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Sustainability guidelines to attaining smart sustainable cities in developing countries: A Ghanaian context

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ABSTRACT

Urbanisation of cities are fraught with several challenges. Smart sustainable city concepts (SSCC) present means to solve these problems. Therefore, over the years, researchers have been studying frameworks to adopt in the formation of smart sustainable cities to solve urbanisation challenges. In this study, a conceptual framework for controlling urbanisation challenges to implementing SSCC in developing countries is presented. The study adopted positivism research philosophy using deductive approach. Principal component factor analysis was used to analyse 76 responses retrieved from a purposive sample. The emanating results generated four components which serves as sustainability guidelines to achieving smart sustainable cities in developing countries. The primary importance of this study lies in providing a framework to enhance the implementation of SSCC in developing countries. This study adds value to the smart sustainable city literature by highlighting strategies for improving cities' smartness and showing key sustainability guidelines required for the attainment of a smart sustainable city in a developing country. The study also brings to light deficiencies in urbanisation in developing countries and provide paths for future research, where it was indicated that future research opportunities lie in improving enabling structures in cities and developing comprehensive measurement tools for determining and controlling urbanisation in developing countries' cities. For the world of practice, the study offers a readily available framework that captures how urbanisation challenges could be conceptualised and solutions could be provided towards the implementation of SSCC in developing countries.

1. Introduction

The process of urbanisation preferably should be geared towards provision of economic and social transformation – an easy way of meeting citizen's needs, improving social cohesion, and maximising resources [57,64]. However, rapid and unplanned growth impedes sustainable development and acts as anathemise to enjoying the benefits of urbanisation. Therefore, in order to circumvent urbanisation problems and enhance its benefits, the smart city concept has been proposed [17,20,24].

Smart city is defined as the congenial integration of physical, Information Technology (IT), social, human systems, and business infrastructures to obtain a collective intelligence, and with the apt use of all interconnected information available; helping for better understanding, better control over operations and better optimisation of limited resources ([34]; Department of Business Innovation and Skills [21], 2013; [58]. Anthopoulos et al. [5] defined smart city simply as the innovation (not predominantly Information and Communications Technology (ICT) – based) that coordinates and manages the six dimensions in the urban space (mobility, environment, economy, people, government and living).

It is irrefutable that the creation of smart cities and ensuring their sustainability from onset could help solve urbanisation problems and leads cities towards sustainable development [20,35,70]. However, the rate at which cities in developing countries are becoming urbanised and the propensity of burdening urban structures due to uncontrollable rural-urban migration and lack of requisite plans to regenerate ageing structures propels the need to think of sustainability of city structures during their formation [8,28,64]. Hence, the introduction of smart sustainable city concepts (SSCC) in developing countries should not only seek to improve the structures in the cities (mobility, environment, people, living, economy, and governance) towards smartness, but also develop the requisite guidelines needed to enhance longevity, resilience, safety, inclusiveness and sustainability [24,62,69] (Table 1).

Hollands [37] postulated that the understanding of what constitutes SSCC is difficult to grasp in literature. This is because the SSCC is novel, and its application could have different meanings in different contexts [12,17,55]. For example, what may be considered as smart and sus-

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Table 1
Urbanisation challenges and sources.

Challenges	Sources
Poor health, urban sprawl, air pollution, scarcity of resources, waste and poor infrastructure arise, Traffic congestion, increasing social inequality	Mahmood [49]; Kim & Han [41]; Rana et al. [59]; Aghimien et al. [1]
Unemployment, greenhouse gas emissions, and degradation of ecosystems and green areas	Mahmood [49]; Danaan [19]; Antwi-Afari [6]
Poor waste Management, high energy consumption, poor educational system, pressure on houses, increase in social vices	Marceau [50]; Monzon [53]; Nautiyal et al. [56];
Threatens sustainable development, deficiency in infrastructure development, stacked growth, inability to implement policies	Chourabi et al. [17]; UNDESA, [64]; Bibri (2019)
Tendency to lock-in current form, social alienation, change in urban and traditional family relations, vulnerable climate change, financing new infrastructure and public services	Nam and Pardo [55]; Catney and Doyle [13]; Chourabi et al. [17]

tainable in a developing country may not be appreciated as such in a developed country due to circumstances such as the needs of the people, the perceived importance of the innovation and culture of the place [4,14]. Therefore, there is the need to create a framework which could fit within a specific study context and could be adopted to improve the implementation of SSCC [68]. This study, therefore, presents a conceptual framework for implementing SSCC in developing countries, the case of Kumasi city. The study develops this framework by first, identifying the challenges of urbanisation in developing countries; second, assessing the available means to overcome these challenges and last, proposing guidelines to enhance the implementation of SSCC in developing countries cites.

