KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Exploring Sustainable Considerations of Smart Cities in Developing Countries: The Case Study of Kumasi City

By

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MASTER OF SCIENCE

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DECLARATION

I hereby declare that this submission is my own work towards the Master of Science in Construction Management and that, to the best of my knowledge, it contains no material previously published by another person, nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

The acclivitous increment in the population of the world comes with its own immense challenges. Cities must be smart and sustainable, particularly now where more than half of human dwellings have become urbanised. Smart city, the concept of improving urban structures with ICTs, intelligence and technologies is appreciated in developed economies, but its formation in developing countries is barely taking roots. Hence, as the concept is well-appraised to be of enormous benefits to city conurbations, examining it in the context of sustainability will provide prima facie of how smart cities could solve urbanisation problems while ensuring sustainable development. The purpose of this study therefore was to explore the sustainable considerations of smart city formation in developing countries, by using Kumasi City as a case study. Adopting the pragmatic research philosophy which informs the use of either a qualitative, quantitative or both research approaches, purposive sampling technique was used to reach the target population of this study. A total of seventy-six research questionnaires were retrieved from the survey, and adopting descriptive statistics, relative importance index, mean score ranking, one-sample t-test and principal component factor analysis, the several parts of the questionnaires were strategically analysed. The reliability of the scale and internal consistency of the variables were checked by using the Cronbach Alpha Coefficient test. In an effort to achieve the objectives of the study, it became imperative to first determine the smartness level of Kumasi city. Borrowing the six dimensions of smart cities formation from Giffinger *et al.*'s studies and identifying independent variables which explains each dimension; respondents and experts were allowed to rank the various variables in the determination of the smartness level of Kumasi city. After subjecting the retrieved data to mean score ranking and relating the findings to the formulated smartness box, it was concluded that Kumasi City is a substantial smart city, and has not attained the smart city level yet. Therefore, the study went on to determine the key sustainable development factors of smart city formation in developing countries. After using one-sample t-test, it was concluded that there were enough evidence to support the claim that the independent variable which explains the key sustainable development factors of smart cities, for instance, improving recyclable and reusable water treatment systems, adopting renewable energy sources, providing good, quality and affordable education and training for all etc. were all drawn from a population such that the population mean was not equal to the hypothesised mean of 3.5. Using relative importance index, the militating factors of sustainable development of smart cities were analysed. It was determined that lack of preparedness on the side of government, financial inclusiveness of the concept and lack of practical application of some of the smart city concepts were the main challenges to the formation, upscaling and sustainable development of smart cities. Adopting principal component factor analysis in determining the critical success factors of sustainable development of smart cities, four main components were extracted which explained 67.927% of the total variance in this dimension. The key findings of the study led to the formulation of a conceptual framework for improving smartness and sustainability of developing countries' cities. In conclusion, the study recommended that government should be prepared and ready, they should set up the requisite policies, make provisions for any financial implications, prioritize increasing the smartness of people as its main agenda, incorporate sustainable principles from the onset and provide the necessary measures to ensure the formation of sustainable smart cities in developing countries.

Keywords: Cities, Dimensions, Ghana, ICTs, Smart City, Sustainable Development, Urbanisation.

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LIST OF ABBREVIATIONS

AESL: Architectural and Engineering Services Limited

ANCOVA: Analysis of Covariance

ANOVA: Analysis of Variance

BRRI: Building and Road Research Institute

BIS: Business Innovation and Skills

CSFs: Critical Success Factors

DA: Development Agency

DESA: Development of Economics and Social Affairs

EC: European Commission

EIU: Economist Intelligence Unit

EP: Environment Programme

EU: European Union

GCI: Global Competitiveness Index

GDP: Gross Domestic Product

GeSI: Global e-Sustainability Initiative

GPS: Global Positioning System

GIS: Ghana Immigration Service

GOG: Government of Ghana

GSS: Ghana Statistical Service

GWCL: Ghana Water Company Limited

IBM: International Business Machines

ICT: Information Communication Technology

IDA: Infocomm Development Authority

IISD: International Institute for Sustainable Development

IOT: Internet of Things

IT: Information Technology

IUCN: International Union for Conservation of Nature

KMA: Kumasi Metropolitan Assembly

LAC: Latin America and Caribbean

MANCOVA: Multivariate Analysis of Covariance

MANOVA: Multivariate Analysis of Variance

MFEP: Ministry of Finance and Economic Planning

MLNR: Ministry of Land and Natural Resources

MOCT: Ministry of Communication and Technology

MOE: Ministry of Education

MOT: Ministry of Transport

MRRD: Ministry of Regional Reorganisation and Development

MTTD: Ministry of Transport and Traffic Directorate

MWH: Ministry of Works and Housing

MV: Missing Value

NaDMO: National Disaster Management Organisation

NRD: Natural Resource Defence

NRDC: Natural Resource Defence Council

NRI: Network Readiness Index

NUP: National Urban Policy

OECD: Organisation for Economic Co-operation and Development

PPMCC: Pearson Product Moment Correlation Coefficient

PPP: Public-Private Partnership

RII: Relative Importance Index

SPSS: Statistical Packages for Social Sciences

UK: United Kingdom

UN: United Nations

UNEP: United Nations Environment Programme

UNHSP: United Nations Human Settlements Programme

UNPD: United Nations Development Programmes

US: United States

WBCSD: World Business Council for Sustainable Development

WEF: World Economic Forum

WCED: World Commission on Environment and Development

WIPO: World Intellectual Property Organisation

WPP: World Population Prospects

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DEDICATION

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

This chapter begins with an overview of the concept of smart cities. It shows some key definitions of the concept, the importance of smart cities and how the idea of smart cities has developed until now with auspices on sustainable development aspects of smart cities. It further delineates the problem statement which influences the purpose of the study. Also, the research questions, aim and research objectives as well as the significance and scope of the study are explicitly presented. Moreover, the chapter outlines the methodology which would be adopted in achieving the key specific objectives of this research.

1.2 BACKGROUND OF THE STUDY

Generally, the world's population is rising, and it has no intent of declining soon. The acclivitous of the population of the world presents itself with the need to provide more infrastructure (soft or hard, physical or social, smart etc.) to meet the needs of the growing population (Lu and Tam, 2013; Jin *et al*., 2014; Seow, 2016). Sadly, the growth of population coupling with continuous increase in rural-urban migration is making the infrastructure deficit so gargantuan to simply construct without incorporating the necessary precautions, smartness and resiliency into structures (Chourabi *et al*., 2012; United Nations, Department of Economic and Social Affairs, 2014; Chatterjee and Kar, 2018).

Dirks *et al*. (2010) purported that more than 50% of the world population lives in urban areas, and this situation is even bound to increase further in years ahead (around 70% of the world population is estimated to be living in cities by 2050 (Jin *et al*., 2014; UN, Department of Economic and Social Affairs, 2014)). Hence, perpetuating the idea that the current infrastructure available in our cities are not enough in terms of quantities; not sufficiently smart in terms of technology, security, and sustainability, and unfathomably anachronistic in terms of the taste of future generation priorities (Marceau, 2008; Mahmood, 2018). Thus, a new and better approach for urban development must be sought, which would incorporate the several sectors of the society through the deployment of Internet of Things (IOT) and distributed computing technologies shaping how we build and deliver services and products (Washburn *et al*., 2010). Hence, birthing the concept of smart cities (Johnson, 2008).

The smart city concept is still emerging, and there is no single definition which can encapsulate the diversity and subjectiveness of the subject matter: the concept is still in progress (Hollands, 2008; Chourabi *et al*., 2012). Some experts over the years have opined their views about what a smart city is, and collaboratively, a smart city may be defined as the congenial integration of physical, IT (Information Technology), social, human systems, and business infrastructures to obtain a collective intelligence, and with the apt use of all interconnected information available which would help for better understanding, better control over operations, and better optimization of limited resources (Harrison *et al*., 2010; Cosgrove, 2011; Department of Business Innovation and Skills (BIS), 2013; Pancholi, 2014). Smart city for this study can be defined as the innovation (not predominantly ICT-based) that coordinates and manages the six dimensions in the urban space (smart mobility, smart environment, smart economy, smart people, smart government, and smart living) (Anthopoulos *et al*., 2019).

The smart city concept appeared in literature during the late 20th century, when the phrase was coined to refer to the development of urban space towards technology, innovation and globalization (Gibson *et al*., 1992). Ever since, the concept has been evolving, and the International Business Machines (IBM) popularised the concept in 2009 formulated as the corporate initiative of Smarter Planet (IBM, 2013). The central motive for smart cities those times have been criticised by scholars as a vendor marketing campaign approach with tenuous impact to urban innovation (Nam and Pardo, 2011; Townsend, 2013; Söderström *et al*., 2014; Höjer and Wangel, 2015).

However, today, the concept has transcended beyond its initial ideology to the provision of solutions to the numerous urban challenges through the usage of technology (Wenge *et al*., 2014; Madakam *et al*., 2018). The concept is being used well in developed countries, and developing countries are also picking it up to ensure that citizens obtain the best from their cities in terms of quality of life, healthcare, security and governance (Chatterjee and Kar, 2018; Mahmood, 2018). The smart city future can be prescience as a mixture of sense, soft, and warm technology (Nautiyal *et al*., 2018). The future smart city can be viewed as an integrative organic system having an artificial nervous system (ability to operate intelligently), embedded intelligence (brains), working sensors (sensory organs), and well incorporated on a working telecommunication networks (nerves) and software (noesis and intellectual competence) (Mitchell, 2006; Kanter and Litow, 2009; Dirks and Keeling, 2009).

The creation of smart cities has been purported in literature to involve two major processes, a bottom-up approach or a top-down initiative (Zygiaris, 2012; Oomens, 2016). However, since the smart city concept is still fuzzy and difficult to conceptualize, many scholars are of the view that, the six dimensions or pillars i.e. (Governance, Living, People, Environment, Mobility, Economy) if available would lead to the creation of the smart city system for any economy (Caragliu *et al*., 2009; Nam and Pardo, 2011; Batty *et al*., 2012; Kumar, 2014, Piro *et al*., 2014; Kumar and Dahiya, 2017).

Nonetheless, it is of utmost important that as we gear towards improving the smartness of our cities, we specifically consider how best to make the smart city system sustainable from the onset, so that we can escape some of the pitfalls which mostly comes from development over the years (Bansal, 2005). It could be envisaged that sustainable considerations of smart cities encompass making sure that the systems we put in place are of no effect on the environment, ensuring that we are able to achieve high reduction of energy and carbon emissions, and creating a utopian congenial level of equality among citizens.

1.3 STATEMENT OF THE PROBLEM

The rapid increment of the population of the world has both positive and negative effects (Ojo *et al*., 2014). The increase in population leads to an increase in human resource and social capital for socio-economic growth (Ratti and Townsend, 2011), but comes with several negativities such as rise in unemployment, pressure on social amenities, traffic thronging, increase in social vices, poor healthcare, poor educational system, pressure on housing, poor waste management, high energy consumption and greenhouse gas emissions (Marceau, 2008; Kim and Han, 2012; Mahmood, 2018; Nautiyal *et al*., 2018). These challenges of increase in population and urbanisation can be solved by adopting the smart city concept (Johnson, 2008; Chourabi *et al*., 2012; de Jong *et al*., 2015; Chatterjee and Kar, 2018).

However, the smart city concept as used by several factions of the general public (engineers, economist, public administrators, urban planners, information technologist etc.) is making the definition and conceptualisation of smart city very difficult to grasp (Hollands, 2008; Boulton *et al*., 2011; Batty, 2013; Razaghi, 2016). More often than not, several scholars tend to define smart cities in their own respective point of slang (see for example definitions from Giffinger *et al*., 2007; Toppeta, 2010; Washburn *et al*., 2010;

Harrison *et al*., 2010; Nam and Pardo, 2011; Zygiaris, 2012) without a full understanding of the concept being a system of systems interconnected and intertwined; which does not depend on only innovations from Information Communication Technology (ICTs), but also encompass policy management and intensive strategic planning of our urban space (Fistola and La Rocca, 2013; Ojo *et al*., 2014; Nautiyal *et al*., 2018).

Several developing countries in Africa are becoming smart by improving their infrastructure with the requisite technologies, by automating our roads with sensors and advance signals, by increasing mobility through the use of internet, advanced Global Positioning System and electronic addresses etc. (Chatterjee and Kar, 2018). Smart cities have been created in its real sense in developed countries, but creation of smart cities in Africa faces some stringent challenges like already developed deteriorating areas which are not smart in the ICT sense, uncontrollable rural-urban migration making tracking of urban populous difficult, insufficient infrastructure and technology in capitalising the smart city concept (Marceau, 2008; Chatterjee and Kar, 2018).

It is irrefutable that creation of smart cities (whether from the scratch through a top-down approach, or improving already existing cities through the bottom-up initiative) can help in solving most of urbanisation problems, but just as Bansal (2005) had expressed, the smart city formation cannot be a panacea to solving all urbanisation problems. Hence, extreme diligence is even required to ensure that the development of smart cities does not create more harm on the environment, and rather incorporates sustainable development factors (social equity, economic prosperity, and environmental integration) in their formation (Landry, 2006; UN, 2011; Meijer and Bolivar, 2016). In achieving this, UN, Development Agency came out with 17 global goals, with goal number eleven specifically formulated in solving the unsustainability of our urban space, i.e. making cities inclusive, safe, resilient and sustainable. They propose to achieve this by ensuring that cities are more inclusive, sustainable, and safe with affordable housing and elimination of urban poor and slums; improving green spaces, mobility and governance of our urban space (UNDP, 2015). However, as developing countries cities are emerging, growing and becoming smart, are they meeting these sustainability targets?

In Ghana, Kumasi is the largest city in terms of population, and the third largest in terms of size (Ghana Statistical Service (GSS, 2010)). Kumasi, identified as one of the cities to have increased its urbanisation rate to 60.6%, and been dubbed as one of the liveable cities in Ghana presents itself as a prolific smart city (ibid). Nonetheless, the idea of smart cities, as well formed and used in developed economies is inchoative in emerging economies like Ghana, where the concept for classifying a city as smart might either be entirely different or merely irrational (Albino *et al*., 2015; Chatterjee and Kar, 2018), and this could be the case of Kumasi City. Also, since developing countries are now getting involved in these smart cities' concepts and creation, it would be imperative to do it sustainably from the onset. Therefore, this study is formulated to assess Kumasi City in light of smart city concepts, and withal also identifying key sustainable development factors which can be incorporated into the formation of the smart city concept in developing countries like Ghana.

1.4 RESEARCH QUESTIONS

1. What are the important sustainable development factors of smart cities in developing countries?
2. What factors influence the sustainable development of smart cities in developing countries?
3. What are the critical success factors for sustainable development of smart cities?

1.5 AIM AND OBJECTIVES OF THE RESEARCH

1.5.1 Aim of the research

The aim of this study is to explore sustainable considerations of smart city formation in developing countries.

1.5.2 Specific Objectives of the Research

1. To identify key sustainable development factors of smart cities in developing countries.
2. To identify the militating factors of sustainable development of smart cities in developing countries.
3. To determine the critical success factors of sustainable development of smart cities.

1.6 SIGNIFICANCE OF THE RESEARCH

Africa has faced a great backlog when it comes to infrastructure and improvement of livelihood of its people. However, the growing urbanisation and increment in population growth did not leave Africa behind (Chatterjee and Kar, 2018). Africa, as purported by the United Nations is seen to have increased in urban population from 14.0% (32 million) in 1950 to 34.5% (279 million) in 2000, and it has been predicted to reach 50% urban growth in 2037(UN, Department of Economic and Social Affairs, 2014). As more cities are growing, there is a rapid increment in infrastructure to cater for the growing population. Hence, it becomes expedient to identify the best ways to improve the resiliency of our structures, maintain security, improve governance, obtain serene environment and attain quality of living in our urban space (Chatterjee and Kar, 2018).

The concept of smart city which has emerged to help solve most of urbanism problems (Johnson, 2008; Chourabi *et al*., 2012; Herrschel, 2013; de Jong *et al*., 2015) is well considered in this study. However, the significance of this study does not lie only in how smart cities could be used in providing solutions to the incumbent problems, but more importantly into exploring key sustainable development factors which could be adopted and implemented in the creation of smart cities in developing countries (Ojo *et al*., 2012; Allam, 2017).

The importance of smart cities cannot be overemphasized. Mitchell (2000) and GeSI (2008) opined that smart cities can assist in lowering the effects of greenhouse gas emissions and energy usage in our cities. The global market of smart cities is expected to reach hundreds of billions of dollars by 2020, with a 16 billion dollars spent annually on smart cities (Pike Research, 2011). The pertinent use of smart cities can help in the better usage of public resources, better increment in quality of living and services rendered while keeping operational cost of public administrations down (Zanella *et al*., 2014).

The well-known idiom of necessities being the mother of invention is engrained in smart cities too (Nautiyal *et al*., 2018). This study is of ample significance, as it serves as model for other cities in Ghana and Sub-Saharan Africa to also identify their upcoming cities in the lens of the six dimensions of smart cities, so that they can know where they have reached in their quest of developing smart cities; the areas they have mastered, the sectors they would be challenged to do more, and the pillars which needs to be improved. Nonetheless, most importantly ensuring that cities become smart and sustainable in meeting the direly demands of the burgeoning population of Africans in urban sectors and related environs.

1.7 SCOPE OF THE RESEARCH

In identifying the scope of this research, it was expedient to consider both the geographical scope and the contextual scope. Contextually, this study was limited to smart cities. There are several upcoming words which could be used to replace smart cities like digitalise cities, intelligent cities, or ICT-Driven cities (Nautiyal *et al*., 2018), however, the study was stuck to the usage of smart cities throughout. In addition, it is noteworthy to know that the idea of 'smart' does not literally mean wise or mental alertness, and hence, the opposite of this word cannot be 'dumb'. Smart, as used in the word smart cities means the use of advance ICT within the urban space, and the opposite would be the lack of its usage thereof (Höjer and Wangel, 2015). Moreover, the study was strategically limited to sustainable smart cities by using Kumasi as a case study.

