides an adequate environment for human living. A city infrastructure is a system of connected utilities, basic facilities, and services of that city, from the smallest units of the community (houses) to the significant city structures and buildings that render services such as electricity, sewage and sewerage and water supply. Infrastructures can be physical, social and economic (O’Grady and O’Hare, 2012). Smart infrastructure is an interconnected network of basic facilities and services with efficient land use pattern, transportation network with coordinated information technology devices (Litman, 2003). The smart concept is an urban design principle and practices that promote efficient integrated basic facilities and services with real-time information communication technology (ICT) so as to achieve sustainable development. The concept of smart infrastructure is derived from the concept of smart city and smart city is described by several literature as a comprehensive system with different elements such as the people, governance, environment, economy, mobility and the living conditions of a given geographical space with efficient ICT that promote smart sustainable environment (Anthony, 2001; Belanche, Casalo, & Orús, 2016; Danielsen, Lang, & Fulton, 1999; Edwards & Haines, 2007; Isa, Dodo, Ojobo, & Alkali, 2016; Miller, 2016; O’Grady & O’Hare, 2012).

The concept of smart infrastructure is an approach that is contemporary in urban planning and design for sustainable infrastructure development because of its integrated ICT approach adopted for sustainable development (Meijer & Bolívar, 2016; O’Grady & O’Hare, 2012; Vanolo, 2013). According to (Miller, 2016), applying the smart concept in smart infrastructure ‘include the use of real-time information and the integrated evolution of urban form, multi-modal transport networks that are cost-effective, efficient, adequate and equitable for movement of the people, goods, and services in a more social, environmental, and physically sustainable area over a long period of time’. It also includes the integration of all real-time information and activities with a viable effective technology to promote sustainable living. The universal perspective of smart infrastructure concept in any settlement or urban development is described according to Figs. 1 and 2 below to include six basic elements such as; governance, people, environment, economy, mobility and the living condition of the people, which are inclusive in its definition and is described as a system. Figs. 1 and 2 illustrate the concepts of smart city and smart infrastructure as applied in this study and which is described as a system of several elements that are integrated with effective functioning technology (ICT).

Smart cities are described by different authors in different ways, but most definitions include six basic elements which are similar in most literature and are identified in Figs. 1 and 2 above (Meijer & Bolívar, 2016; Vanolo, 2013). The Figs. 1 and 2 above describe smart infrastructure as the integration of different element in a settlement with the aid of technology (Caragliu, Del Bo, & Nijkamp, 2011; Miller, 2016). This study adopts the smart infrastructure concept as described above as the research framework of this study and its application is discussed in section 2.2 aspect of this study below for the assessment of smart infrastructure for the sustainable urban development of Lagos metropolis.

Infrastructure in Lagos metropolis is a significant challenge that poses a social, economic and physical threat to sustainable living (Oduwaye, 2009). The situation of smart infrastructure in Lagos metropolis according to (Fadare & Oduwaye, 2009) and other literature shows that smart infrastructure in Lagos metropolis is a mirage and the condition of infrastructures such as road, drainage, electricity and other infrastructure is described as appalling with ugly environmental sights, slum areas, poor electricity, poor sanitation, inadequate and inappropriate use of open spaces, informal settlement, unorganized commercial areas and disjointed transportation system. The study of (Fadare & Oduwaye, 2009) advocate rebranding the Lagos metropolis through regeneration of the city with heavy investment in modern infrastructural facilities, especially electricity supply, roads, bus rapid transit (BRT) and railway system based on the evidence of severe infrastructure challenge in the metropolis. The study concludes that the “Lagos metropolis infrastructure is classified as very low in terms of her economic infrastructure, social infrastructure, physical infrastructure and other global quality indicators for sustainable development” (Fadare & Oduwaye 2009. pg. 797).

The study of (Bansal, Shrivastava, & Singh; Belanche, Casalo, & Orús, 2016) identified several urbanization challenges and

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