2. Theory

2.1. The urbanising world: challenges in the face of improvement

The population of the world have skewed towards urban other than rural with about 54% of the world population living in urbanised areas [64]. As of 2014, in northern America, 82% of the population lived in urbanised regions, in Latin America and Caribbean, 80% of the population lived in urban areas, while the population of people who lived in urbanised regions in Europe were around 73% (ibid). However, as of 2014, in Asia and Africa, majority of the population were residing in rural regions as compared to urbanised areas. It has been purported however that by 2050 the rate of urbanisation in Asia and Africa will surpass the urbanisation rate in other continents by nearly 90% [63].

This swift pace of perceived urbanisation of developing countries comes with its own challenges. In Ghana, policies developed during the colonial period, and those machinated after post-independence have resulted in significant changes in Ghana's population and urbanisation [32]. As a result, Ghana has moved from a rural dominated populace to an urbanised country subject to the 2010 housing and population census report which described that more than half of Ghana's population (50.9%) live in urbanised areas in the country [28]. This has resulted in high traffic thronging, air pollution, high energy consumption, poor waste management and pressure on houses within the urbanised conurbations [28]. In Nigeria, the rate of urbanisation is in all time high due to the rapid increment in population causing high concentration of people in cities which puts pressure on the limited available resources [1]. In India, to improve urban mobility, healthcare, energy supply and generate affordable housing for its ever-increasing population, the government has adopted a smart cities initiative since 2015 to renew, extend and develop new areas in the country [67].

The rapid shift of the population of developing countries toward urban is rather creating an immature imbalance between the rural sector and urban region. This uneven spatial distribution of population has been purported to come with challenges such as urban thronging, urban sprawl, urban poor, unemployment, environmental degradation and poor infrastructure [28,41,49,56]. Rana et al. [59] opined that urbanisation in developing countries could have the propensity of resulting in poorly educated individuals due to the premise of not having enough good educational institutions in the cities. The existence of more uneducated people in cities also may present a crucial challenge for the attainment of smart sustainable cities and could lead to increased social vices, stacked economic growth and unemployment [19,49,60]. Developing countries' cities have the tendency of been locked-in current form due to the potential of development decisions being influenced by post-politics, the need of high capital for smart sustainable city projects and the presence of embargoes and sanctions from international relations which encumber any form of development for these countries [13,17,55] (Table 1).

2.2. Solving urbanisation crises: the birth of smart city concept

The smart city concept became an area of interest during the late 20th century when the phrase was coined to mean the development of urban regions toward innovation, globalization and technology [29]. Ever since, the smart city concept has been evolving. The International Business Machines (IBM) popularised the smart city concept in 2009 as the corporate initiative of Smarter Planet [39]. The central motive for the propagation of smart cities by IBM was criticised by scholars as a vendor marketing campaign approach with tenuous impact to urban innovation [36,55,61].

However, today, the concept has transcended beyond its initial ideology to provide solutions to numerous urban challenges through the use of technology [48]. Mitchell [52] and GeSI [26] opined that smart cities could assist in lowering the effects of greenhouse gas emissions and energy usage in cities. Zanella et al. [70] also proposed that the adoption of smart cities could help in better usage of public resources, better increment in quality of life and services rendered while keeping operational cost of public administrations down. Smart cities could also enhance transportation within cities and accelerate movement of the general public, hence reducing traffic congestions [65]. Smart cities could also ameliorate progress in areas such as energy production, mobility and transportation, ICT, and closely link and create several interdisciplinary opportunities to improve services while reducing energy and greenhouse gas emissions (ibid). Therefore, smart cities could be viewed as the potential solution to sustainable development of urban conurbations leading to enhanced urbanisation [20,35].