Considering the geographical scope of this study, first, developing countries were considered. Throughout literature, it was purported that Africa and Asia have grown in urbanisation as compared to the other continents (UN, Department of Economic and Social Affairs, 2014). However, several studies have been conducted on Asia, and it seems they are on the verge of understanding and upscaling the smart city concept as compared to Africa (see for example; Roberts and Kanaley, 2006; Mabbit, 2006; Choe and Roberts, 2011; Dahiya, 2012; Kumar and Dahiya, 2017). In Africa, it was understood that several countries have grown in urbanising their cities; examples of such countries are South Africa, Libya, Tunisia, Algeria, Nigeria, Mauritius and Ghana (UN, Department of Economic and Social Affairs, 2014). From the 2010 Population and Housing Census report, it was observed that Ghana has moved from a rural to an urban population (50.9% of the population now lives in urban areas) (GSS, 2014). Hence, showing a strategic reason to consider Ghana for this study, so that the study can explore the sustainable consideration of smart cities in Ghana. In Ghana, greater Accra region was seen to be highly urbanised 90.5% and the second most urbanised area was Ashanti Region (60.6%) (ibid). The study tends to focus on Kumasi in the Ashanti Region, because it is the second most urbanised area, and unlike Accra which is already urbanised, exploring sustainable consideration of smart cities using Kumasi will produce clear results of highly informed consent which will benefit other non-urbanised cities in following and improving to making their cities smart and sustainable through a strategic bottom-up process.

1.8 SUMMARY OF METHODOLOGY

The research methodology section of this study was carefully deliberated by considering all the several research philosophies available (epistemology, ontology, axiology, pragmatism etc.) (Kothari, 2004). These research philosophies influence the research choice, and informs on the strategy and research approach to adopt. For this study, the pragmatic research philosophy was used. This particular philosophy was adopted based on the avowal of (Tashakkori and Teddlie, 1998) that the pragmatic research philosophy is best when there is difficulty in choosing between either positivist or interpretivist. Thus, at one stance, it becomes important to involve yourself in the research through the interpretivist philosophy, while at a different stance, you have to stay away from influencing the outcome of the results in obtaining real value facts (positivist) (Saunders *et al*., 2009). For pragmatism, the most important determinant is the research question, and the research question should be such that either adopting a positivist or interpretivist approach would be appropriate (Tashakkori and Teddlie, 1998).

Intuitively, from the philosophical stand of this research, it was overt that both the deductive and inductive research choice should be appropriate for this study. Also, it was inferred that adopting case studies and surveys as the research strategy would help in achieving the objectives of this study (Collis and Hussey, 2013). The mixed methods approach to research (quantitative and qualitative research approach) was also used for this study, because (Wilson, 2014) is of the view that for a pragmatic research philosophy, the appropriate research approach could either be a qualitative, quantitative or a combination of both as it becomes appropriate in answering the research questions.

The population for this study encompassed the agencies of the state who have lines of influence on the urbanisations of our cities. Hence, it includes, but not limited to the following (Building and Road Research Institute, Ministry of Communication and Technology, Ministry of Education, Ministry of Finance and Economic Planning, Ghana Immigration Service, Ministry of Land and Natural Resources, Ministry of Works and Housing, Ministry of Transport, Ministry of Regional Reorganisation and Development, National Disaster Management Organisation, Ministry of Transport and Traffic Directorate etc.) (GOG, 2019). Though all these agencies of state have a duty in the urbanisation of our cities, but considering the levels of government of Ghana, the highest political and administrative authority in the local government is the district assemblies. Ashanti Region has 27 district assemblies (GSS, 2010), and the one which directly influences the Kumasi City is the Kumasi Metropolitan Assembly (KMA). Hence, this study considered KMA and other major institutions in the Kumasi City who have experiences in the several systems which are used in classifying a smart city (Infrastructure, education, health, economy etc.).

Data for the study were obtained from primary and secondary sources. Secondary data were gathered from extant literature on smart cities, smart city conceptualisation, smart sustainable cities and smart resilient cities. Google Scholar, Emerald, Scopus and other scientific searching engines as well as the library and KnustSpace were contacted and searched for articles, reports and research papers on the topic understudy. The obtained information was strategically grouped according to their relevance and importance. The irrelevant ones were discarded, and the pertinent ones which have informed knowledge of the subject matter understudy were reviewed and noted.

The obtained variables from literature review were strategically compounded into close-ended questionnaires and served to the target population in person and electronically. The questionnaires were formulated in such a way as to provide answers to the strategic objectives of the study after analysis. Chen and Jin (2013) state that questionnaire survey is the most broadly adopted approach in quantitative research.

The primary data retrieved from the study were analysed using several tools of analysis like the Descriptive Statistics (Means, Frequencies and Standard Deviations), One-sample t-test, Principal Component Factor Analysis, and Relative Importance Index. The reliability of the scale and internal consistency of the variables were checked by using the Cronbach's Alpha Coefficient test. Internal and external validity of the study were also attained through content-related validity measurement. Software for the analysis were Nvivo, Statistical Packages for Social Sciences (SPSS), and Ms Excel.

1.9 LIMITATIONS OF THE RESEARCH

Every research is likely to have some potential limitations. The limitations of this study had to do with the timeframe of the study which was very short, hence, it did not give much room to enable the collection of more responses from the target population for analysis. Moreover, sampling and measurement errors are issues which cannot be overridden entirely in any research. Notwithstanding, careful consideration, intent and adept approaches were used in computing and analysing the data. Therefore, this study can be seen to provide precise findings for further deliberations and contribution to knowledge.

1.10 ETHICAL CONSIDERATIONS

Ethics was considered key part of this study, because according to Saunders *et al*. (2009), ethics has a major effect on the collaboration of respondents during data collection. As a relevant approach to safeguarding respondents' integrity, ethics must not be under-looked in any research (Knight and Ruddock, 2008). The study observed several ethical behaviours like protecting the self-esteem, privacy, discretion and confidentiality of the respondents of the survey. This study considered the entire ethical issues laid down for postgraduate research students in formulating data collection tools and providing informed consent to the respondents. Thus, the respondents were made aware of where the questionnaire was coming from, the reasons or purpose behind the study, the significance of the research, and most importantly how the information provided would be used, and how their rights and privacy would be protected. Respondents also had absolute right to either disclose or refuse to disclose or either not to partake or otherwise freely, as far as they fell within the sample frame of the study.

1.11 ORGANIZATION OF THE THESIS

This dissertation was arranged chronologically, following the rules and guidelines of presenting master's thesis in KNUST. Holistically, the dissertation consisted of five main chapters (General Introduction, Literature Review, Research Methodology, Data Analysis and Discussion of Results, and Conclusions and Recommendations of the study). However, under each main chapter were several sub-headings and sub-subheadings as per the ideas which became necessary to present and express in each main chapter. Notwithstanding, clarity was given and care was taken, so as not to create several subheadings to confuse the reader and lose the meaning of the content. Following this chapter was the literature review section (Chapter 2), where several theories on smart cities, sustainable smart cities and smart resilient cities were presented and well effected, with tuned intention of meeting the specific objectives of the study. Moreover, attention was drawn to the sustainable development principles in smart cities creation, challenges and critical success factors for implementation of such principles. In addition, in an effort for determining how data would be collected, what data is to be taken and how collected data would be analysed, the chapter three (Research Methodology) became the succeeding chapter after the literature review. Following suit from thence is the chapter four (Data Analysis and Discussion of Results). This chapter presented in its entirety the analysis of the obtained data from the field survey, an explicit explanation of the analysis and tools used, and the discussions of the results obtained from the analysis. Afterwards, the conclusions, recommendations and directions for future research were presented in the last main chapter (Chapter 5). The conceptual diagram of this arrangement is displayed in Figure 1.

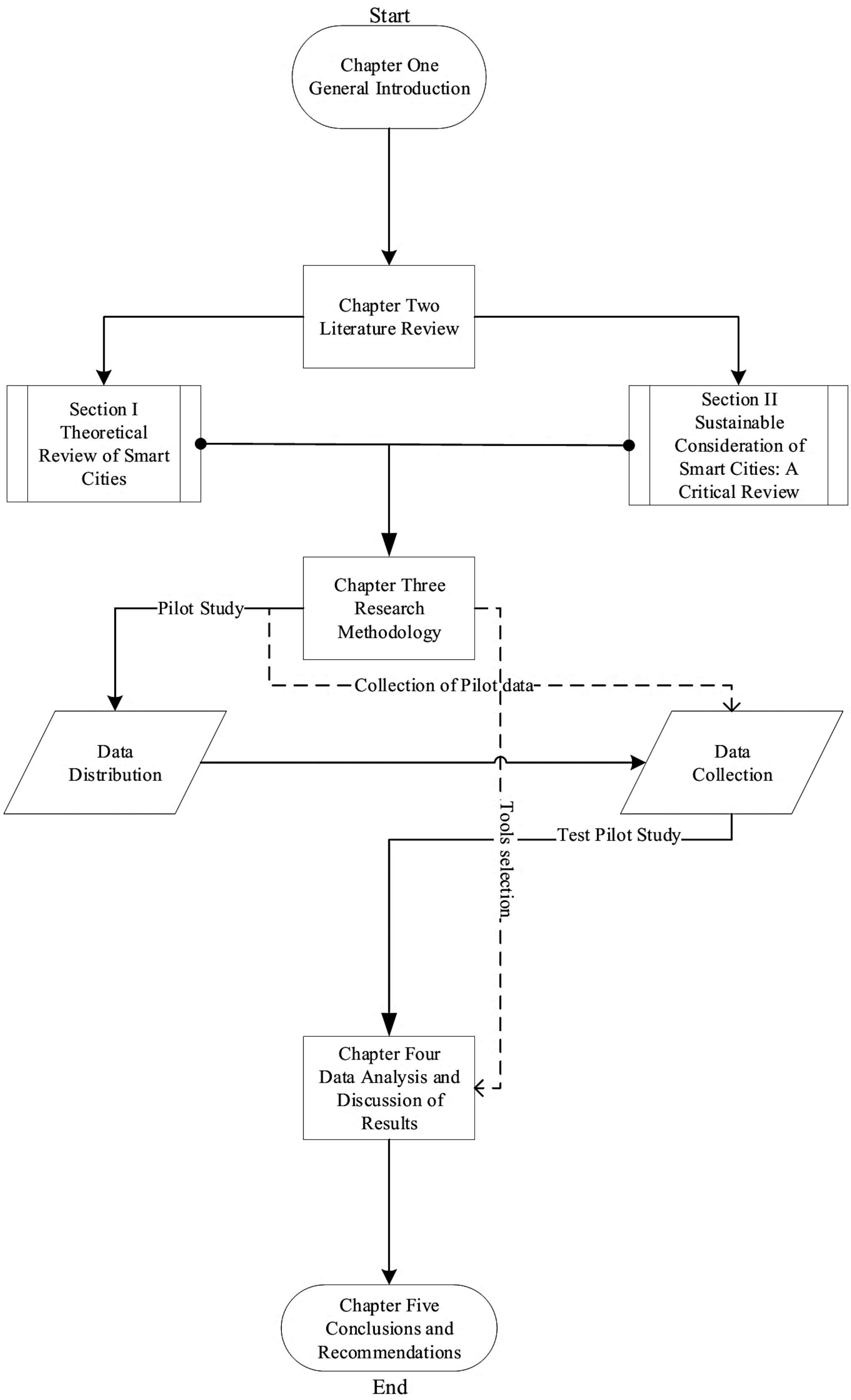

Figure 1.1: Conceptual diagram of thesis organisation

Source: Author's construct (2019)

1.12 SUMMARY OF CHAPTER ONE

This chapter presents a synopsis of the study being conducted. Iteratively, in this chapter the form to which the study would take is presented under the organisation of the research. Also, a critical consideration of the introduction of this chapter should give you a clear view of the idea being presented in this study which was strategically influenced by the gap in literature overt in the problem statement section. With such a gap, various research questions were formed, and the aim and objectives of the study were formulated from thence. Since the research should be under a controlled condition and quite specific in obtaining the objectives of the study, the methodology to be adopted and the scope of the study were delineated. Lastly, to show the importance of this work to practice and scholarship, the significance of the study was also presented.

CHAPTER TWO

LITERATURE REVIEW

SECTION I: THEORETICAL REVIEW OF SMART CITIES

2.1 INTRODUCTION

This chapter presents a holistic, systematic, and well-thought out panoptic review of literature on smart cities, population, rural urban migration, smart city objects and sustainable considerations of smart cities. At first instance, the study presents a review on the population and rural urban migration by considering both the world view and the perspective of Ghana. Succeedingly, the smart city concept is presented, which comes out as an all-encompassing concept for controlling the effects of urbanisation and increase in population in our cities. The assorted benefits and conflicting but informing definitions of smart cities are presented. Afterwards, the study conceptualises the sustainable smart city concept by considering sustainable development factors and how the concept has fare so far in the making of smart cities. The theoretical review concludes by providing a critical review on the six dimensions or pillars of smart cities, which have been used and accepted by many scholars as a strategic approach in conceptualising smart cities. Lastly, upscaling of smart cities and its resulting challenges and implications are explicitly delineated at the concluding section of this chapter.

2.2 POPULATION AND RURAL URBAN MIGRATION

Currently, the population of the world is over 7 billion people, and more than half of this population lives in our urban areas (Dirks *et al*., 2010). The shift of the population toward urban is creating an immature imbalance between the rural sector and the urban region. In 2007, the global urban population exceeded the global rural population, and the global urban population has remained predominant ever since (UN, Department of Economic and Social Affairs, 2014). Bhatta (2010) purported that the growth in the population of our urban cities is either as a result of rural-urban migration or natural population growth. Natural population growth is envisaged to have occurred when the number of births in an urban sector is more than the number of deaths comparatively (ibid).

Migration on the other hand is influenced by the advent of better prospect elsewhere (caused by technological advancement, economic growth and development) or the presence of unfavourable conditions at current abode engendering one to look out for better prospect elsewhere (Batty and Marshall, 2009). For rural urban migration, Bhatta (2010) is of the view that several push and pull factors are drawn in place which causes people to move from rural areas to urban sectors. For instance, unemployment and bad sales is a push factor which will compel people to move from rural areas to urban region, while good working systems, high security, decent job and quality lifestyles in our urban sectors could pull individuals from rural to urban. This comparative imbalance between rural and urban sectors poses some stringent challenges to cities, government, citizens and officials (Breuer *et al*., 2014).

The challenges of urbanisation have been delineated in literature. For instance, unplanned urban growth leads to high unemployment status, traffic congestions in cities, urban poor who are not seen or neglected, poor housing structures (several slums), waste and pollution of land, air and water bodies (Kim and Han, 2012; UN, Department of Economic and Social Affairs, 2014; Mahmood, 2018; Nautiyal *et al*., 2018).

However, irrespective of these obvious challenges with rise in population and its incumbent increase in unplanned urban populous, it could be appreciated that, the agglomeration of people in cities presents an easy way of providing for the needs of the citizens (be it health, water, energy, education) etc. as compared to sparsely fragmented rural settlements. In other words, there is maximization of resources and easy supplement of the needs of a large group of people as compared to the rural area (Ojo *et al*., 2014). Ratti and Townsend (2011) puts it in a more radiant perspective that urban agglomeration helps in boosting the national economy of nations, it creates an utopian atmosphere which improves social cohesion, breaks cultural barriers, allow easy sharing of the common good and improves quality education and health care.

2.2.1 Urbanization from the World View

Globally, the world population has skewed towards urban than rural. Since 2014, about 54% of the world population lived in urban areas; an unfathomable scenario in about six decades ago. In 1950, 70% of the world population were living in rural areas; nonetheless, the rural population is predicted to decline to 34% by 2050. Hence, inferring that about 66% of our living space will be urbanise by 2050 (UN, Department of Economic and Social Affairs, 2014).

In northern America, a much of 82% of the population are living in urbanised regions, in Latin America and Caribbean, 80% of the population lives in urban areas, while the population of people living in urbanised regions in Europe is around 73%. In sharp contrast, for Africa and Asia, the population is rather rural than urban as at 2014, with only 40% and 48% of the population living in urban regions in Africa and Asia respectively (UN, Department of Economic and Social Affairs, 2014). Notwithstanding, it is predicted that by 2050, there would be a rapid increment in the urbanisation of Africa and Asia as compared to the already urbanised continents (UN, World Urbanisation Prospects, 2015). On the other hand, with a steady growth in rural population since 1950, the rural population of 3.2billion as at 2014 is expected to decline or remain at 3.2 billion in 2050. Out of this 3.2billion rural population in 2014, 90% of the population were in Africa and Asia; with largest rural population recorded in China followed by India (ibid).

The urban population has also grown rapidly from 746 million in 1950 to 3.9 billion in 2014. Though Asia has a high level of rural areas, however, the number of people living in urban areas in Asia amounts to 53% of the total urbanised sectors of the world, followed by Europe (14%) and 13% for Latin America and Caribbean (UN, Department of Economic and Social Affairs, 2014). It could be projected that about 2.5 billion more people would be added to the urbanised area by 2050; majority of these people (about 90%) would be from Asia and Africa and specifically from Nigeria, China and India (UN, World Urbanisation Prospects, 2015). Though population growth in our cities have always be on the increase, but a few cities in Europe and Asia have experienced or would be experiencing a decline in urban population mainly due to low-fertility rate or natural disasters (UN, Department of Economic and Social Affairs, 2014).

2.2.2 The Perspective of Ghana

Policies during colonial period, and those machinated after post-independence have resulted in significant changes in Ghana's population and urbanisation (Government of Ghana, National Urban Policy, 2012). As a result, Ghana has moved from a rural dominated population to an urbanise country subject to the 2010 housing and population census report. GSS (2014) opined that, more than half of Ghana's population (50.9%) now lives in urbanised areas in the country.

The urbanisation of Ghana resulted from policies formulated by government such as decentralisation and area reclassification, variation in spatial development, town and country planning ordinance, economic recovery programme, national building regulation, growth and poverty reduction etc., as well as natural growth and internal migration in the country (Songsore, 2003; Owusu, 2005; Adarkwa, 2012; GSS, 2014). In developed economies, urbanisation is mostly fuelled through industrialisation then innovation and service-led economy (Government of Ghana, National Urban Policy, 2012). However, the urbanisation of most African countries has been neglected of the copious benefits of going through these stages, hence, leading to an urbanisation without enjoyment of its accompanied benefits, to a predilection of the unending challenges of urbanisation without a happenstance (ibid).

Ashanti Region is 61% urbanised as at 2010, and this is mainly due to net-in migration in the region as compared to natural growth (GSS, 2010). According to the GSS (2014), 87% of the people in Kumasi were deemed to be literate; about two-thirds of the people in Kumasi have treated pipe borne water filling their homes from the Ghana Water Company Limited (GWCL), and about one-third had an efficient waste disposal system rather than dumbing them on landfills personally. The ICT literacy and computer usage in Ashanti Region was 12.8% for population above the age of 12 years; urban mobility and health facilities was averagely low throughout the country as at 2010 (GSS, 2014).

The increment in the population of urban settlements in Ghana is seen to be skewed towards some few cities (Accra, Kumasi, and Takoradi) which is termed as urban primacy. The uneven spatial distribution of the population comes with its unprecedented challenges like urban thronging, urban sprawl, urban poor, unemployment, environmental degradation, poor infrastructure etc. (GSS, 2014). These challenges pose a serious problem for urban officials and planners, city dwellers and government in perfecting economic integration of cities.

2.3 THE BIRTH OF SMART CITIES CONCEPT

The increment in the population of the world, with precise interest in the agglomerations found in our cities avowedly depicts the need for improved infrastructure in our cities, where the number of people in our urban areas would be more than those in the rural areas fortuitously (Chourabi *et al*., 2012; United Nations Human Settlements Programme, 2012). However, the provision of infrastructure cannot be done merely without incorporating the necessary technologies into urban structures and ensuring the sustainability of the approaches thereof, hence birthing the concept of smart cities and sustainable smart cities as used and understood by most researchers today (Johnson, 2008; Chourabi *et al*., 2012; Breuer *et al*., 2014; Eremia *et al*., 2017).

The smart city concept became an area of interest during the late 20th century when the phrase was formulated to mean a development of urban regions toward innovation, globalization and technology (Gibson *et al*., 1992). Wenge *et al*. (2014) posited that the main reason behind smart cities is to apply advanced ICTs to solve urbanisation problems, improve resilience, sustainability and overall attractiveness of our cities.

The smart city concept been proclaimed as a new paradigm for controlling and managing urbanism problems has engendered many countries to formulate smart city related agendas (Chourabi *et al*., 2012). For instance, United States is one of the pioneers of the smart city concept, having purported and proposed it usage in developing smart communities for its citizens; in 2009 the European Union (EU) formulated the digitalised city agenda to capitalise on creating a smart, resilience and comprehensive cities in Europe (Paskaleva, 2011). In Asia, there have been several policies and plans put in place by economic giant countries like Japan (i-Japan strategy 2015); the 2006 u-Korea development strategy of South Korea, and the 2015 Intelligent Nation plan of Singapore (Ng, 2011; Shin and Kim, 2012; IT Strategic HQ, 2013); in all taking advantage of the smart city concept to circumvent the problems associated with urbanisation and increase in population.

Hollands (2008) purported that the smart city concept is still emerging, and there is no single definition which can encapsulate the diverseness of the subject matter which means different things to different stakeholders. The concept is still fuzzy with several basic questions unanswered. For example, how do we conceptualise the smart city concept, and by what measure do we label a city as smart (Caragliu *et al*., 2009; Nam and Pardo, 2011)? The blurry nature of the concept is as a result of the diversified portfolios of smart city meeting the interest of several people (Bowerman *et al*., 2000; Al-Hader *et al*., 2009; Harrison *et al*., 2010).

Moreover, the involvement of business corporations like Cisco, IBM, Siemens etc. is making upgrading and acceptance of the smart city concept by city officials, urban developers and general citizens very difficult: this is because no one wants to start an activity which will tend to pack money into the pouches of these big ICT corporations without solving the actual problems on ground (Vanolo, 2014; Sadowski, 2016).

In setting the records straight, it could be envisaged that if care is not taken the smart city concept would become an utopian didactic tyrannical city out of nowhere which citizens cannot inhabit; particularly, considering how the media have been hyping the concept in relations to these giant ICT companies in Europe and America (Vanolo, 2014). Graham and Marvin (2001) discussed that the provision of technological infrastructures by the private sectors could incite urban divisions as evidenced in the functional separation between blockaded technological enclaves and left alone disregarded spaces. For example, Songdo in South Korea and Kerala in India are nexuses of these smart city concept managed by private firms which have faced local resistance as been too expensive to construct and incompatible with the locals' culture and living (Davis, 2010).

2.3.1 Smart City Definitions (What it Means to a lot of People)

The smart city concept is equivocal, and means a lot to diverse range of people (Hollands, 2008; Chourabi *et al*., 2012). Caragliu *et al*. (2009) assayed that smart cities are about people, institutions and technology. Meijer and Bolivar (2016) explicates these three areas further, to them: smart city is about cities with smart people (focusing on the human resources), smart city is about cities with good collaborations (focusing on governance) and smart city is a technological wise city (focusing on technology). However, other scientists are of diverse opinions as to what smart cities is all about. For instance, considering it from a technological angle, Harrison *et al.* (2010) is of the view that the smart city concept is all about leveraging city structure to maximise collective intelligence. Washburn *et al*. (2010) also argues that smart cities is about creating a more suitable, clever, interrelated and efficient infrastructure components and services through the use of smart computing technologies. Giffinger *et al*. (2007) strategically came out with a brilliant comprehensive idea for defining smart cities. According to the authors the six dimension (characteristics) or what has been made to be called the six pillars of smart cities thus, (Smart Mobility, Smart Economy, Smart People, Smart Environment, Smart Governance and Smart Living) could help in outlining what a smart city is (Giffinger *et al*., 2007). Likewise, Balakrishna (2012) opines that the smart city concept can be defined from the environment, people, economy, governance, living and mobility perspectives.

Caragliu *et al*. (2011: 70) defines a smart city as ‘a city with investments in human and social capital, traditional (transport) and modern communication infrastructure fuelled by sustainable economic growth and high quality of life with a wise management of natural resources, through participatory governance.’ Other ferocious definition of smart cities as argued on by Shapiro (2006), Caragliu *et al*. (2011), Walravens (2012), Lombardi *et al*. (2012), Lee *et al*. (2013) etc. are presented in Table 2.1.

Table 2.1 Smart City Definitions

DEFINITIONS	SOURCE
• Incorporating the use of ICT in urban conurbations	Toppeta (2010); Walraven (2012); Lee *et al*. (2013)
• Involving smart computing technologies and modern technologies	Washburn *et al*. (2010); Lombardi *et al*. (2012); Angelidou (2014)
• Encompassing people with high development index (smart people with higher qualifications	Shapiro (2006); Winters (2011); Lombardi *et al*. (2012); Kumar and Dahiya (2017)
• User-centred and interactions as a key part in smart cities	Yigitcanlar *et al*. (2008); Hollands (2008); Calderoni *et al*. (2012); Kourtit *et al*. (2012)
• Combination of key elements in definitions (smart people, smart technology etc.)	Giffinger *et al*. (2007); Hollands (2008); Sauer (2012); Schuurman *et al*. (2012)
• Concerning an investment in human and social capital	Caragliu *et al*. (2011)

Source: Author's Construct (2019)

2.3.2 Assorted Benefits of Smart Cities

The benefits of cities are enormous, among which is the contribution to the Gross Domestic Product (GDP) of countries (up to 80% of GDP is generated by cities) (UNEP, 2013). Cities are able to achieve this huge contribution to GDP because they provide access to labour, private enterprise, easy accessed information, enhanced mobility and institutions which helps to create a macroeconomic facilitating setting for sustainable economic development. More so, as engines of economic development, they provide vital stimulus for national and global economic growth (ibid). In addition, cities from time memorial have been associated with social and economic transformations with a huge emphasis on quality of life, mobility, increase life expectancy and a driver to poverty reduction both in rural and urban sectors (UN, Department of Social and Economic Affairs, 2014).

Schaffers *et al*. (2011) averred that smart cities help in dealing with challenges in urbanisation such as greenhouse gas emissions, urban sprawl and agglomerations, energy usages, unemployment and poor economy through the labour market policies, sustain innovation economies, and optimising energy and water usage and savings. Smart cities which incorporates ICT, can facilitate urban growth and improve urban areas and reformation (Graham and Marvin, 2001). The goal of smart cities is to ensure 40 percent reduction in greenhouse gases by improving energy efficiency of buildings and implementing the usage of smart energy grids (Vanolo, 2014).

Also, smart cities can enhance transportation within our cities and accelerate movement of the general public, hence reducing traffic congestions (Vanolo, 2014). Furthermore, smart cities ameliorate progress in areas such as energy production, mobility and transportation, ICT etc. and closely linked and create several interdisciplinary opportunities to improve services while reducing energy and greenhouse gas emissions (ibid). Smart cities could be view as a potential solution to sustainable development of our urban conurbations leading to enhanced urbanisation (Herrschel, 2013; Yigitcanlar, 2016; de Jong *et al*., 2015). On the other hand, smart cities play a role in making intelligent decisions in cities through the application of new software and incorporated hardware which allows for real-time analytics in optimising business processes and improving finances (Washburn *et al*., 2010).

2.4 SMART CITIES AND SUSTAINABLE SMART CITIES: EMPIRICAL REVIEW

After going through the fundamentals of smart city, thus how it came into being, the several factions of the concept to diverse people, and the benefits of the concept to society and scholarship, it becomes expedient to now conceptualise the idea and fixate it well into this study. By adopting an inductive approach to research, the various conceptualisation and methodologies adopted by several researchers are presented and well-ingrained into this sub section of the study.

2.4.1 The Inductive Approach

The inductive approach to research allows us to take our time in coming out with the conceptualisation of an idea. With the inductive approach, definition is developed by considering the synthesis of how others have defined the concept in theory or practice. Depending on how significantly true these definitions are, this approach leads to the definition of one or a combination of definitions (Höjer and Wangel, 2015). Hence, Strauss and Corbin (1998, p.12) are of the view that, 'this approach allows the researcher to start from a wide area, and qualitatively allows the theory to emerge from the available data.' Thomas (2006) asserted that the primary purpose of inductive approach is to allow for the freedom of flow of information without restricting the researcher's ability imposed by structured methodologies, hence enabling the research to flow from important and easily available themes.

2.4.1.1 Cities

Cities are the hub of our living, it is where we create, trade, produce, and consume most of everything. De la Peña (2013) assayed that cities are the central axis of humanity. Cities makes up of only 2% of the earth land mass, but contains more than 50% of the world's population, contribute about 80% to Gross Domestic Product and use close to 75% of energy generated, responsible for approximately 80% of greenhouse gas emissions, and consume around 85% of the world's resources (UN, Environment Programme, 2013; Lee *et al*., 2013; UN Department of Economic and Social Affairs, 2014).

Cities of today are seen as drivers of innovation, inclusion, health, environment and businesses (Kroes, 2010). Goodall (1987) and Kuper and Kuper (1996) defines a city as complex system, which is comparatively large with stable settlements and comprises of land usage, housing, transportation, utilities and sanitations. Dahiya (2012) opined that cities epitomise the highest forms of human dwelling, the ground for secondary economic activities, the centre for producing goods and services, and the hub for entrepreneurship and social inclusion which is spearheaded by the advent of modern ICTs infrastructure which links one city to another in real time. Cities as usual attracts the best and brightest in any trade (skilled or unskilled) since it provides better prospects than its rural counterpart (Dahiya, 2012).

Table 2.2 Cities Types, Populations and Examples

CITY TYPE	POPULATION (In the City)	Totals as at 2014 of the urban areas	EXAMPLES
1. Megacities	> 10 million	453 million (12% of the urbanised world)	Tokyo (38Mil), Delhi (25Mil), Shanghai (23Mil), Mexico City, Mumbai, and Sao Paulo (21 Mil), Lagos, Cairo
2. Large Cities	5 – 10 million	> 300 million (8% of the urbanised world)	Santiago, Madrid, Singapore, Bangalore, Johannesburg, Luanda
3. Medium-sized cities	1 – 5 million	363 million (10% of the urbanised world	Sydney, Addis Ababa, Motevideo
4. Cities	500K – 1 million	Around 50% of the urbanised world	Newcastle, Conakry, Kansas, Bournemouth, Bristol, Accra, Kumasi
5. Small Cities	< 500K	Around 20% of the urbanised world	About 525 cities

Source: Author's Construct (2019)

Cities can be grouped into 5 main distinctive kinds based on the population the city can hold. Table 2.2 depicts the various categories of cities, population of people it can subsume, and cities in the world that fell under such categories.

2.4.1.2 Meaning of the Word 'Smart' as Used in Smart Cities

Smart, as a qualifier in the word smart cities has different connotations but divergent view about what scholars mean by its usage. One thing is certain, 'smart' does not necessarily mean wise or mental alertness, and hence, the opposite of this word cannot be 'dumb'. Nevertheless, nobody would love to live in a dumb city anyway, and a dumb city in its entirety is not realistic. However, smart, as used in the word smart cities means the use of advance ICT within the urban space, and the opposite would be the lack of its usage thereof (Höjer and Wangel, 2015). From instrumental perspective, smart can be seen as not holding any value in the word smart cities. However, other authors such as (Hollands, 2008; Allwinkle and Cruickshank, 2011; and Kitchin, 2014) are of different views that smart in the word smart city is a planned outcome and a sought-out goal for cities; could be viewed in the same vein as sustainability which we should strive to achieve.

In that regards, Vanolo (2014) proposed that a city would be seen smart if it serves as a relation between the urban space and technology and it incorporates issues such as the ability to create innovation, adherence to change towards e-governance, social learning and the chance of having ICT imbedded structures. Al-Hader *et al*. (2009) also argued out the smartness concept beautifully, to them the smartness of smart city is perpetuated to engulf in its ability to transmit and receives data adopting communication protocols between networks. According to Meijer and Boliva (2016), the smartness of a city is rather plunge to its ability to attract people and to substantiate collaborations between people through the use of Information Communication Technologies (ICTs).

2.4.1.3 Smart Cites

Hall (2000) defined a smart city by focusing on the optimization of technology into city objects. A smart city is a city that controls and incorporates conditions of all its crucial infrastructures, ensure better optimisation of resources, plan it preventive maintenance activities, and monitor security aspects while maximizing services to its citizens (Hall, 2000). A smart city is one that incorporates the educational sector in its formation as well as all forms of city life (Kumar and Dahiya, 2017). Hence, it must incorporate people with higher qualification and must be seen to have smart people with most of them being graduates.

A smart city is a city of urban openness, i.e. it is one that encourages urban innovation, cooperation, information sharing, and interoperability while also enabling citizens to openly access data in fields ranging from budgetary spending, logistics, income to health (Johnson, 2008; Schaffers *et al*., 2011; Ganapati and Reddick, 2012). In its entirety ensuring that the degree of openness is increasing the innovation drive in the city and giving citizens chance to develop applications and offer new products to improve quality of life (Lee *et al*., 2013). Moreover, a smart city can be defined as one that facilitates green communities, innovation and increased life quality through high-tech intensive technology and advanced city elements through information sharing and connecting people (Bakici *et al*., 2013).

Chen (2010) is of the view that a city which takes advantage of sensor capabilities and communications incorporated into city structures to monitor its mobility, energy, governance, quality of life, security and environment is a smart city. Nam and Pardo (2011) adds their concession that a city is deemed to be smart if it adds information to its physical structures to enhance conveniences, improve mobility and maintain energy, expatiating of quality of water and air, easily determining problems and finding solutions quickly, deploying resources efficiently and sharing data openly. Eger (2009) argues that a smart city, in other words, a smart community is one which makes a witting effort to use the available technologies at its disposal to improve and promote businesses in the urban space or community; increasing civic pride, quality of life and recreating cities for a new economy and society with rich captivating community benefit.

Nam and Pardo (2011) makes a justifiable conclusion that all the diverse meanings of smart cities can be agglomerated into three main areas i.e. technological focus, humanistic concentration, and institutional dimension.

2.4.2 Understanding Sustainability and Sustainable Development

The Brundtland report popularised the sustainable development concept in 1987 in their published work 'Our Common Future' during the World Conference on Environment and Development (WCED). According to WCED (1987), sustainable development is defined as the development which enables us to provide for the current generation, without jeopardizing the ability of the future generations to provide their own needs. In order for sustainable development to be attained there must be a fulfilment of these three main principles: environmental integrity, economic prosperity and social equity (WCED, 1987; Elkington, 1998).

The International Institute for Sustainable Development (IISD) explicates environmental integrity to be the principle that ensures that our activities do not affect the ecosystem where we abode, because these ecosystems have inadequate renewing capacity and ability (IISD, 1995). Thus, when the natural environment become compromised through population growth combined with depletion of natural resources, emission of greenhouse gases, waste and decreased biodiversity, then the basic necessities of life such as water, air, and food become compromised as well (Pearce *et al*., 1989; WCED, 1987; Doering *et al*., 2002).

By ensuring equality and access to the commons in the society, the social equity principles is deemed to be fulfilled. WCED (1987) purported that pivotal to the definition of sustainable development is the avowal of supply of needs both now and in the future. Needs does not comprehend only the basic necessities of life, but more importantly also considers the quality of life available for citizens' usage (WCED, 1987; IUCN, 1996; UNEP, 2013; UK Secretaries of State for the Environment, 1994).