Irrespective of the benefits of smart city concept to solve urbanisation problems, understanding the make-up of a smart city is equivocal and it means differently to diverse range of people [2,17,37]. For instance, Caragliu et al. [12] posited that smart cities are about people, institutions and technology. Meijer and Bolivar [51] explicated that smart city concerns with smart people (focusing on human resources); collaborations (focusing on governance), and technical (focusing on technology). Harrison et al. [34] were of the view that the smart city concept is all about leveraging city structures to maximise collective intelligence. Washburn et al. (2010) also argued that smart cities are about creating a more suitable, clever, interrelated and efficient infrastructure components and services through the use of smart computing technologies. Giffinger et al. [30] also developed a comprehensive idea of defining smart cities by using six dimensions (characteristics) in urban space (mobility, economy, environment, people, governance and living) to describe what a smart city is. The fuzzy nature of smart city concept leaves several basic questions still unanswered. For example, how do we conceptualise the smart sustainable city concept for developing countries; by what measure could we improve the urban structures in cities, and what strategic ways could smart city concepts leads to urban sustainability [34,65,69]?

2.3. Smart city framework and its adoption in developing countries

Yigitcanlar et al. [69] opined that a city cannot be called smart if it is not sustainable in the first place. However, one main difficulty of the smart sustainable city concept is to understand which dimensions are needed to determine whether a particular city is smart and sustainable. Several studies have formulated ways of determining the smartness and sustainability of cities. For example, Giffinger et al. [30] adopted a six-dimensional framework to classify medium-sized cities in Europe towards smart city development. These six dimensions consists of considering cities' mobility, environment, people, living, governance and economy. Also, Zygiaris [71] developed a comprehensive measurement system using six layers to determine a smart and sustainable city which comprises of city layer, green city layer, instrumentation layer, innovation layer, open integration layer, and application layer. Lazaroiu and Roscia [43] came out with a smart city index which was used in the distribution of funds for European 2020 strategic plan. Lombardi et al. [47] improved the triple helix model (universities, industry and government) by adding a fourth model (civil society) to enhance knowledge-based innovation in SSCC characterisation. Other compelling frameworks and indices have been developed by several institutes such as the global power city index by the Japanese Institute for Urban Strategies; Smarter Cities Ranking by the United States Natural Resources Defense Council and digital economy ranking by economist intelligence unit [3,4,40].

Ghana is a developing country in Africa with Kumasi city being it largest city in terms of population (1.73million) [27]. The population size of Kumasi makes it qualified to be classified as a medium-sized city (1 – 5 million people) [64]. The six-dimensional framework proposed in determining the smartness and sustainability of medium sized cities in Europe could be adopted for the case of Ghana because it focuses on the actual elements in cities which needs improvement such as people, environment, economy, governance, living and mobility. Therefore, in conceptualising smart sustainable city framework for developing country's cities such as Kumasi city, the six dimensions in urban space proposed by Giffinger et al. [30] could be adopted. This six-dimensional framework has been used by several other studies [4,47,71]. As a result, it uses fit into the context of the study. Therefore, there is the need to determine the sustainability guidelines which could be implemented along these six dimensions in urban space to enhance understanding of what a smart sustainable city should be in a developing country.

2.4. Smart sustainable city concepts for improving urban structures

Aoun [8] opined that one of the best ways to improve sustainability of cities is to implement efficient, cleaner and sustainable operations while minimising environmental footprints. For example, mobility in cities could be improved through the adoption of renewable energy vehicles and the usage of computer vision, light detection and ranging, and other sensing technologies on public transport to control traffic and improve travelling efficiency [15,33,60]. Lee et al. [44] stressed that smart sustainable cities could be obtained by adopting effective public private partnerships, shaping value added business models, and incorporating emerging technologies into smart city systems. Eremia et al. [23] and Chhaya et al. [16] also purported that smart grids could be developed in cities to help maintain high standards for energy consumption and lead to the creation of smart sustainable energy through the practise of smart metering and efficient public lighting. Lee et al. [44] opined that green technologies could be implemented to transform the urban space towards sustainability. Adopting an efficient, reliable and low carbon technologies could lead to the transition of a carbon free economy where resources could be used judiciously while leading the whole city towards sustainable development [10,11].