Economic prosperity on the other hand is hinged on the provision of goods and services to improve the standard of living throughout the world. In as much as the fulfilment of any of the principles without the other does not leads to sustainable development, the economic prosperity principles are influenced solely by the performance or meeting the needs of the environment and social principles (WCED, 1987). For instance, the provision of homes, food or clothing will involve the usage of natural resources like cutting down trees for construction, for heating and firewood for cooking. Inability of any society in controlling their economic prosperity principles would lead to a compromised wellbeing and health (WCED, 1987; Schmidheiny, 1992; WBCSD, 2002).

Sustainability is a broad concept, and its usage is varied in several areas: in academia, businesses, manufacturing, buildings etc. (for example see Bansal, 2005; Entrop and Brouwers, 2009; Martens and Carvalho, 2016; Singla *et al*., 2017). Therefore, it is imperative to specify the kind of sustainability this study is considering i.e. urban sustainability. Castells (2000) asserted that a city is said to be sustainable if its current approaches to production, does not overtime affects its future conditions for reproduction. Hiremath *et al*. (2013) provides a clear current definition of urban sustainability as one that balances urban development and environmental protection with an interest in economic prosperity, urban mobility, good health provisions, enormous comestibles and basic needs, and quality of living in our urban space.

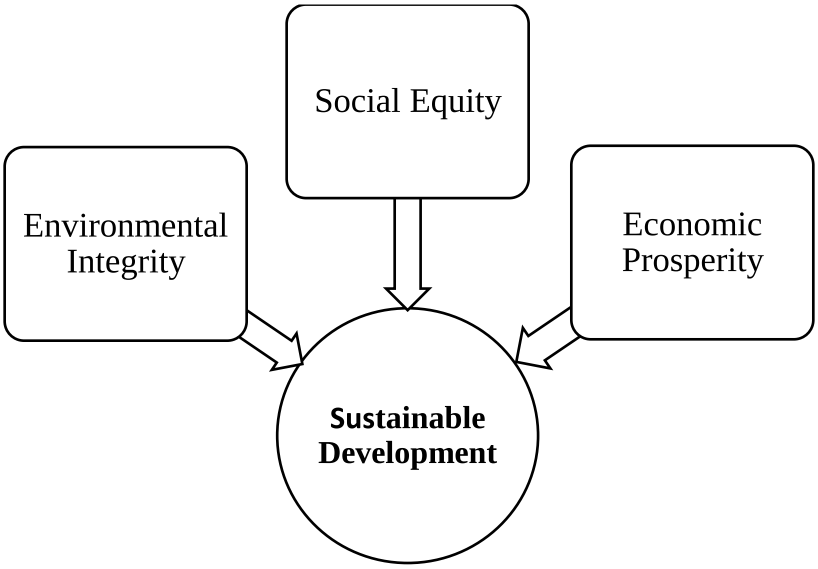

Figure 2.1 Sustainable Development Principles

Author's Construct (2019)

Applying sustainable development principles to the development of smart cities could yield tremendous benefits and lead to the provision of solutions to problems while eliminating the chances of creating further problems for future generation. Hence, ensuring that after satisfy the current generation's needs, there are enough undisturbed provisions available for the future generations to also satisfy their own needs. In other words, it can be viewed that smart cities are good, but their creation should not come in to solving only the current problems of urbanisation by using, exhausting or affecting the current limited resources, but however, the smart cities concept should be able to solve the problems of today, as it also prepares and helps future generations to also meet their own needs.

2.4.2.1 Sustainable Smart Cities

The need to incorporate sustainable development factors in smart cities engendered the notion of sustainable smart cities. Mostly not combined, many authors would rather consider a city as smart or sustainable (Satterthwaite, 1997). Therefore, sustainable smart cities could be viewed as an all-encompassing approach which would help recoup the benefits of both smart cities and sustainable cities. A study conducted by Ahvenniemi *et al*. (2017) depicted very interesting results on smart cities and urban sustainability. According to them, after considering some smart city and urban sustainability indicators, it was revealed that smart city focused more on social sustainability while urban sustainability targeted the environment related factors. Notwithstanding, smart cities have a more predilection towards economic sustainability as compared to urban sustainability (ibid). Therefore, to achieve the full benefit of sustainable development, combining smart cities and urban sustainability could come in-handy (Kramers *et al*., 2014; Ahvenniemi *et al*., 2017).

It is surprising, however, from Ahvenniemi *et al*. (2017) studies that smart cities, though assessed to involving the usage of technologies and application of ICTs (smartness), had little impact on helping us achieve environmental sustainability (see Figure 2.2, smart city did not contribute to environmental sustainability), but rather urban sustainability assessments were seen to be focused more on environmental sustainability with tenuous impact on economic and nothing on social equity (vice versa for smart cities).

Notwithstanding, the fact that smart city is paying more attention to social inclusion is noteworthy, because in the past most urban development disregard the possibilities for citizens' participation (see for example Ford, 2010), and most sustainability studies reported of the flimsy attention given to social equity factors in sustainable development (Vallance *et al*., 2011; Murphy, 2012).

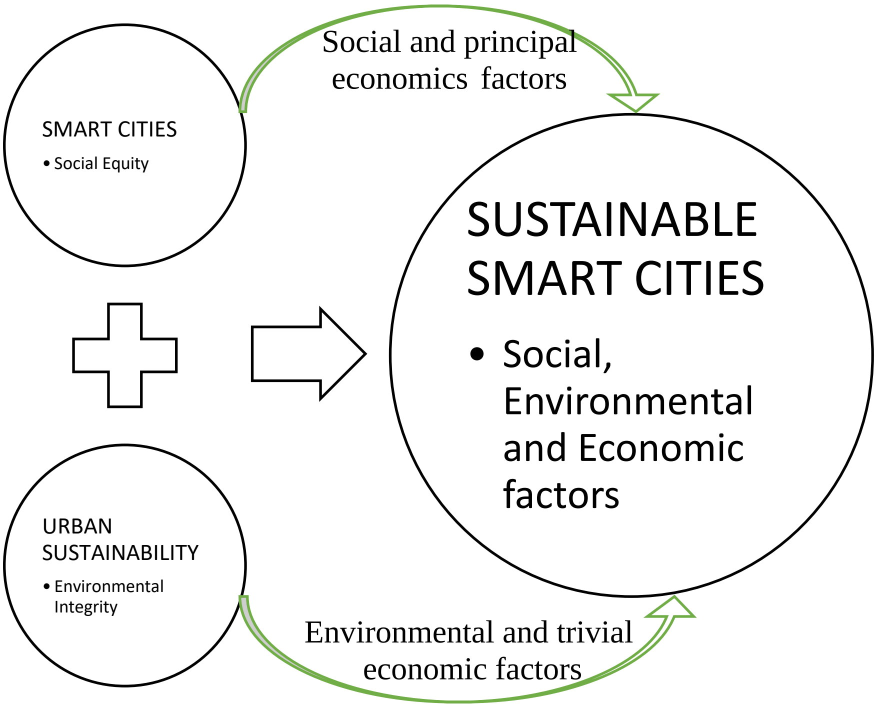

Figure 2.2 Conceptual diagram of sustainable smart cities

Source: Author's Construct (2019)

From Figure 2.2, it could be seen that sustainable smart cities can be obtained when there is an intentional effort to improve our urban space to be smart through incorporating ICT and technologies into our urban infrastructures, and also harvest the nonpareil importance of maintaining urban sustainability in our urban conurbations. As seen from Ahvenniemi *et al*. (2017) studies, sustainable smart cities can be attained through the contribution of social equity factors from smart city concept and environmental integrity factors from urban sustainability with a combined effect of economic factors from both to ensure a sustainable smart city. Thus, in defining what a sustainable smart city is, Höjer and Wangel definition of smart sustainable city could be used as a benchmark. According to Höjer and Wangel (2015), a smart sustainable city is one that enables occupants to achieve their own needs without limiting the ability for other people (currently) or future generations to also achieve their own needs, and where the whole concept is supported by the infusion of ICT. Withal, while Höjer and Wangel coined the term smart sustainable city, this study intended to look at the term in a different array as sustainable smart city.

This study agrees with (Hollands, 2008; Allwinkle and Cruickshank, 2011; and Kitchin, 2014) that the word smart is a normative term which needs to be attained. Hence, in that light, as cities are becoming smart, one will intend to consider how best cities can become sustainable as well, rather than considering cities now as sustainable and looking at how they can become smart. The novelty of the study lies in incorporating sustainability in the developing field of smart cities and not integrating smartness into the fuzzy area of sustainable cities.

Therefore, from Figure 2.2, this study defines a sustainable smart city as a city that ensures that as it is pertinacious and determined on developing it urban structures and processes in becoming smart; it presupposed without balking ensures that its developments do not have any negative effect on environment, the economy and the society as a whole. In other words, as the city becomes smart in meeting the needs of the current generation, it does not jeopardize the ability for people (currently in other regions, country etc.) and future generations in also meeting their own needs.

2.5 SMART CITY FRAMEWORK

In understanding the smart city framework, several researchers have numerous views of the objects or constructs which when available and fully implemented would make a city smart (Giffinger *et al*., 2007; IBM, 2009; Washburn *et al*., 2010; Caragliu *et al*., 2011; Lee *et al*., 2013 etc.) IBM (2009) purported that the formation of smart cities comprises of intelligence, interconnection and instrumentation. “The development of smart cities involves the application of ICT, environmental sensors, digital footprints of the inhabitants, manipulation of the resulting data using statistical techniques, and finally the use of complexity modelling and advanced visualisation in order to make sense of it all" (Campkin and Ross, 2013, p. 3).

The creation of smart cities is seen to involve two main areas, either a top-down approach or a bottom-up initiative. Considering top-down approach to city formation, the focus shift to building up a smart city from the scratch, mostly in a new area which is going to be developed to incorporate the smart technologies or processes into urban structures (Breuer *et al*., 2014). It is mostly seen as the control room approach. Examples of such cities have been developed at Rio De Janeiro in Brazil, Songdo in South Korea and the Masdar City in Abu Dhabi (Singer, 2012). However, most smart cities built through the top-down approach has been chastised as one which appears as an alien to the citizens in that particular locality; mostly running into excessive delays and cost overruns which do not attract any economic activity hence preventing people from moving there (Conway, 2013; The Economist, 2013; Sennet, 2013). Cities are about people, and people must be integrated in its designs, in terms of the real problems which these innovative technologies embedded in cities are charged to solve (Breuer *et al*., 2014).

The bottom-up approach is one which incorporates the people living in the cities in its design. In fact, change is being purported and brought by the people unlike the top-down initiative where a large IT company comes in with their technologies trying to control everything that happens in the city. The bottom-up approach recognises openness, freedom and serendipity in the livelihood of our cities (Lindsay, 2011). This approach is most often dubbed the default mode of urban development (Echanove and Srivastava in De la Peña, 2013). Irrespective of the preference for this method of smart city formation, leaving everything to citizens tends to take a long time before smart cities are upscaled in taking charge of several aspects of the cities. It also poses problems of interoperability, barriers and incentives into making the smart cities (Breuer *et al*., 2014).

2.5.1 The Six Dimensions of Smart Cities

Giffinger *et al*. (2007) identified the six-dimensional frameworks for classifying smart cities; also known as the six pillars of smart cities (smart mobility, smart people, smart governance, smart living, smart environment and smart economy). These six pillars have been explicated below.

2.5.1.1 Smart Economy

Smart Economy is concerned with the ability to innovate, the spirit of entrepreneurialism, flexibility of the labour market, ability to transform and integrate into international markets as well (Giffinger *et al*., 2007; Lombardi *et al*., 2012). Torres *et al*. (2005) and Bakici *et al*. (2013) are of the view that smart economy is about knowledge and innovation integration, where these clusters are used for establishing and driving cooperation between stakeholders. Smart economy is also alleged to be an amalgamation of the enterprise economy and innovation or ideas economy in order to create a green economy which fosters sustainability and reduction of costs; hence using available resources to nurture and carry out innovative approaches (Schaffers, 2011; Zygiaris, 2012). Smart economy is being purported by some key researcher as one that promotes business formation: attracting new and retaining existing businesses; managing resources wisely and improving sustainable economic growth and high quality of living, with a flexible labour market and having the propensity of integrating into international markets (Hollands, 2008; Caragliu *et al*., 2011; Giffinger and Gudrun, 2010).

2.5.1.2 Smart Mobility

Smart Mobility deals with the improvement in our transport systems, reducing accidents, traffic thronging and ensuring the easy flow of traffic around cities. This involves the use of modern, sustainable and safe systems and incorporating Information Communication Technologies into structures (Giffinger *et al*., 2007; Vanolo, 2014). When discussing smart mobility, researchers tend to consider how sustainable transport systems are, the accessibility of it either internationally and or locally, its safety and sustainability etc. Smart mobility encompasses the use of sensors in monitoring our transport systems, the kind of transport systems adopted, its usage of energy and its effect on the environment, using mobility sensors to improve schemes used to monitor traffic, adopting the use of wireless sensor network node technology, intelligent wireless technology, tracking, and network planning and deployment (Liu and Peng, 2013; Hancke *et al*., 2013).

2.5.1.3 Smart Governance

Smart Governance is concerned with the transformation of government to make cities smarter (Meijer and Bolivar, 2016). It incorporates four main concepts which are government of smart city, smart administration, smart urban collaborations and smart decision making (Osborne, 2006; Torfing *et al*., 2012). Vanolo (2014) expatiated the smart governance concept as one that leads to a pellucid government system, takes part in the decision making within our urban space and make use of public services and quality political strategies. Meijer and Bolivar (2016) opined that smart governance is about using ICT to obtain better outcomes and more open governance processes through new forms of human collaborations. Batty *et al*. (2012: 505) highlights that 'smart governance is a characteristic concerned with governmental management of a city whenever the city is promoting itself as smart. 'Alkandari *et al*. (2012) purported that government should take charge of the smart city concept and mark up specific areas of priority, and Winters (2011) argues that city officials must concentrate on promoting higher education in their urban space and this would lead to the making of their cities smart.

2.5.1.4 Smart Environment

Smart Environment is associated with sustainability and keeping our surroundings off waste and other pollutions. Hence, making our surroundings appealing and managing resources efficiently (Giffinger *et al*., 2007). One key thing about sustainability is the environment. Hence, making sure that our activities does not leads to adverse climate change and continual resource depletion. Increase in population leads to increase in infrastructure provision, and as well documented, the activities of the construction industry contribute so much to greenhouse gases emissions, waste and energy consumption (Anderson and Thornback, 2012; Nagapan *et al*., 2012). Smart Environment as a pillar looks at how our smart city can incorporate warning systems for natural disasters, uses smart grids to reduce energy effects on the environment, and efficiently manage life on land, on water, biodiversity, promotes greenness and maintain our natural heritage and resources (Giffinger *et al*., 2007; Komninos, 2009; Lee *et al*., 2013).

2.5.1.5 Smart Living

Smart Living encapsulate the diverse part of the social and healthy environment. The interoperability between humans and their environment. Thus, considering our health being, ensuring quality of life, personal safety, social cohesion, educational and cultural services amidst others (Caragliu *et al*., 2011; Lombardi *et al*., 2012). This pillar, though very important has been facing several castigating reprimands about its standing as a strong pillar of its own. For instance, Shapiro (2006) is of the view that quality living could be achieved if all the other pillars of smart city are well effected and implemented. According to Shapiro's argument it can be viewed that achieving a smart governance (openness and sharing of data), smart environment (caring for the effects on the naturals), smart people (improving education, competencies and knowledge), smart mobility (improving and expediting transportation and infrastructure) and smart economy (enhancing the industry, innovation, entrepreneurship and business creation) would all lead to the achievement of smart living. Hence, this pillar should not stand alone. Nevertheless, Giffinger and Gudrun (2010) is of the strong view that smart living looks more into safety and security, food, health and social inclusion which features a broad area and must be considered differently.

2.5.1.6 Smart People

In this study, smart people are the sixth pillar of smart city dimensions, and unlike a phantom sixth, it is purported to be the most important among all the six dimensions. This is because without smart people, none of the other functions can perform to its full realisation (Caragliu *et al*., 2011). People must be smart to ensure smart mobility, to keep their environment clean, to govern well, to integrate and create better economies and to incorporate sustainability in everything they do. Divergent to the conventional view of smart city being the incorporation of ICT in urban infrastructure, (Shapiro, 2006; and Hollands, 2008) are of the concession that smart cities start from the development of human capital and capabilities rather than lingering on ICT deployments to create smart cities. Therefore, the label smart city should refer to the aptitude of clever people to generate clever solutions to solve mind-blogging problems. Hence, Vanolo (2014) puts it in a nice way that smart people deal with creativity, tolerance, cosmopolitanism and the level of qualification of people in terms of social and human capital in the indulgence of public living.

2.5.2 Other Compelling Dimensions in Conceptualising Smart Cities

Apart from the six dimensions of smart cities which will be used for conceptualising smart cities for this study, it is worthy to note that several researchers have developed other integrative approaches in helping us know which cities are smart rather than accepting self-proclamation and looking in the wrong directions in classifying smart cities. For instance, 70 European medium-sized cities were ranked by the University of Vienna by using an assessment metric which is similar to the one used for this study (Giffinger *et al*., 2007). In their metric, a critical pillar like smart mobility was divided into sustainable transport system, easily accessible internationally and locally, safe and sustainable transport etc.

The Intelligent community forum also developed another assessment criterion based on five main target areas: innovation, advocacy and marketing, digital inclusion, broadband connectivity, and an educated workforce which they use in announcing 21 smart communities worldwide yearly. More recently within the past five years, Zygiaris (2012) developed a comprehensive measurement system using six layers in defining smart cities. According to the study by Zygiaris, smart cities can be conceptualised by viewing them from the perspective of a city layer, green city layer, instrumentation layer, open integration layer, application layer and an innovation layer. In 2012 however, Lazaroiu and Roscia (2012) came out with a smart city index which was used in the distribution of funds for the European 2020 strategic plan. Nevertheless, this index was seen to have a limitation of obtaining information and assigning weighting to indicators.

A more sophisticated approach in measuring of city smartness was proposed by Lombardi *et al*. (2012) which looks at an improved triple helix model which considers the three main areas: universities, industry and government (adding a fourth one: civil society) in managing a knowledge-based innovation system. Several other measurement systems have been developed. For example, the global power city index by the Japanese Institute for Urban Strategies, Smarter Cities Ranking by the US, Natural Resources Defense Council whose measurement is more of environmental specific. Scientist Joel Kotkin in collaboration with Forbes also publishes world smartest cities which mostly encourages economic hub of cities; argued to be very efficient and integrative (IDA, 2012; Albino *et al*., 2015).

Notwithstanding, this research tends to focus the conceptualisation of Kumasi City by adopting the Giffinger *et al*. (2007) six dimensional pillars of smart cities because, this approach has been used by several researchers over the years (see for example: Lombardi *et al*., 2012; Zygiaris, 2012; Albino *et al*., 2015) in conceptualising smart cities. Moreover, the six pillars could be seen as a neoclassical and traditional approach which incorporates and encompass several if not all the fields which needs to be studied and documented in coming out with the smart city concept of any city (Ojo *et al*., 2014; Albino *et al*., 2015). Figure 2.3 below depicts the proposed approach in conceptualising a smart city in developing country (Ghana).

2.5.3 Measures of Performance

Throughout literature, several researchers have tried to conceptualise the idea of smart cities for easy acculturation, but a generalisation and universally agreed approach have not been formulated yet (Giffinger *et al*., 2007; Holland, 2008; Winters, 2011; Zygiaris, 2012; Albino *et al*., 2015; Kuyper, 2016 etc.) However, most studies and other independent bodies (for example the intelligent community forum; smart cities ranking etc.) try to determine or come out with some parameters for ranking cities in the world (Albino *et al*., 2015; Akande *et al*., 2018). In a nutshell, there has been a formulation of approaches which are used in measuring the performance of cities so far in the light of becoming smart cities, and sustainable in the process (Giffinger *et al*., 2007; Lombardi *et al*., 2012; Zygiaris, 2012; Albino *et al*., 2015).

In coming out with these performance measurements, there are some dimensions which researchers or independent ranking bodies look out for. For instance, the Giffinger *et al*. (2007) six dimensions were adopted by Lombardi *et al*. (2012) in their formation of the triple helix model, while Albino *et al*. (2015) referred from Lombardi *et al*'s studies in their smart cities' dimensions and performance measurement research. Measurement of performance of cities is also being determined by the use of indexes. For example, the Economist Intelligence Unit (EIU) in the year 2000 used the digital economy ranking in assessing the infrastructure quality of countries in terms of their incorporation and readiness to adopt ICTs (Al-Nasrawi *et al*., 2015). Other indexes used in measuring city performance in becoming sustainable and smart includes: Global Competitiveness Index (GCI) used by the World Economic Forum since 2005; Network Readiness Index (NRI) also managed by the World Economic Forum (WEF); Global Innovation Index used by the World Intellectual Property Organisation (WIPO) and Green City Index used by EIU since 2009 under the sponsorship of Siemens etc. (ibid).

However, irrespective of the several indexes and methods of measurement available in determining the smartness level of a city, none of the indexes captures all the dimensions which makes up a smart city. For instance, the Green City Index mostly harness on environmental issues while giving little or no consideration to economic factors. The Global Competitiveness index also focusses on the economies of countries and leaves little room to consider other dimensions of smart cities. Therefore, using any of the above indexes for determining the smartness level of Kumasi city would render it inappropriate. Al-Nasrawi *et al*. (2015) purported that the inability of the indexes capturing all the six dimensions of smart cities renders them inappropriate for determining the smartness level of any city fully. Hence, adopting a two stage conceptual approach which looks at the determining the smartness of a particular city through the strategic lens of the six dimensions and finding sub-dimensions under each pillar to enable experts through their experience and observation to rank these variable could be considered appropriate as compared to the use of indexes (Al-Nasrawi *et al*., 2015).

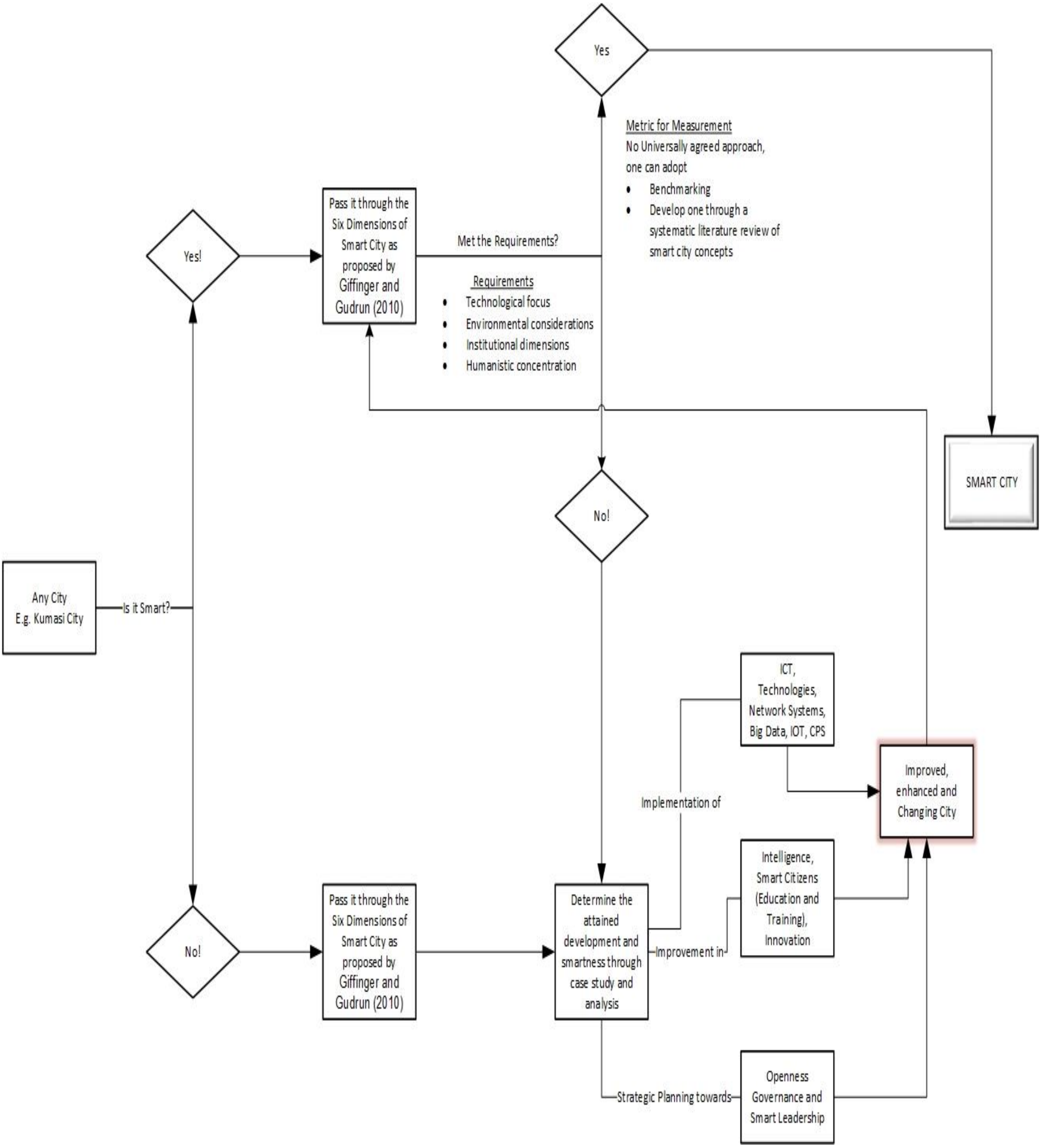

Figure 2.3: Conceptualising a Smart City

Source: Author's Construct (2019)

2.5.3.1 Formulating an Index or Rating for Measuring Kumasi City

Akande *et al*. (2018) purported that the formulation of an index requires the creation of an appropriate weighting for the variables. Most of the studies are opaque in their methodology for weighting (Zygiaris, 2012; Lombardi *et al*., 2012; Albino *et al*., 2015; Al- Nasrawi *et al*., 2015). There are two main methodologies for weighting, which are the equal weighting method and the participatory methods. The equal weighting method is when each variable is giving the same weighting irrespective of its contribution to the attainment of a variable or solution while participatory methods is when a variable weighting depends on its contributions. Kahn (2006) used the equal weighting method by assuming all variables to contribute the same under a phenomenon study. However, the participatory method is preferred in coming out with measurement of cities as seen in works of (Kahn, 2006; Mayer, 2008; OECD, 2008; Giffinger and Gudrun, 2010).

Therefore, by adopting the six dimensions of smart cities as proposed by Giffinger *et al*. (2007) in determining the smartness level of Kumasi city, the various dimensions were given weightings based on their participatory contribution to seeing or making a city smart. The weighting given to each dimension was based on a systematic literature review about what researchers through their numerous studies considers which dimension to be of high importance as compared to the other in the transformation of cities to becoming smart.

Giffinger and Gudrun (2010) came out with a score table for ranking cities through their achievement level obtained from descriptors of some selected cities for their studies. According to them, the metric for ranking cities was divided into four main ordinal scale, which are: Basic, High, Advanced and State of the Art. To achieve this Giffinger and Gudrun (2010) used a quantitative analysis, and put the smartness category on a scale of 1 to 4. Taking inspiration from this research, and through a systematic review of literature, this study also adopted a similar approach to ranking the dimensions of Kumasi city in enabling us to identify the smartness level of the city.

Inferring from systematic review of literature, and from experts' views, smart people, one of the dimensions of smart cities is seen as the most important aspect of the dimensions of smart cities (Shapiro, 2006; Hollands, 2008; Caragliu *et al*., 2011; Vanolo, 2014). Therefore, this study gave this dimension a rating of ten (10) as the highest rating which any dimension can obtain in leading a city to becoming smart. The next important dimension is smart economy, which is being purported to be the amalgamation of the enterprise economy and innovation of ideas in creating green economies which promotes sustainability, quality life, and nurturing and improving innovative approaches in the city (Schaffers, 2011; Zygiaris, 2012). Smart Economy was given a rating of nine (9). Smart Mobility was the third most important dimension from review of literature and urban researchers' experts' views. Hence, given a rating of eight (8). This dimension was considered to be important because of its linkages in improving smart economy, quality of life and sustainability of our environment by considering the use of modern, sustainable and safe systems which have no effect on the environment (Giffinger *et al*., 2007; Liu and Peng, 2013; Hancke *et al*., 2013; Vanolo, 2014). Following suit is smart environment, given a rating of seven (7), smart environment is purported as an important pillar in city formation because it generally looks at ensuring quality living, protecting the environment from harm, promoting biodiversity, greenness and maintaining natural heritage and resources, which are considered important for our existence (Giffinger *et al*., 2007; Komninos, 2009; Lee *et al*., 2013). Smart Governance was given a rating of six (6). Smart governance is considered as one important dimension which could ensure the achievement of the other dimensions of smart cities. This is because government of a city, its administration, collaboration and decision making all falls under this important pillar, and a city cannot become smart when this dimension is not pellucid and smart (in terms of technology and innovations in solving problems). The last important dimension is smart living, and it was given a rating of five (5). This dimension is mostly seen as the outcome of all the other dimensions of smart cities. Hence, smart living could be achieved when a city has smart people, with a well-integrative smart economy, boosted by a smart mobility, leading to a smart environment, with the whole process enhanced by smart governance and finally resulting to smart living in the city (Shapiro, 2006). Hence, the ideal smart city.

2.5.4 Upscaling of Smart Cities Objects

Upscaling is simply an approach to take what have been developed minutely in labs or theory and implement it practically on the field or make them available to a wider audience. Kuyper (2016) defines upscaling of smart cities as an initiative which helps to harness the smartness and sustainability prospects of smart cities on a large scale. While there have been a lot of thought on the smart city conceptualisation, little is said in literature about upscaling the smart city concept (Oomens, 2016). Kuyper (2016) opined that it is imperative to include upscaling of smart cities plans during the conceptualisation stage or the knowledge stage in creation of smart cities. Van Winden (2016) proposed three main ways in which smart city concept could be up scaled, which are: replication (duplicating an already made up smart city in a different locality, but within the same system or county), expansion (increasing the smart city grid without triggering urban sprawl, or improving functionality and adding on more partners); roll-out (improving current conditions by bringing compatible innovations into urban areas). Also, Jolly *et al*. (2010) created seven dimensions of upscaling of smart cities which are geographic scaling, replication, institutional scaling, quantitative scaling, organisational scaling, deep scaling and functional scaling.

2.5.4.1 Challenges

The challenges of upscaling of smart cities from an idea in theory to more practical based through smart city pilot projects is very overt (Schaffers *et al*., 2011; Deloitte, 2015; Van Winden, 2016). Just as with many problems of upscaling, the issue of funding is predominant with the upscaling of smart cities. However, funding issues are not the only problem that smart cities are combating, but also the conflicting interest of several parties involved in smart city initiatives (private company interest, politics, citizens' participation among others) as well as the lack of skills, technology and the requisite professionals (Van Winden, 2016). Also, Kuyper (2016) asserted that lack of understanding of end-users of smart cities could also be barrier to its upscaling as well as lack of a working business model.

2.6 FIRST SECTION SUMMARY

This section in a nutshell presented the theoretical backings of the study. The purpose for the concept of smart cities as understood or needed by government and city officials was overt (engraved in urbanisation and population growth) as compared to the alternative intentions of giant ICT companies. Moreover, the development of the concept from the initial ideology to current usage is also explained in this section. Also, the chapter gives a remarkable insight into the sustainable development factors and their impact or influence on smart city formation. Lastly, the study concludes by considering the six pillars of smart cities, and approaches adopted in scaling up the smart city objects. The whole review of this section is summarised in Figure 2.4.

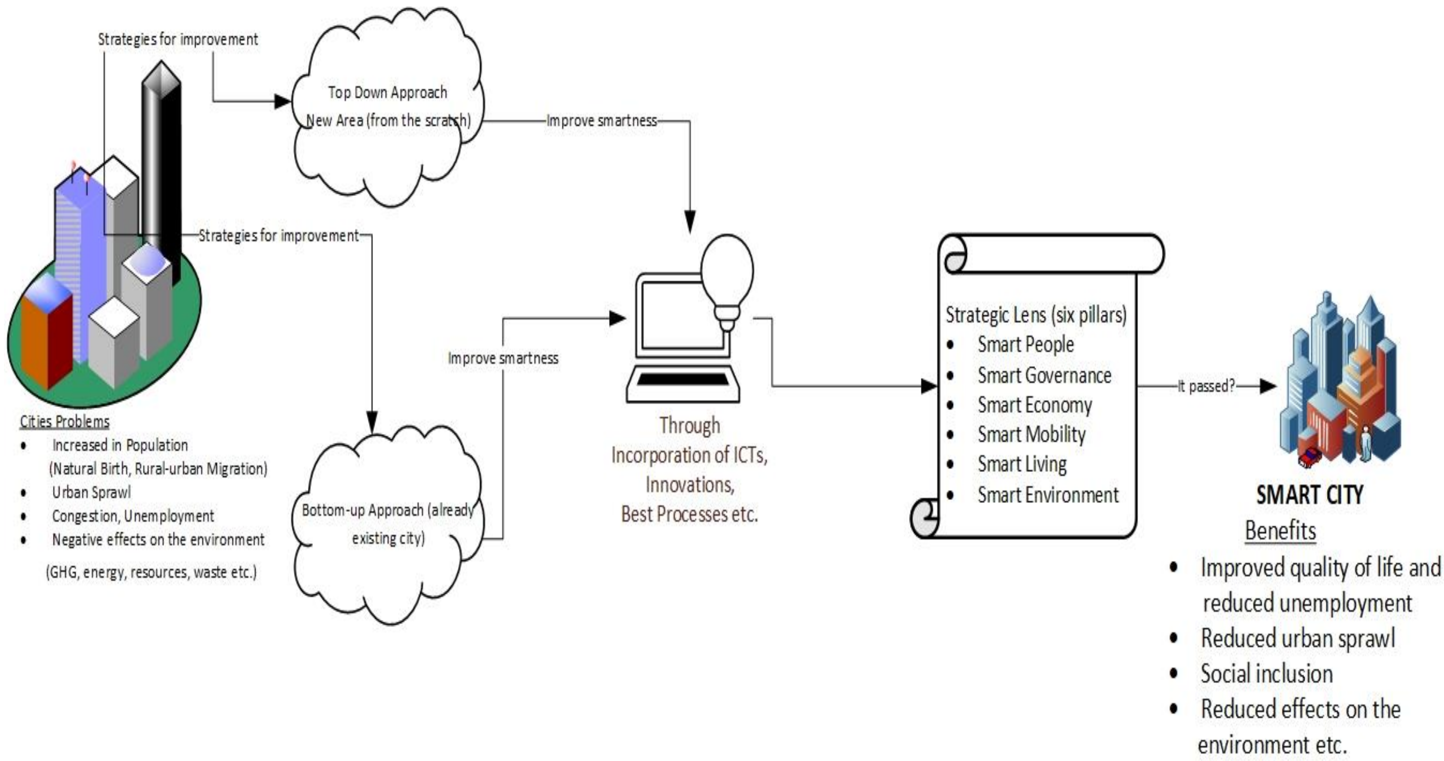

Figure 2.4: Simplified theoretical review for this study

Source: Author's Construct (2019)

SECTION 2: SUSTAINABLE CONSIDERATION OF SMART CITIES: A CRITICAL REVIEW

2.7 INTRODUCTION

This chapter provides a comprehensive review of literature on sustainability and sustainable development factors with specific insights on how such intriguing approaches could help in maximizing the smart city concept usage in developing countries. The review presents a reliable gap and challenges facing the adoption of the smart city concept and the sustainable perception of the whole approach in developing countries. The review is important since it leads to addressing the research problems, objectives and research questions of this study which seeks to explore the sustainable considerations of smart cities in developing countries. The chapter opens by providing an exhaustive overview on the approach of review of literature adopted, and a classifying stand for adopting a psychometric approach in selecting impactful definitions from tons of several conflicting but informative definitions and concepts on the smart cities, sustainability and sustainable development factors for this study. Key sustainable development factors are identified and presented in this study as well as militating factors for the implementation of sustainability in smart cities concept in developing countries. The chapter concludes by considering critical success factors for sustainable considerations of smart cities in developing countries.