Vanolo [65] assayed that to ensure sustainable development of smart cities, there must be clear set of rules and roles, which should be non-conflicting but compatible in achieving established goals along the triple bottom line of sustainable development. For instance, policies should be put in place to incorporate resource efficiency in city formations, regenerate ageing districts, ensure robustness of systems, and incorporate design and planning in symphony with the environment [8,17,69]. Also, mechanisms should be created to enhance autonomy and administrative control of inhabitants in smart cities [65]. Ling [46] reckoned that by implementing proper planning and management of population within a limited environment, there is the opportunity to improve health and economy of the population through proper monitoring and accountability tools. Government must therefore endeavour to share urban growth equitably and sustainably, ensure open and transparent governance and involve citizens in its decision making [64].

Cities must be ready to go beyond technology and adopt a new level of complexity where SSCC could provide an enabling environment for continuous learning by investing in human capital and improving educational lag in cities such as ICT, digital and technological skills [37,42,[69]. There must be the willingness to obtain and maintain data for the city to assist government officials in predicting accurate, reliable and appropriate urbanisation trends, and developing policies to promote comprehensive and impartial urban and rural development [64]. Also, smart sustainable city must be prepared to incorporate internet of things (IoT) principles in its urban fabric and improve the smartness of built infrastructures and other connected devices in cities [17,61].

3. Methods

The positivism research philosophy which informs the use of deductive reasoning was adopted for this study [7,22]. To achieve the objectives of the study, survey research strategy was used [18]. Close-ended questionnaire was developed based on factors obtained from literature and considering the context of the study. The questionnaire was sent to the respondents of the study within Kumasi city who were identified using the purposive sampling technique. Purposive sampling technique was adopted for the study because of the novelty of the SSCC which could be well-interpreted by experts in the area. Also, Babbie [9] asserted purposive sampling technique should be used when one wants to study a particular cultural setting with knowledgeable experts within the area of study.

The respondents for the survey were purposefully selected as experts when they could pass all these criteria. A respondent should be working in an organisation which has a link of influence in the urbanisation of cities; should have expertise and performing daily duties in any of the systems in the urban space (mobility, education, finance, governance, environment); should have experienced or familiarised with the SSCC and should understand urban sustainability and urbanisation challenges. These criteria were created to ensure that only experts who understand SSCC were contacted and chosen for the survey. This was held firmly because according to Kumar and Dahiya [42], smart cities require the expertise of officials who understand the six dimensions in urban space (mobility, environment, living, governance, economy, and people). Therefore, a total of 95 respondents were targeted purposefully of which 76 (80%) were retrieved. The response rate was considered appropriate according to the affirmation from Moser and Kalton [54] that the results of a survey could be considered as insufficient and biased if the return rate is lower than 30 – 40% of the totals sampled or distributed.

The questionnaire was divided into two main parts. The first part of the questionnaire covered the background information of the respondents. This consisted of questions such as area of expertise, and number of years of working in current positions. A nominal scale was used for this part of the questionnaire. The second part of the questionnaire considered the factors for sustainable development of smart cities in developing countries. A five-point Likert scale was used to measure the respondents' understanding of the significance of the factors to ensure sustainable development of smart cities in developing countries. An appropriate rating was provided from '1′ – not significant to '5′ – very significant.

The background information of the questionnaire was analysed using descriptive statistics. Principal component factor analysis (PCFA) was used in analysing the second part of the questionnaire which dealt with the factors for sustainable development of smart cities in developing countries. PCFA was used because according Williams et al. [66], factor analysis could be adopted when one wants to improve measures, check validity of variables, test hypothesis, develop and improve scales, reduce variables and understand inherent characteristics. Cronbach's alpha coefficient test was used to check the internal consistency of the variables and reliability of the scale. The Statistical Package for Social Science (SPSS) version 25 was used to analyse the data in this study.

4. Results and discussions

The area of expertise of the respondents were mainly in the field of governance (7.9% of the 76 responses retrieved), environment (27.6%), infrastructure and planning (43.4%), business and finance (11.3%) and education (27.6%). These fields of expertise cut across the six dimensions in urban space needed for the conceptualisation of the SSCC. Hence, efforts were not given to level up the different fields in the respondents because understanding of concepts in any of the six dimensions is not correlated to experience in one field only, but rather a well-integrated grasp of the entire six dimensions [42]. It was also identified that 76.3% of the respondents had worked in their current position for at most 10 years while 23.7% had worked for at least 11 years with 5.3% of these 23.7% having worked over 20 years in their current position.

4.1. Analytical tests

Howland and Wedman [38] asserted that Cronbach's alpha coefficiencies of 0.700 or more are those with very high reliable scale. The Cronbach's alpha co-efficient value of the variables in the second part of the questionnaire was 0.960 for 25 number of items. Hence, showing that the scale used for the study was very reliable. According to Field [25], PCFA is appropriate for analysis when the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity is greater than 0.500 and the significance values is less than 0.05 respectively. After analysis, the KMO measure of sampling adequacy for the variables in this dimension was 0.880 and the Bartlett's Test of Sphericity had a significance value of 0.000. Hence, showing that variables in this dimension are not an identity matrix, and employing PCFA as the tool of analysis would be appropriate.

The Guttman-Kaiser eigenvalue rule method was used for factors extraction in this study. According to the eigenvalue rule, eigenvalues are fixed at one such that components are retained in the analysis if the eigenvalues extracted are greater than one [31]. Table 2 shows four components extracted (had eigenvalues more than one) which cumulatively explain 67.93% of all the total variances in this dimension. The four components are proven to be substantial based on the avowal of Field [25] who asserted that factors extracted should explain at least 50% of the total variance in any dimension (Tables 2 and 3).

4.2. Findings

Table 2 shows the four components which were extracted after the PCFA. The components' column shows the number of components extracted. Component one had an initial total eigenvalue value of 12.76; component two had an initial total eigenvalue of 1.84; component three had an initial total eigenvalue of 1.28, and component four also had an initial total eigenvalue of 1.10. After rotation, it can be deduced from Table 2 that component one retained 22.59% of the total variance in this dimension, component two also retained 17.60% of the total variance in this dimension, component three and component four retained 16.42% and 11.32% of the total variance in this dimension respectively. Cumulatively, the four components explain 67.93% of the total variance in this measurement.

By inspecting Table 3, it can be deduced that ten factors loaded on component one, with the highest loading been 0.832 i.e., incorporating the IoT principle. The least factor loaded under component one was developing an effective public private partnership which shape models, add value and incorporate emerging technologies in smart city systems (0.435). Field [25] was of the view that factors loadings below 0.300 are those which have low collinearity to be regarded as important and to be considered as part of the variables under a certain component. Therefore, inspecting Table 3 again, it can be deduced that all the variables under the four components had factors loadings greater than 0.300. Hence, they can all be considered as important for further discussions.

The highest loaded factor for component two was development of smart grids and usage of smart metering to ensure smart sustainable energy (0.746). The lowest loaded factor on this component was ensuring an open and transparent governance (0.430). In total seven factors loaded on this component. With a factor loading of 0.718, incorporating resource efficiency from the onset was the highest loaded factor for component three, and a transition to a carbon free economy was the lowest loaded factor for component three (0.540). Component three had a total of five loading factors. The last component had only three loading factors. The first variable had a factor loading of 0.770 i.e., regenerating ageing districts and ensuring robustness of systems in urban space. With a factor loading of 0.523, intentionally going beyond or averse of the smart city concept on technology was the least loaded factor on component four.

Since all the extracted components had at least one factor loading very high on it, the study kept all these four inter-correlated extracted components for further discussions. Therefore, irrespective of component four having a total variance explained of 11.32%, the factor loadings of this component were also relatively high. Hence, rendering it important to be considered as part of the four sustainability guidelines proposed by this study. The four sustainability guidelines are: component one called developing smart policies for smart living; component two dubbed applying sustainable principles for sustainable development; component three termed enforcing sustainable practices into smart city concepts, and component four labelled developing effective plans for continuous improvement.