2.8 CRITICAL REVIEW APPROACH TO RESEARCH

The review presented in this section is more of a critical analysis of theoretical and methodological views from important urban studies on the subject of smart city, sustainable development factors of smart cities and critical success factors for sustainable consideration of smart cities. Critical reviews, since its inception in 1990s, as inspired by

Michel Foucault's attempt to identify the underground understanding implicitly found in most diverse forms of knowledge, whether it is of public view, policies, moral dissertations, scientific knowledge or orthodox wisdom, and most often having conflicting boundaries between these several factions (Elden, 2016). The basic assumption for critical review is that truth is a historical and contingent product; thus, some key historical and geographical paradigms enables us to identify between true and false, appropriate and inappropriate (Vanolo, 2014).

2.9 SUSTAINABLE SMART CITIES: CONCEPTUAL REVIEW

Indefatigably, cities must constantly ensure that their activities do not affect the sustainability of its environment, and of their neighbouring environs by using any intelligent technologies available to them in decreasing effects (waste, greenhouse gases, energy consumption etc.) on the environment (Ahvenniemi *et al*., 2017). The target of sustainable smart cities is not only on achieving environmental integrity, but also in attaining economic prosperity and social equity, hence an embodiment of sustainable development principles (ibid). Thus, seeking to manage urban functions in a way so as to maintain balance between social, economic and environmental factors of sustainable development (Stratigea, 2012).

Sustainable considerations of smart cities are then fixated on producing cities, and incorporating all the necessary Information Communication Technologies (ICTs) into our urban space without harming the natural environment (Alusi *et al*., 2011). Continuous and unplanned urban growth endangers sustainable development when documented policies becomes idle, and the necessary infrastructure is not developed (UN, Department of Economic and Social Affairs, 2014). Urbanisation is integrally incorporated into the three pillars of sustainable development; thus, economic prosperity, social equity and environmental integrity (Bansal, 2005).

Developing countries have been observed to be having rapid urban growth from the year 2000 to 2030. Hence, it could be projected that about 5 billion people would be added to the urban dwellers of developing countries by 2050. This whooping number of people presents a huge challenge of how to combine urbanisation and sustainability. Currently, cities of today consumes about 80% of the world's energy; therefore, a well-thought out approach should be advised to reduce the greenhouse gas emissions and carbons which comes from buildings, mobility and city dwellers now and in the future (Alusi *et al.*, 2011).

The sustainable considerations of smart cities would look at how to incorporate some green building materials in construction, how to ensure that resources are used efficiently, how to ensure zero waste management system of our cities, how to shift people from personal cars to public transport, cycling or walking, and how to maximise water efficiency and produce a 100% carbon-neuter energy for our cities (Harvey, 2011). In other words, Vanolo (2014) pronounced that a smart city is an efficient, green, socially-inclusive and technically advanced city. Intuitively from Vanolo's definition, Yigitcanlar (2016) expressed that a smart city is one that considers finding solutions to environmental, societal and economical challenges in our urban conurbations. Hence, informing the reasons to identify these key sustainable development factors ingrained in the smart city concept.

2.10 KEY SUSTAINABLE DEVELOPMENT FACTORS OF SMART CITIES

The key sustainable development factors of smart cities are the elements which must be overt in the formation and development of smart city concepts, or they are those factors which smart cities must incorporate to ensure the sustainability of the whole concept. Sustainable development is grouped into three main principles (social equity, economic prosperity and environmental integrity), therefore, in considering these key sustainable development factors, it would be expedient to consider them in the light of these three main principles in capturing and coming out with all the essential factors which needs to be considered in the creation of smart cities.

Notwithstanding, researchers over the years have shared their views on how smart cities incorporates sustainability principles in its formation and creation. For instance, Marsal-Llacuna *et al*. (2015) professed that smart cities cogitate the environmental friendliness and liveliness of past cities while ensuring sustainability and quality of life for its citizen and as usual making use of technology. Lazaroiu and Roscia (2012) purported their view by mentioning some key factors which a smart city should have in order to make the whole concept sustainable. According to them, a smart city should be sustainable, comfortable to live in, attract locals and foreigners, safe and secured, enabling grounds for business survival, technological and very interconnected. Alusi *et al*. (2011) added their view that to obtain a sustainable recognised smart city, cities must typically include measures to reduce carbon emissions, enhance resource efficiency and economic development goals and create unique designs which helps to harness energy efficiency for the smart city concept.

From Nam and Pardo (2011) studies, Caragliu *et al*. (2011) envisioned and concluded that investment in the several aspects of smart cities components could yield sustainable development factors such as effective and efficient management of waste and natural resources, enabling environment for innovation and better services for citizens while consolidating and enhancing political issues and governance. Smart cities contain sustainable development factors such as air and waste pollution mitigation, water and energy efficiency and conservation measures (Meadows, 1999); greener environment and social equity (de Jong *et al*., 2015).

Finally, Dhingra and Chattopadhyay (2016) described the goal which a sustainable smart city must attain. These goals include among others the adaptable, scalable, and resiliency of cities. Thus, a sustainable smart city must improve quality of life for its citizens, create an enabling environment for business growth and boom the economy, promise enhanced health access and improved social services for its citizens, establish an environmentally responsible and sustainable approach to development, incorporate an integrative and efficient distributed and easily accessed basic amenities in the city like transport, water, energy, telecommunication and other utilities; have at heart, measures and initiatives to combat and control climate change biodiversity of its environment, and provide an open and efficient governance which is citizen inclusive.

2.10.1 Social Equity Factors

Equality in sharing of the benefits of the common good is very imperative, and needs to be well-thought out in the formation of smart cities (whether top-down approach or bottom-up initiative). The UN, Department of Economics and Social Affairs (2014) purported that smart cities should include the citizens as part of their formation. Explicitly delineating that there must be appropriate usage of ICTs for a better service delivery to the publics, need for building institutional capacities and applying integrative means to achieve urban sustainability, provision of easy access to health and quality lifestyle which would be available for everyone in our cities. Thus, sharing the urban benefit equally and sustainably, mobilizing investment and improving rural settings to improve rural livelihoods. Vanolo (2014) was of the view that until a city achieves the status of being social inclusive, it cannot be dub as smart city.

Shelton *et al*. (2015) opines that smart cities should incorporate smart infrastructures and guidelines with improved Public Private Partnership (PPP) and citizen participation targeting to creating a more liveable and sustainability inclusive environment. Smart cities through the use of ICT has increased productivity, enabling and enhancing communication and transportation in our urban conurbations (Höjer and Wangel, 2015). Caragliu *et al*. (2011) conceptualise the idea of smart cities and purported that it should enhance development of culture and the society through a network of infrastructures and enable social inclusion of several different cultures in our urban space. Easy access to services and social amenities, and empowering citizen participation in a smart city can be tagged as achieving the social equity factor of sustainable development (Sinner *et al*., 2004; Bramley and Power, 2009).

2.10.2 Environmental Integrity Factors

The increase in population is without doubt having significant effect on the environment when left unplanned and managed. To ensure that smart cities adheres to environment integrity, UN, Department of Economics and Social Affairs (2014) is of the view that smart cities should incorporate diversified policies for managing spatial distribution of the population and internal migrations. Policies such as land rights allocations, land use management, and regional development zones could be created and implemented to force policy makers or urban city officials in incorporating these policies in formation of smart city (ibid). In the adoption of smart mobility by the smart city concept, citizens are encouraged to make use of public buses, energy efficient vehicles and in so doing reducing the energy consumption and greenhouse emissions into the atmosphere (Aletà *et al*., 2016).

Vanolo (2014) opined that smart cities should be green and sustainable, preserve natural vegetation, water bodies and the environment. The sustainability of smart cities is envisioned in its ability to reduce energy consumption and greenhouse gas emissions. A sustainable smart city must involve renewable energy usage in its design, adopt measures to control pollution and waste while monitoring resources and improving the quality of water (Manville *et al*. 2014). Caragliu *et al*. (2011) also added that the motive of a sustainable smart city is to ensure environmental and social sustainability as the city emerges and develops.

2.10.3 Economic Prosperity Factors

In creating the desired future, it is important to incorporate certain key sustainable development principles or factors which would cater for the economic prosperity aspect of our living. UN, Department of Economics and Social Affairs (2014) purported that a holistic approach should be adopted in the formation of our cities such that there would be a lot of income and employment opportunities. There is the need to ensure proper and efficient mobility, reduced cost of energy and easy access to other benefits like water, ICT, and health at reduced cost. Smart cities through employing ICT has led to cheaper products and empowering consumption levels in our urban space (Höjer and Wangel, 2015). Caragliu *et al*. (2011) opined that smart cities should enable easy development of business models, tenaciously harness social and relational capital and emphasize on achieving a high technological and creative industries in the long term.

2.11 INFLUENCING FACTORS OF SUSTAINABLE DEVELOPMENT OF SMART CITIES

The militating factors which paralyses the improvement or adoption of sustainable processes in the creation of smart cities have been excogitated in literature. According to the European Commission (2008), there is the need to upgrade skills, research and innovation to improve the knowledge economy. Urban issues could also have the risk of shifting very often towards the field of post-politics where decision is influenced heavily by political decisions and ambitions (Catney and Doyle, 2011). Vanolo (2014) explicate further on the political ties, and opines that smart city is indebted to policies and planning ideas, and would require conventional wisdom in depoliticising the genuine concept of improvement in our cities from the cankerous ambitions of politicians.

Moreover, the smart city concept is creating a new trend of problems between the public private relationships in the management of cities (Deakin and Al Waer, 2011). The formation of smart cities without ensuring that citizens are smart in the usage of the cities and understanding of technologies leaves the city ajar without any sense in what we create. How then can we improve the sustainability thereof without incorporating citizens' education and knowledge in technology into the formation of smart cities, so that we can solve urban problems (Vanolo, 2014)?

Urban primacy is also a serious problem and a backlog to sustainable development of urban space. Hence, there is the need to reduce urban agglomeration in cities of countries in order to decrease the challenges of concentration of economic and administrative functions while providing solutions to some of the challenges of sustainable development in our urban sectors such as: urban poor, provision of housings to meet the growing population, basic social amenities and reducing negative effects on the environment (UN, Department of Economic and Social Affairs, 2014).

Government should be ready and prepared for smart cities, thus, successful sustainable smart cities requires competent, judicious and responsible governments who are ardent in managing and controlling city expansion and conjuring economic benefits from cities; being caught unawares would be very disastrous (UN, Department of Economic and Social Affairs, 2014). Chatterjee and Kar (2018) are of the view that developing economies are facing serious challenges in incorporating sustainable development factors into smart city concepts because of lack of proper plan and frameworks and validation of performance to global standards.

Most cities lack skilled workers, especially the technically or vocationally trained ones, and this slows down the economic growth of cities (Kamar and Dahiya, 2017). In fact, the construction of cities of tomorrow, runs the risk of being so much technological without an ounce of how best we can frame solutions and solve problems promoting sustainability in our settings (Vanolo, 2014). Smart cities have been so much focused on virtual environment instead of real time application, hence, one challenge to ensuring sustainable smart cities is to take advantage of urban sustainability and collaborate it with technologies and ICTs; implement it in real times and provide solutions to the lack of environmental sustainability approaches of the smart city concept (Ahvenniemi *et al*., 2017).

Alusi *et al*. (2011) purported that one of the militating factors to ensuring sustainable development of smart cities has to do with the creation of the smart cities itself (especially the top-down approach) which is purported to be very expensive (financially inclusive). From inference, we can appreciate that the benefit of having a sustainable smart city can be seen and valued in the long term, but the start-up capital proves to be very high, and mostly requires a partnership between the public and private sector to initiate such financially inclusive projects (ibid). However, the sort of Public Private Partnership (PPP) available for traditional projects appears not to work well for smart cities. Gunawansa (2010) expressed that the traditional PPP approach will not work for smart cities development because a completed city will require a long term and a high level of maintenance, it also appears difficult in binding developers and users of the sustainability standards incorporated, and also, there is a specific type of public acceptance needed to galvanise the interest of the public and businesses in the long term etc.

2.12 CRITICAL SUCCESS FACTORS CONCEPT

The concept of critical success factors has been in use since the early 1960s. However, its usage did not gain popularity until late 1970s when other scientist began to use this approach in identifying the factors which if available would make one competitive over the other (Leidecker and Bruno, 1984). The Critical Success Factors (CSF) methodology is an approach that is keen to make clear those few points or areas which needs to be improved to ensure future success (Boynton and Zmud, 1984). Rockart (1979) was the first person to propose the usage of CSF which was used as an information system analysis. Munro (1983) also suggested that CSF could be used to in directing efforts into developing of working strategic plans. High performance of concepts was also associated with the CSF approach (Anderson, 1984) through overt identification of the factors which needs to be worked on (Boynton and Zmud, 1984).

Notwithstanding, Ferguson and Dickinson (1982) proposed a slightly different usage of critical success factors: as one than can be used to formulate guidelines for monitoring corporate activities. Also, CSF improves relational approach to obtained data which is useful in planning efforts (Boytnon and Zmud, 1984). In summary, critical success factors are intriguing and important factors, generating needling and focused attention on them in circumventing bad approaches and improving already identified spectrums of success.

2.12.1 Critical Success Factors of Sustainable Development of Smart Cities

Sustainability of our cities is very important and cannot be overridden. Hence sustainable development should be treated as a priority to enable us reap the bounteous benefits which comes from considering sustainable development of smart cities. Nevertheless, as the world becomes urbanized, sustainable development challenges tends to surfeit mostly in developing countries where it is purported to be urbanising rapidly (UN, Department of Economic and Social Affairs, 2014). Some critical success factors which can be adopted in improving the sustainable development of smart cities are as follows;

Aoun (2013) opined that one of the best ways to improve the sustainability of our today and future cities is to implement efficient, cleaner and sustainable operations minimising environmental footprints. Moreover, cities must incorporate resource efficiency usage from the onset, regenerate ageing districts, ensure robustness of systems, incorporate design and planning in harmony with the environment (ibid). Governments must endeavour to share urban growth equitably and sustainably (UN, Department of Economics and Social Affairs, 2014). Also, Canning and O'Dwyer (2019) were of the view that a transition to a carbon free economy through efficient use of resources while meeting population demands would create a more environmentally sustainable solution. Efficient, reliable and low carbon technology is one of the key requirements for next generation of smart cities (Batty, 2013).

It could be envisaged that sustainable development of smart city would be realised if smart mobility in our urban space is improved through the usage of sensors and actuators, allowing real-urban data to be obtained and analysed (Chen-Ritzo *et al*., 2009). Analysis from urban data could help in monitoring, forecasting and managing urban flows and integrating the functioning of socio-economic activities. Lee *et al*. (2013) opined that, smart cities could be made sustainable through incorporation of green technologies in the transformation of urban space through master planning and infrastructure development. Moreover, overcoming challenges by adopting an effective Public Private-Partnerships which will shape models, add value and incorporates emerging technologies into the smart city system (ibid). Ling (2005) reckoned that sustainability of our cities could be achieved by implementing proper planning and management of the population within the limited impact on the environment with accrual benefits to health and economy.

Irrefutably, one critical success factor which could help alter and improve the sustainability aspect of our cities as they become smart is obtaining and maintaining data (UN, Department of Economics and Social Affairs, 2014). Big data analytics should be taken seriously by governments and city officials to help in predicting accurate, reliable and appropriate data on urbanisation trends, and developing policies to promote comprehensive and impartial urban and rural development (ibid). Kumar and Dahiya (2017) opined that to ensure economic sustainability of smart cities, cities should harbour an environment of human transformation through continuous learning, and giving out such learning to informal workers to upgrade their skills in order to make them creative with the ability to innovate in all parts of their lives.

Eremia *et al*. (2017) purported that development of smart grids in cities would help in maintaining a high standard for energy consumption in smart cities and leads to the creation of sustainable smart energy. The development of smart grids is very important as such approach would lead to the promoting of clean energy sources, efficient public lighting, smart metering, influencing the usage of electrical vehicles, and inculcate consumers into the platform (Chhaya *et al*., 2018).

Vanolo (2014) assayed that to ensure the sustainable development of smart cities, there must be a clear set of rules and roles, non-conflicting and not intersecting which will separate urban government from politics and observe it in the lens of the environment and technology. The researcher further reiterated that smart cities can gain grounds if we create mechanisms which will lead to the autonomous and administrative control of inhabitants in smart cities. Lee *et al*. (2013) purported that challenges in creation of sustainable smart cities can be reduced by shaping value-added business models in cities and integrating disparate technologies in a productive ecosystem.

In ensuring sustainable smart cities we must introduce a new level of complexity where we look at the smart city concept beyond technology. Though technology cannot be overridden entirely it should serve as an avenue for creating new type of innovative environment, which will require the need for development of a balanced creativity skills, innovation-oriented institutions and virtual collaborative spaces (Landry, 2000). For a sustainable continually improving smart cities, the development and training of our human capital is very significant (Hollands, 2008). Hence, improving the lag in education for those who are digitally illiterate and ensuring the learning and improvement of knowledge in IT in schools, organisations and industries to revamp the smart city principles through enhanced knowledge and sustainability (Cairney and Speak, 2000).