4.3. Sustainability guidelines to attaining smart sustainable cities

4.3.1. Developing smart policies for smart living

To make developing countries' cities smart and sustainable, it could be veered from the findings that ensuring the development smart policies for smart living could lead to the introduction of several innovative platforms into the urban fabric. For instance, the incorporation of the internet of things principles into Kumasi city could enhance its mobility and create connected platforms which could boost businesses and entrepreneurships in the city. UNDESA [64] opined that the willingness to obtain and maintain data by city officials could enable the prediction of urbanisation trends and even promote impartial distribution of wealth between the urban and rural sectors. The implementation of sensors and actuators in mobility of the city could help reduce the traffic congestion

Table 2
Total Variance Explained using the Guttman-Kaiser Eigenvalue Rule.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Var.	Cum.%	Total	% of Var.	Cum.%	Total	% of Var.	Cum.%
1	12.76	51.04	51.04	12.76	51.04	51.04	5.65	22.59	22.59
2	1.84	7.36	58.40	1.84	7.36	58.40	4.40	17.60	40.19
3	1.28	5.13	63.53	1.28	5.13	63.53	4.11	16.42	56.61
4	1.10	4.40	67.93	1.10	4.40	67.93	2.83	11.32	67.93

Table 3
Factor loadings of extracted components.

Extracted Components and their Variables	Factor Loadings	% of Variance Explained
Component 1: Developing Smart Policies for Smart Living		**22.59%**
Incorporating the Internet of Things (IOT) principle	0.832	
Obtaining and maintaining data (Big data analytics)	0.779	
Developing policies to promote comprehensive and impartial urban and rural development	0.732	
Enhancing the usage of sensors and actuators for improving smart mobility	0.715	
Proper planning and management of the population within the limited environment	0.641	
Setting clear non-conflicting rules which differentiate urban governance from politics	0.637	
Enabling environment for continuous learning	0.633	
Adopting an efficient, reliable and low carbon technologies	0.583	
Ensuring the use of technology, management and organisation, and development and implementation of policies	0.526	
Developing an effective Public Private Partnership which shape models, add value and incorporate emerging technologies in smart city systems	0.435	
Component 2: Applying Sustainable Principles for Sustainable Development		**17.60%**
Development of smart grids and usage of smart metering to ensure smart sustainable energy	0.746	
Improving educational lag especially in relation to ICT and technology usage	0.682	
Implementing efficient, cleaner and sustainable operations to minimize environmental footprints	0.636	
Incorporating smart built infrastructures in general	0.621	
Shaping value added business models, and integrating disparate technologies in a productive system	0.545	
Incorporating green technologies in the transformation of our urban space	0.506	
Ensuring an open and transparent governance	0.430	
Component 3: Enforcing Sustainable Practices into Smart City Concept		**16.42%**
Incorporating resource efficiency from onset	0.718	
Involving citizens, and ensuring an efficient vibrant economy	0.708	
Incorporating design and planning in symphony with the environment	0.665	
Practising the sharing of growth equally and sustainably in urban areas	0.608	
Transition to a carbon free economy	0.540	
Component 4: Developing Effective Plans for Continuous Improvement		**11.32%**
Regenerating ageing districts and ensuring robustness of systems in urban space	0.770	
Creating mechanisms which lead to autonomous and administrative control of inhabitants in smart cities	0.646	
Intentionally going beyond or averse of the smart city concept on technology	0.523	

drowning the city and improve its travelling efficiency [28]. Smart policies imbedded in SSCC could enable proper planning and management of population and also reduce the pressure on housing in the city. To reduce high energy consumption and air pollution in city, policies such as the usage of low carbon technologies and the use of renewable public transport could be encouraged. Li et al. [45] opined that the creation of a sustainable urban space and investment in advance technologies could improve transportation and waste management of cities. Therefore, in order to reduce the influence of smart policies decisions from being influenced by post-politics, policies for development should be clear and non-conflicting with political ambitions, but with a focus on improving the living conditions of the citizens and creating an enabling environment which promotes continuous learning, improvement and sustainable development [17,65,69].