Cities must be ready to take advantage of the smart city concept. According to Townsend (2013), most cities must be prepared to move from wires to wireless, and incorporate the 'Internet of Things' principle as more devices gets connected on the internet. Angelidou (2014) also proposed that having a national and documented local strategy towards sustainable smart city development would help in ensuring that the approach is effectively done. Chourabi *et al*. (2012) summarised the critical success factors for the implementation of smart cities. They identify eight main critical success factors as the availability and usage of technology, management and organisation, development and implementation of policies, incorporating and esteeming the natural environment, involving people in communities, ensuring an efficient and vibrant economy, openness of governance and a smart built infrastructure.

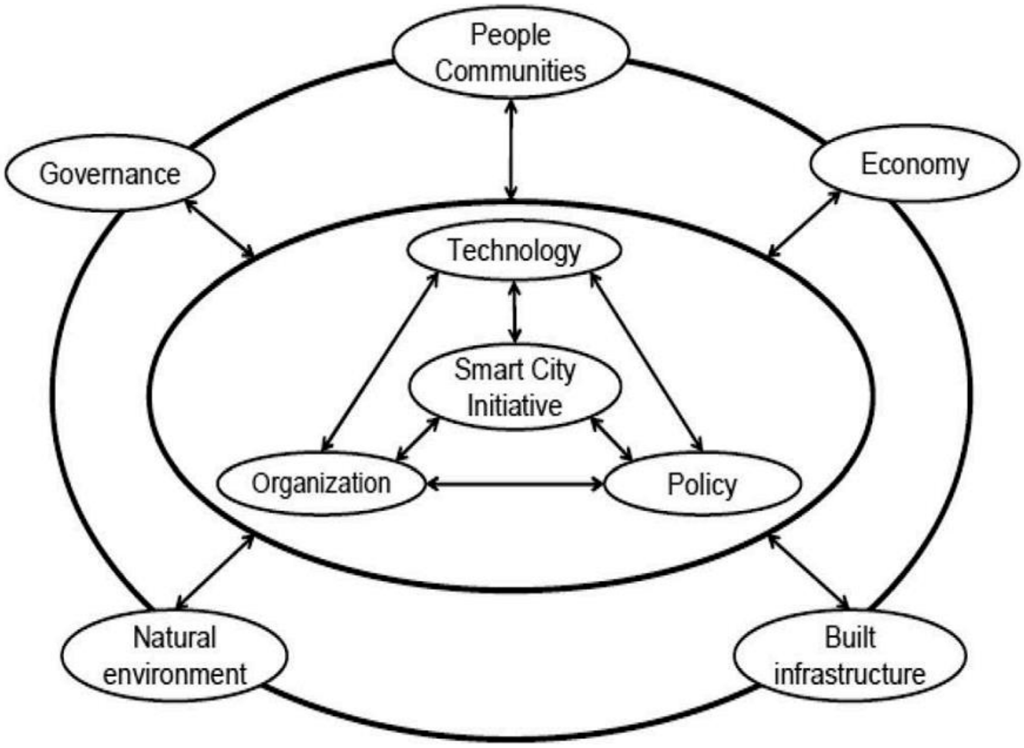

Figure 2.5: Critical Success Factors for Smart City Initiative

Source: Chourabi *et al*. (2012)

Inferring from Figure 2.5, it can be deduced that according to Chourabi *et al*. (2012), the most significant factors which must be improved and implemented into making any city smart are technology, organisation and policy, while economy, people communities, governance, natural environment and built infrastructure are considered as secondary layer or elements to be developed and implemented.

2.13 THE CONCEPTUAL FRAMEWORK OF SUSTAINABLE SMART CITY

In coming out with a sustainable smart city model, first, some basic notions must be set right. Thus, it can be viewed from literature that there are divers' definitions, understanding and approaches to what the smart city concept means to a lot of people (Bowerman *et al*., 2000; Al-Hader *et al*., 2009; Harrison *et al*., 2010). Moreover, the concept is quite divergent and different from one locality to another (Weisi and Ping, 2014). Notwithstanding, I emphatically agrees with Hollands (2008) on the avowal that no city can proclaim itself smart without comparing it to some standards. In relation to that and considering how several researchers have classified smart cities (Giffinger *et al*., 2007; Lombardi *et al*., 2012; Zygiaris, 2012; Albino *et al*., 2015). The study intends to develop this model of Kumasi City by first considering its current smartness, then identifying the sustainable development factors available, any militating factors and critical success factor for sustainable development of smart cities. Building on the first conceptual model of how smart city would be determined from this study, a new improved model, integrating the sustainable development principles is now developed in the Figure 2.6.

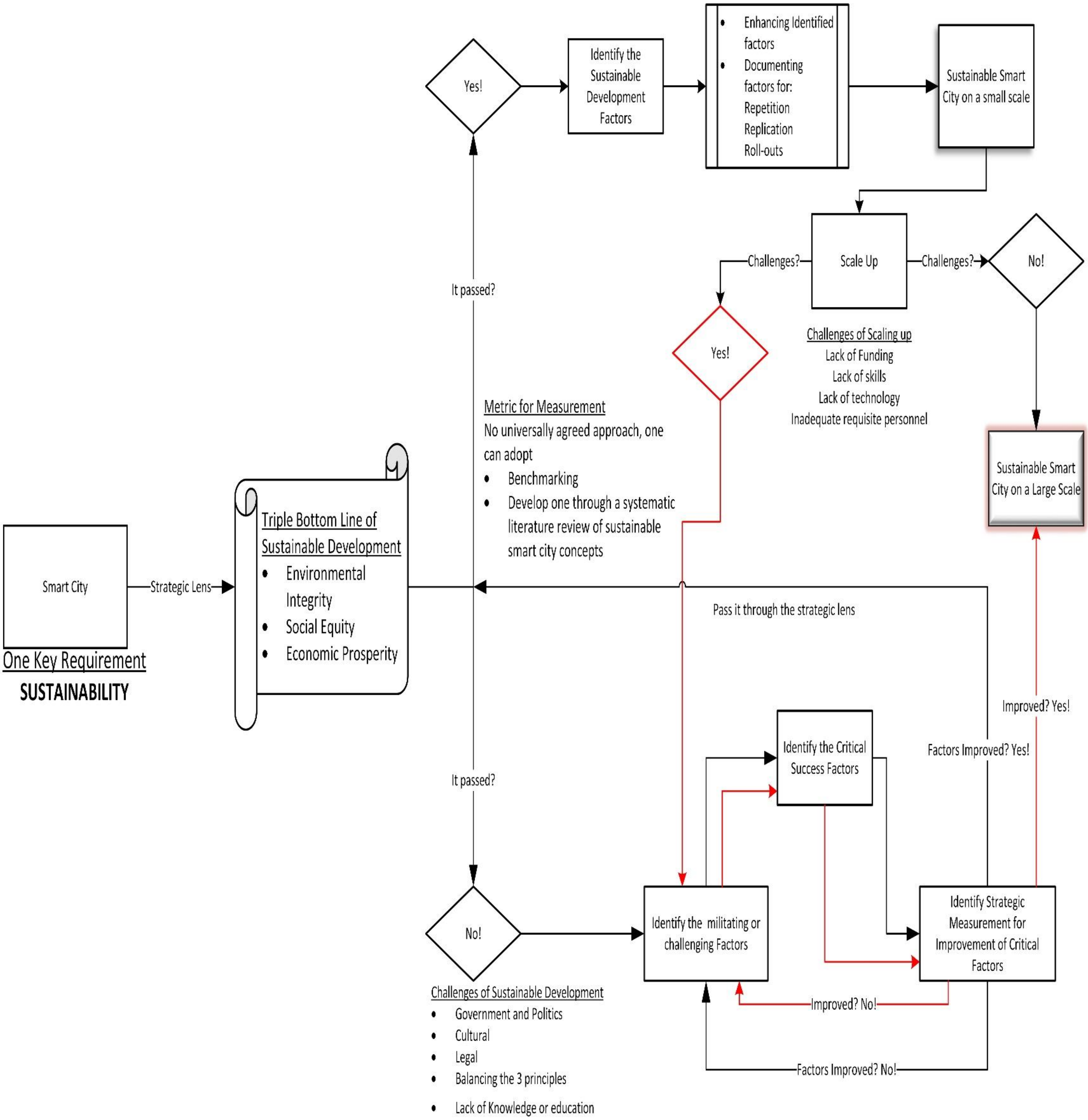

Figure 2.6: Conceptualize Sustainable Smart City Approach

Source: Author's Construct (2019).

2.14 CHAPTER SUMMARY

This chapter presented critical review on sustainability and sustainable development factors which can be incorporated into smart city concept in developing countries. In summary, the literature at this section provided the essential variables which could be tested with our sampling to determine how these factors could be implemented in development of sustainable smart cities in developing countries.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Henning *et al*. (2004) asserted that research cannot be done in vacuity: and hence, it must be created within a specific paradigm, beheld through the strategic lens of particular mindset and constructed using identified and appropriate approaches and strategies; this is called research methodology. Therefore, this chapter is dedicated to reporting on the research methodology or framework adopted for this study. It broadly considers the various philosophical underpinnings and approaches used in conducting research, and why specific ones were employed in steering the study to achieving its specific objectives. The chapter broadly, like the research onion formulated by Saunders and Lewis, firstly presents on the research philosophy (where the various philosophies were discussed) and a concession made on the philosophy which would be adopted for the study. Following chronologically in similar vein of discussing theories, and determining what was adopted for the study are presentations made on: the research approach used (either deductive or inductive); the research strategies to be implemented (whether experiment, survey, case study etc.); the time horizons which the study was conducted (longitudinal or cross-sectional); and the data collection methods employed (interviews, questionnaires, observations etc.). Also, the chapter presents on the population and sampling frame of the study, and concludes by discussing the data processing approaches and tools of analysis which would be used in analysing the primary data to be obtained from respondents of the study.

3.2 RESEARCH PHILOSOPHY

The research philosophy deals with the nature of knowledge, and how that knowledge would be developed. Hence, it contains assumptions of the way in which one views the world, and this affects or influences one's research strategy and methods (Saunders *et al*., 2009). Creswell (1994) is of the view that for research philosophy, four main areas are very important, thus, ontology, epistemology, axiology and methodology. Guba and Lincoln (1994) also suggested four different research paradigms which are post positivism, critical theory, positivism and constructivism. In order to situate your study in the proper research philosophy, one must discuss the several overreaching approaches and know how best to place your research in the continuum of what have been identified.

Generally, an action should be guided by some sets of belief, and this is what Guba (1990) defines as a research paradigm. Denzin and Lincoln (1998) assayed that a paradigm has three main parts: epistemology, ontology and methodology. Notwithstanding, Creswell (1994) and Collis and Hussey (2013) decided to keep their philosophical cognitive on four main assumptions, namely, ontological, epistemological, axiological and methodological. In explicating further, works by Thurairajah *et al*. (2006) threw more light on the stance of the various research paradigms. According to their study, language and process of the research deals with rhetorical and methodological assumptions while the philosophical stance of a research is more concerned with ontology, epistemology and axiological assumptions. These various paradigms appear to be very critical and requires intent identification because it influences the research instruments which would be chosen (Christou *et al*., 2008).

Ontology is more concerned with how the researcher views the world (natural reality). Thus, whether it is seen in the strategic lens that reality is independent and outside the influence of the researcher, or dependent on some parameters which can only be checked when some human behaviours and ideas are examined and analysed (Collis and Hussey, 2013; Thurairajah *et al.*, 2006). Simply, the ontology philosophy can be described as the theory of being, hence, the composition, the various parts which makes it up, and how they interact with each other (Blaike, 1993; Marsh and Stoker, 2002). The ontological position consists of two main planes: the objectivism and the social constructivism (subjectivism) (Thurairajah *et al*., 2006).

Subjectivism is mostly based on a social phenomenon: explained as the thoughts and consequence actions of humanistic behaviours about their existence (Christou *et al*., 2008; Saunders *et al*., 2009). This approach is ardent on the view that nothing happens without a cause, hence, it is a formed behaviour which causes some realities to exist (realities are not objective in nature) (Christou *et al*., 2008).

Objectivism holds the view that our influence or behaviours cannot affects the reality. Thus, we cannot use our thoughts and consequence actions to change what is in existence, because they are far beyond humanistic capabilities (Saunders *et al*., 2009; Bryman and Cramer, 2005).

Epistemology positions to inquire about how knowledge was acquired, the processes of acquisition and the validation of the knowledge thereof (Gall *et al*., 2003). This philosophy creates a room for us to know and understand which knowledge is to be accepted in a field of study (Saunders *et al*., 2009; Campana, 2010). In addition, epistemology shows the relationship that exist between the researcher and the subject of inquiry, and it shows how the researcher interacts with the subject of inquiry to form a genuine knowledge through observations (Christou *et al*., 2008). For easy understanding, epistemology can be defined as the philosophical position which informs us about science, which tells us about how the knowledge was created, and which shows how the created knowledge was collected and analysed (Babbie, 1995; Orlikowski and Baroudini, 1991; Saunders *et al*., 2009). In literature, three key epistemological positions are identified: positivism, realism and Interpretivism.

Positivism philosophical stance is concerned with the creation of knowledge from existing theories, and using the knowledge to develop hypothesis, afterwards gathering of data and subjecting those data back to hypothesis testing again (Saunders *et al*., 2009; Campana, 2010). Thus, it can be viewed as one that assumes the position of a natural scientist (Saunders *et al*., 2009). Positivism mainly deals with the explanation, prediction and controlling of an occurrence (Guba and Lincoln, 2004). Predictions based on theory can be tested by collecting data objectively (Weber, 2004). This epistemology is of the view that, there is independency of either physical or social reality and the observation is reasonably unbiased in forming scientific knowledge (Gall *et al*., 2003).

Realism deals with scientific enquiry. This philosophical stance is viewed that what the senses shows us as reality is the truth. Realism is very distinct from idealism in the perspective that realism believes there exists an embodiment of knowledge beyond what the mind can envisage or comprehend. Hence, one can attribute realism to positivism in the essence that they both assumes the scientific creation of knowledge. This assumption reinforces the data collection approach and making sense of the data collected (Sarantakos, 2005).

Interpretivism is in sharp contrast to positivist, thus, the interpretivist assumes a subjective view instead of an objective stance (Christou *et al*., 2008; Saunders *et al*., 2009). The positivist approach mostly generalised their identification of knowledge to already dissipated laws similar to the physical science, and this is where critics of the positivist approach are so vehement on disputing. Thus, for instance, according to

Saunders *et al*. (2009), the social world is so complex, and would contain certain rich information which cannot be obtained easily by following some law-like generalisations in a manner as the positivist approaches the social world.

The clear incongruence between the positivist and interpretivist approach is how they approach knowledge. Table 3.1 shows the differences between these two extreme planes of the epistemological philosophy

Table 3.1 Differences Between Positivism and Interpretivism

SN.	POSITIVISM	INTERPRETIVISM	SOURCE
1.	Objective in nature	Subjective in nature	Saunders *et al*. (2009); Christou *et al*. (2008)
2.	Follows some law-like generalisation principles, gathering data and subjecting them back to hypothesis testing	Adopt a more reliable approach like case studies, ethnography, action research etc.	Campana (2010); Saunders *et al*. (2009);
3.	Knowledge formed through the aggregation of verified facts	Interpretation of social phenomena which affects reality	Bryman and Cramer (2005) Christou *et al*. (2008)
4.	Takes the position of a natural scientist	Emphasize on realism of concept	Baiden (2006)

Source: Author's Construct (2019)

Axiology deals with how much value or less value the researcher places on the whole investigation, thus, considering it as a matter of value or fact (Bossé, 2006). Saunders *et al*. (2009) asserted that axiological positioning considers that the researcher has values and that these values affects how the study is conducted and the results interpreted. Thus, the axiological positioning affects the credibility of the research. There are two main externalities when it comes to axiological positioning, thus, is the research value-free or value driven? (Bossé, 2006). It is irrefutable that humans' behaviour is greatly influenced by imbedded values (Heron, 1996), therefore researchers must state their values as informed consent of what study they are doing and how they will go by doing them (Saunders *et al*., 2009).

3.2.1 Pragmatism (Research Philosophy Adopted)

Saunders *et al*. (2009) opined that pragmatism follows the philosophy that there is no single approach which can encapsulate and explain a subject matter, and thus, there may be multiple realities, hence adopting only one particular stance would appear inadequate and inappropriate. Experienced researchers tend to follow through with a mixed approach between the two extreme ends of research paradigms (Positivist and Interpretivist) which is modified and adapted and called the pragmatic research philosophy (Collis and Hussey, 2013).

In pragmatism, the most important determinant is the research question, and the research question should be such that either adopting a positivist or interpretivist approach would be appropriate (Tashakkori and Teddlie, 1998). Intuitively, it can be deduced that the pragmatic philosophy favours the use of either a deductive or inductive research approach; for ontology it can be either objective or subjective in nature; in considering the axiological nature, one can be value-free or biased; and one has the freedom to use either qualitative, quantitative or a combination of both for research strategy (Tashakkori and Teddlie, 1998). Nonetheless, pragmatists do not necessarily have to use different or all of the methods available to their disposal, but only those which deemed significant and appropriate to the study at hand.

Epistemologically, this philosophy was chosen because it is seen as a midway between the positivist philosophy and the interpretivist philosophy. Hence, it gives the researcher the opportunity to mix different research methods in an effort to finding solutions to the key issues at hand through theories and frameworks. In addition, sustainable smart cities cannot be seen as a fact unless views from experts and policy developers are taken into consideration to enable us to appreciate the practical views of how the study objectives would be achieved.