4.3.2. Applying sustainable principles for sustainable development

The incumbent probability of cities becoming smart without being sustainable presents the need to intentionally ensure that the adoption of any of the SSCC are done along the sustainability principles to ensure a sustainable development. Cities of developing countries could be challenged with high energy consumption and high emission of greenhouse gases. Therefore, the development of smart grids and the usage of smart metering could reduce the amount of energy usage in cities and promote sustainable energy consumption [16,23]. The propensity of developing countries city becoming full of uneducated people could be reversed when policies are put in place to intentionally improve the educational lag in cities by incorporating the usage of ICT, digital and technological skills within city's construct and quotidian activities of the people [37]. Also, to reduce environmental footprints in cities, infrastructures could be built by adopting smart and green building technologies and introducing efficient, cleaner and sustainable principles into urban structures. The economy could also be improved through shaping value added business models and integrating disparate technologies to boost production systems in cities [44].

4.3.3. Enforcing sustainable practices into smart city concept

Giving actions to principles could ensure their implementation on the field. Therefore, the deteriorating nature of developing countries' cities could be prevented if the development of cities incorporates resource efficiency from onset and establish mechanisms to transition its improvement towards a carbon free economy [11]. For example, cases where financial constraints might not be a problem, development of cities mobility could adopt the usage of renewable energy vehicles and incorporate emerging technologies such as computer vision and light detection and ranging to improve travelling efficiency and reduce accidents [60]. Also, cities could be planned to be in symphony with the environment whereby infrastructures are built with the environment in mind with technologies in place to reduce the effects of infrastruc-

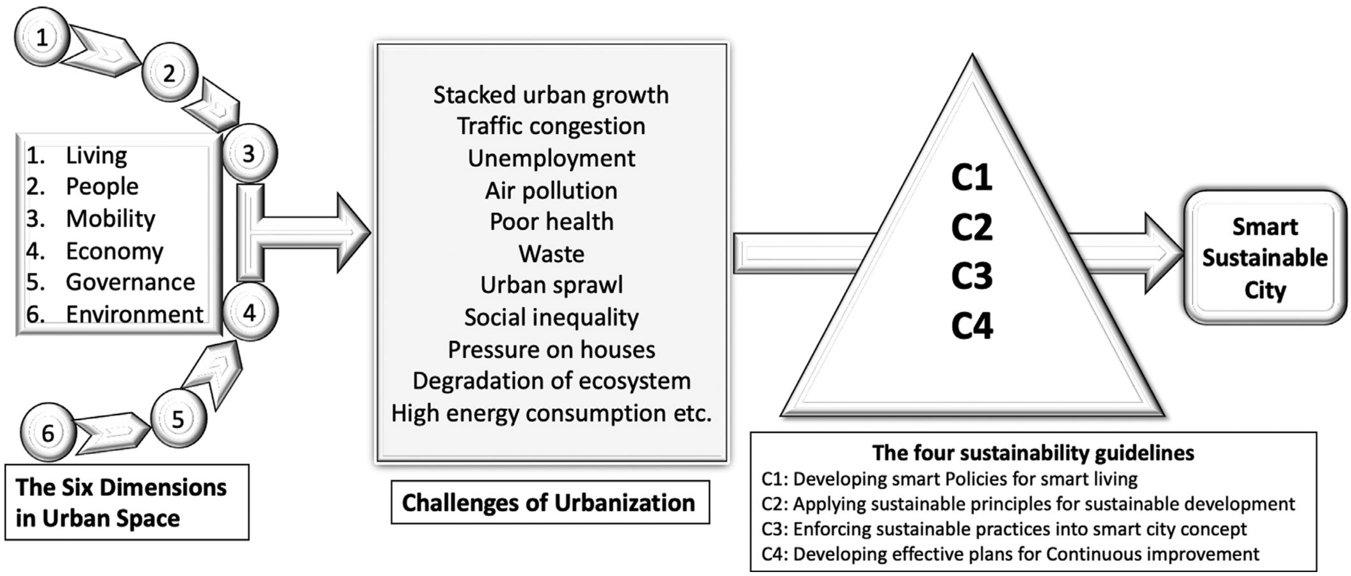

Fig. 1. A Framework for the attainment of smart sustainable cities.

tures on the environment and vice versa [8]. Cities could also be created around citizens involvement towards an efficient vibrant economy which could be run by citizens creativity, ingenuity and innovativeness. Consequently, such economy could practice an open and sharing platforms to share growth and development equally and sustainably within the urban conurbations [64].

4.3.4. Developing effective plans for continuous improvement

The urbanisation of developing countries' cities is being assessed to increase exponentially in the years ahead (UN, World Urbanisation Prospects, 2015). Therefore, the development of sustainability guidelines should also cater for ways to ensure continuous improvement. Policies could be introduced to ensure regeneration of ageing districts to available standards and improve robustness of existing systems to cater for changes in technologies and improve resiliency to unforeseen circumstances. With the existence of big data and other emerging platforms, autonomous control of cities and management of citizens wellbeing could be enhanced to reduce eventualities such as outbreak of diseases and easy evacuation of inhabitants during natural disasters. The rate for development of city structures should always be executed towards smart and sustainable concepts and not just the implementation of technologies to solve urbanisation challenges [8,65].

4.4. A framework for the attainment of smart sustainable cities in developing countries

The six dimensions in urban space adopted for Kumasi city enables the conceptualisation of the various elements of the city which needs to be considered in order to understand, measure and improve to become smart and sustainable. These six dimensions, thus, living, people, mobility, economy, governance, and environment becomes overwhelmed when population in cities increases beyond carrying capacity or when plans are not put in place to cater for the increment in population growth beforehand. The adoption of SSCC could help overcome the challenges burdening the six dimensions in urban space such as air pollution, waste, unemployment, traffic congestion, urban sprawl and social inequality. The existence of these challenges act as impediments to the attainment of the benefits of urbanisation and the realisation of a smart sustainable city. This study therefore proposed four sustainability guidelines based on the SSCC which could be adopted to improve urban structures to become smart and sustainable. These four sustainability guidelines could act as collective policies to assist in controlling urbanisation challenges and stimulate the implementation of various SSCC to ensure the attainment of smart sustainable city in a developing country such as Kumasi city (Fig. 1).

5. Conclusion

The study at hand presents a conceptual framework for controlling urbanisation challenges to the implementation of smart sustainable city concepts in developing countries. The study found through extant literature some key challenges to the urbanisation of developing countries to include urban sprawl, traffic congestion, poor waste management, high energy consumption, poor educational system, pressure on houses and increase in social vices. These challenges prevent developing countries from reaping the benefits of urbanisation and attaining a sustainable smart city. Also, the consensus on what could be measured and improved in cities towards improving city's structures is still debatable in literature. This study, therefore, adopted the use of six dimensions in urban space (living, people, mobility, economy, governance, and environment) to conceptualise the urban structure of Kumasi city – a medium-sized city. The study also determined several smart sustainable city concepts which could be implemented to improve urban structures towards smartness and sustainable development. Through the adoption of principal component factor analysis, the several smart sustainable city concepts were grouped into four sustainability guidelines viz developing smart policies for smart living; applying sustainable principles for sustainable development; enforcing sustainable practices into smart city concept, and developing effective plans for continuous improvement. These four sustainability guidelines could be implemented to help control urbanisation challenges and lead towards the attainment of a smart sustainable city in a developing country.

For the world of practice, the present study provides a mediation framework which enables the understanding of challenges of urbanisation of developing countries and postulates innovative sustainability guidelines which could help control incumbent challenges and enable the implementation of smart sustainable city concepts in urban structures. For theory, the study could serve as a substantive base for other prospective studies which might want to conduct similar analysis within an analogous study context.

Despite the contribution of the study there are some limitations which must be considered when interpreting the results of the study. For example, the sample was obtained from one city in a developing country. Also, intrinsic limitations exist in the adopted sampling technique and tools used for analysis. For these reasons research findings might not fully reflect the general view of sustainability guidelines which could be implemented to attain a smart sustainable city in a developing country. Therefore, future research may use more than one city in a developing country or several cities in developing countries and assess similarities and differences between the challenges and propose strategic sustainability guidelines to cumber these challenges. Moreover, further study could be done in improving enabling structures in cities in developing countries and developing comprehensive measurement tools for determining and controlling urbanisation.

Declaration of Competing Interest

There are no conflicts to declare.

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