3.3 RESEARCH APPROACHES

Research approach is concerned with the stepwise procedures and action plans adopted for a research from one stage (general assumption) up to the interpretation of data (Creswell, 2013). The philosophical stance of the study affects the type of approach adopted for any study (Creswell, 2009). Kwofie (2015) was of the view that the research approach provides an avenue to propose a general view of the research problem while providing answers to the research questions. Research approach consists of two key areas, deductive and inductive approach. Easterby-Smith *et al*. (2008) formulated three main reasons which will influence a researcher to choose a particular approach. Firstly, the research design to be used will caused one researcher to choose one approach over the other. Secondly, the research strategies and choices also influence the decision and lastly knowledge in the different research conducts.

3.3.1 Deductive

This approach deals with existing theories that have been widely been accepted or ideas about a subject by identifying the theory and testing through observations to confirm the theory (Ofori-Kuragu, 2013). The deductive approach mostly consists of a top-down initiative in the creation of the theory and testing of hypothesis while maintaining the independence of the researcher. Hence, the process starts from the identification of the relevant theories and the use of scientific study through observations to confirm these theories. Kwofie (2015) added on that, the deductive approach is concerned with testing of patterns identified through observation to confirm the actual occurrence of the patterns from general to specific. This approach mostly adopts the quantitative methods for its data collection and analysis in testing the validity of assumptions.

3.3.2 Inductive

Inductive approach is used mainly in formulating theories, and it begins with the study of specific instances of societal issues, through the identification and development of patterns from the analysis of data gathered (Ofori-Kuragu, 2013). Kwofie (2015) asserted that this approach engages in a bottom – up perspective, where through the study of specific issues moving up to the broad generalization of the specific situation. Inductive, adopting the qualitative methods in its data collection and analysis means it is subjective in nature. In developing theories using inductive approach, it can be said to be one that helps in gaining more understanding of the problem from the perspective of society such that the researcher is part of the search in identifying the phenomenon, collecting data and analysing it for deeper understanding (Saunders *et al*., 2009).

3.3.3 The Research Approach Adopted

In considering the research approach adopted for this study, preference favoured the use of the deductive research approach as it is more appropriate and suiting to the use of pragmatist research philosophy. The deductive research approach is objective in nature, and in exploring the sustainable development factors of smart cities, it was imperative to allow for experts' views collection through primary data by using structured research questionnaires.

3.4 RESEARCH STRATEGIES

The research strategy plays a very prominent role in all paradigms (Pathirage *et al*., 2005). Guba and Lincoln (1994) is of the assertion that research strategy mainly involves two key areas (quantitative and qualitative approaches). Notwithstanding, Baiden (2006) expressed that research strategy consists of three distinct areas rather, which are quantitative, qualitative and triangulation. The decision to use any of these three broad areas depends on number of factors like; the purpose of the study, the research questions and the type and ease of getting the needed information (Naoum, 2012).

3.4.1 Qualitative

Qualitative research mostly takes place in a naturalistic setting. Thus, it tends to consider the quotidian activities of people and groups of communities. Mostly useful for educational settings and processes. Denzin and Lincoln (2003) assayed that the qualitative research involves a naturalistic approach, understanding the subject matter; looking at interpreting or making sense of issues, by considering the meaning which people attach to them. Qualitative research can be viewed as a form of social interaction in which the researchers learns and converses with the subject being studied (Jean, 1992). Alternatively, Crotty (1998) explicated further that the qualitative research is a research process which involves forming meaning of reality.

Creswell (2003) opined that this research approach consists of different knowledge claims, several methods for collecting data and diverse enquiry initiatives could be employed. Sources of data for a qualitative research includes case studies, interviews, questionnaires, documents, researcher's impressions and responses (Bryman, 2004). Sprinthall *et al*. (1991) had previously through their studies enumerated some sources of data as one that could be obtained from observations, interviews, documents and opinions. In addition, this type of research approach enables us to identify patterns in the data collected, and reporting such findings in the respondents' own words (Denzin and Lincoln, 1994).

3.4.2 Quantitative

Quantitative research approach is the approach that enables in the investigation of quantitative properties and their relationships systematically (Wadsworth, 1997). Creswell (1994) opined that the quantitative research approach considers past actions, words, or records with a statistical significance, and measures the findings of these observations. Wadsworth (1997) in an effort to explaining the quantitative research approach simply said that this approach would enable you to know how many, to what extent or how much of the parts is found in the data analysis and counting. The objective of this approach is simple; how do we employ mathematical models, theories and hypothesis concerning a natural phenomenon (Sarantakos, 2005). Sources of data collection are mostly concerned with the employment of questionnaires, surveys, and experiments and using mathematical tools in analysing them (Hittleman and Simon, 1997). Quantitative research approach uses variables on a subject and by adopting some tools like correlation; descriptive statistics (mean, standard deviations, frequencies etc.); regression etc. to express the differences between the various variables.

3.4.3 Mixed or Triangulated

The mixed method or triangulated approach is a mixture or the use of both quantitative and qualitative approaches to undertake an observation for generalization of phenomenon on the assumption that there is an increased understanding of such phenomenon through the collection and analysis of copious data (Creswell, 2013). In following the philosophical view of pragmatism, the mixed method approach enables the collection of data either simultaneously, or sequentially commencing with a survey of generalization and later with an interview for the detailed view form respondents (Creswell, 2009). The mixed approach has also been used as a tool for coming out with diverse context often with an emphasis on the purpose of bringing different acumen rather than the simplicity of the qualitative and quantitative approach (Agbodjah, 2008). Irrespective of the benefit of combining both approaches, the mixed approach has been tagged as an expensive and time-consuming approach.

3.5 RESEARCH DESIGN

The research styles fall under any of the three main research strategies proposed by Baiden (2006). Thus, it could either be experiment or surveys (quantitative); case study, action research, grounded theory, ethnography etc. (qualitative); or convergent, transformative, explanatory or exploratory sequential etc. (mixed method).

3.5.1 Experiment

As a research style, experiments are used mostly in the scientific or natural researches sciences and some forms of psychological social researches, so as to establish causality between two variables through the exploratory and explanatory mode to answer the how and why research questions (Saunders *et al*., 2009). With the aim at developing theories, the experiment research style is used in data collection through observing problems known as hypothesis under a controlled environment with a high sense of reliability and trustworthy of findings (Bryman, 2004; Baiden, 2006). In experiment research, we mostly look for treatment for a phenomenon which is expected to be one variable, by keeping the control factors for the other variables and measuring the outcome of both variables. While experiments undertaken in the natural sciences are mostly done in a controlled laboratory, those in the social sciences are conducted in the fields (Owusu-Manu *et al*., 2012).

3.5.2 Survey

Surveys are used as tools for the collection of large number of quantitative data for exploratory and descriptive research through the use of standardized questionnaires (Saunders *et al*., 2009) and structured interviews with the aim of generalising from sample to population using statistical analysis (Creswell, 2009). In congruence to the deductive methodology, surveys are adopted for answering the who, what, how many and by how much research questions. In studies with the need for a high degree of validity and reliability, the survey research style is adopted (Kwofie, 2015).

3.5.3 Case Study

Case studies are for empirical or exploratory investigations where the researcher has to do an in-depth analysis. It is mostly employed within a context of existence, and its purpose is for gaining rich understanding of such existence (Baiden, 2006; Saunders *et al*., 2009). In choosing case studies, one must be of the idealist mindset of ontological position, Interpretivism through the epistemological paradigm and a value driven stance of the axiological perspective; case studies could either be single, multiple, embedded or holistic (Pathirage *et al*., 2005) in providing insight into the phenomenon (Fisher and Purcal, 2010); it should be done through the collection of several data over a time period (Creswell, 2009). Yin (2003) opinionated that case studies are forms of empirical enquiry in which one looks into a contemporary phenomenon within its real-life context, especially where the boundaries between the phenomenon and context are not very overt.

3.5.4 Grounded Theory

Mostly called as a theory building strategy, which enforces the researcher to combine both the inductive and deductive research approaches to explain the behaviours and actions of respondents in a survey (Creswell, 2009; Saunders *et al*., 2009). In this research style, the researcher adopts numerous collections of several data which are subject to further observations to confirm or reject predictions generated from such data.

3.5.5 Action Research

This type of research style is so involving and requires several expertise to pull it through (Baiden, 2006). For action researches, the researcher and the participants are both involved in finding solutions to problems of genuine concern within a setup, where the researcher focuses the action, charge and uses participants' involvement in detecting, evaluating and taking various actions (Baiden, 2006; Saunders *et al*., 2009).

3.5.6 Ethnography

As mentioned earlier, this style is used when one adopts the qualitative research methods. Ethnography also follows the inductive research approach by considering a particular group over a period in their natural settings through observatory or collection of primary data (Creswell, 2009). This style is tagged to be very time consuming and involving; as the inquirer must be able to explain the phenomenon just as the respondents shows it. Hence, the only way to do that accurately is to get the inquirer involved in the setting where the research is being undertaken (Saunders *et al*., 2009). Therefore, it is not surprising that this research style adopts the inductive approach, because a high degree of flexibility is required in this regard to easily see and record the changing patterns of behaviours observed in real context (Saunders *et al*., 2009).

3.5.7 The Research Strategy and Design Used

The research strategy and style employed for this study were the use of case study and survey questionnaires (quantitative approach). Thus, focusing on a single appropriate setting for this study (Kumasi City). Case studies helps us to find specific issues associated with the identified locality, and providing solutions geared towards the identified cases. Yin (2010) is of the view that case studies should be employed when the study is relatively new, and there exist unclear boundaries relating to the scope of the study, as well as the need to obtain an in-depth, holistic and rich view on phenomenon.

Hence, Yin's statement supports the choice of research strategy for this study; which is contemporary, and requires in-depth investigation.

3.6 TIME HORIZONS

Every project is time-bound. Thus, it must be done or completed within a certain time limit. In research, we have two main time horizons; the longitudinal and the cross-sectional time framework for project completion (Saunders *et al*., 2007; Bryman, 2012). However, Saunders *et al*. (2007) stated emphatically that the research approach or methodology adopted for a particular study does not influence or determines the time horizon which the study must adopt.

3.6.1 Longitudinal

The longitudinal time frame looks at obtaining data repeatedly over a period of time. This is mostly adopted when one needs to study a particular changing variable to enable the researcher to get the actual results and changing patterns and how such would affect the study (Goddard and Melville, 2004). Mostly for change and development type of studies, and it promotes the establishment of controls over variables being studied.

3.6.2 Cross-Sectional

The cross-sectional time horizon is sometimes called the snapshot time framework. This is mostly employed when the study is already established, and what is left is for the research to collect data a particular point in time (Flick, 2015). It is mostly done when one needs to collect data to easily prove or debunk a theory already existing, identified or formulated through the literature review. It is one time (not recurring at several points in time) and done and completed within a specific time frame.

3.6.3 The Time Horizon Position of this Study

The time horizon adopted for this study is the cross-sectional timing which enables the researcher to focus on the current situation on the ground. The opposite to this approach is the longitudinal timing, which promotes repeated cycles of data collection, testing, surveys and analyses. This study adopted the cross-sectional approach because of time constraints of the project, but most importantly because of the nature of the study which could be very unstable as new technologies and changes are implemented into our urban structures sporadically. Hence, adopting a longitudinal approach would provide different results which could make it difficult in assessing the current level of smartness of Kumasi city. In other words, it could lead to an unending to and fro of smartness of Kumasi city, and the effort of knowing the actual smartness level and providing factual solutions for proper improvement would have been defeated.

3.7 RESEARCH PROCESS DESIGN

In research, there are some sets of decisions concerning the topic or problem one is studying, this is what is referred to as research design (Creswell, 2013). It appears to be one of the most important areas on academic investigation, because it shows how the study will be carried out, so as to achieve the objectives of the research. Burns and Grove (2003) expressed their views that research design presents the scheme in which the study would be conducted, controlling variables as they could hinder the reliability of the findings. Thus, to arrive at a reliable and valid finding, one must use the best research design available to solving the particular research problem.

With the aim of the study in mind, one can easily identify the type of research design which needs to be adopted to each of the purpose of the study. Research designs have been grouped into three main broad areas: descriptive, exploratory and explanatory (Bourne, 2005; Malhotra, 2007; Kelly, 2009). Descriptive research design is mostly adopted to collect information about the current state of an occurrence; looking at variables in a particular event and applying an appropriate approach to it (Sekaran, 2003). Bourne (2005) explicates that, the exploratory study is usually done with the aim of finding understanding about a mind-blogging development or to increase in knowledge a contemporary thought in a form of suggesting that present itself for further discussion. Explanatory research is used when one wants to explicate the research problems and create hypothesis. Hypothesis testing is used when it is vital to identify the link that exist between variables, thus, whether they correlate or varies (Sekram, 2003). This study adopted both explanatory and descriptive research design because it could be identified that the purpose of this study falls within the parameters of these two designs as explained by the researcher above.

3.7.1 Unit of Analysis

To enable the researcher to easily identify or come up with the best data collection method or a good representation of the population (best-fit sample size), the researcher must firstly identify the unit of analysis (Sekram, 2003). Sekram (2003) stated that unit of analysis are grouped into five main types: individual, dyads, groups, organisation and culture. Considering the purpose of this study, the organisation unit of analysis was chosen. Thus, the study considered the Kumasi City and the various agencies of the state who had direct line of influence on how the city operates. Notwithstanding, it must be reiterated that primary data were obtained from individuals in these organisations who are experts and representatives of the organisations considered for the study (unit of observation). The focus was to obtain the expertise of these various organisation in relation to sustainable smart city development and implementation in emerging economies.

Speer (2002) is of the viewed that, the unit of analysis chosen by the research is also affected by the environment in which the researcher operates (artificial environment (laboratories); or natural environment (field surveys)). This study adopted the field survey or we can say it was influenced by the natural environment. Dipboye and Flanagan (1979) shared their opinions that field surveys or natural environment is mostly used in organisational studies so as to validate the outcomes of the research.

3.8 DATA COLLECTION METHODS

After going through the philosophical stance of the study, the research approach, research strategies, research choices and time horizons, and making decisions on which option to use for the study and reasons for choosing one over the other; the next step is to identify the techniques and procedures which would be used to collect data. The data collection methods adopted for a study is very important as it influences the attainment of the research objectives and purpose of the study. Tongoco (2007) was highly concerned about the fact that in data collection no amount of analysis (no matter how careful it is done) can make up for a poor data which does not reflects the population intents. Hence, collection of data must be taken very seriously with all aptness.

3.8.1 Sources of Data

Data sources are mainly either primary or secondary. This study resorted to the use of primary data by adopting the quantitative research approach which mostly employs the use of survey questionnaires as the data collection tool. Secondary information for this study was obtained from undertaking an in-depth desk literature review and identifying pertinent variables which helps in identifying the smartness of Kumasi City, the sustainable development factors of smart cities, militating factors of sustainable development of smart cities and the critical success factors for sustainable development of smart cities in developing countries. The variables obtained were strategically compounded into close-ended questionnaires which were distributed to the target population to solicit their matchless expertise in meeting the objectives of this study.

Secondary data was not used for this study. However, secondary data are those data sources which could be obtained from the database of an institution or company, or the data collected by an independent body, or the data used by another person in their study. Notwithstanding, the several types of data as seen in literature is presented in the next sub-section below.

3.8.1.1 Types of Data

Saunders *et al*. (2009) grouped quantitative data into two main types: categorical data and numerical data. Brown and Saunders (2008) purported that quantitative data can be grouped into the various types by using a scale, mostly in ascending order of numerical precision. Since numerical measurement would have several levels, choice of techniques, presentation and summarising analysis is influenced by the diverse levels. Appreciating the inconsistencies that exist between quantitative data becomes very pertinent. Firstly, analytical software is able to produce reliable information from such sources, and secondly, the accuracy of the measurement makes it easy for the researcher to choose the best option for analysis (Saunders *et al*., 2009).

Categorical Data are data which are grouped in categories considering the characteristics which categorise or shows the variable; they cannot be calculated numerically (Brown and Saunders, 2008). Though categorical data are descriptive, they can still depict areas which are overloaded and even cases where data is equally evened. Saunders *et al*. (2009) further divides categorical data into two main distinct forms: nominal and ordinal data. Chi-Square, measures of central tendency (mean, median, mode, variance and standard deviation) are examples of statistical analyses which can be conducted for categorical data.

Nominal (dichotomous) data is for only qualitative groupings. Jaykaran (2010) postulated that nominal data can only be counted but not measured. For example, gender, race, colour etc. Though these types of data are grouped under categorical, their order do not give out any meaningful comprehension (Jaykaran, 2010).

Ordinal (ranked) data is the exact opposite of the nominal data in as much that, the ordinal data give out logical meaning to the data measured (Saunders *et al*., 2009; Jaykaran, 2010). This is the accurate option of the categorical data type of quantitative data. This type is accurate because it tends to define the actual position of each data. Mostly for scales or ratings where the respondents are entreated to indicate how the agree or disagree with a statement, or variable (Saunders *et al*., 2009). Ordinal data can be ranked in order of magnitude (Jaykaran, 2010). Ordinal data can be analysed by using visualisation tools (presenting data in tables and using charts). Notwithstanding one can also do a hypothesis testing of ordinal data by using non-parametric tests like the Mann-Whitney U-test or the Wilcoxon Matched-Pairs test.

Numerical Data are data which can be calculated or measured numerically (quantifiable data) (Brown and Saunders, 2008). This means that their accuracy is far above that of the categorical data, because numerical data assign each variable on a numerical scale (Saunders *et al*., 2009). For numerical data, Saunders *et al*. (2009) is of the concession that, these types of data can be divided into ratio or interval data and also into continuous or discrete data.

Continuous data are those data in which sometimes they are operated in a constraint but their values have the propensity of taking up any other value on the basis that it can accurately measure it (Dancey and Reidy, 2008). Analytical tools for continuous data include: multiple regression, correlation, path analysis, logistic regression, ANOVA, MANCOVA, MANOVA, ANCOVA, Box Plots, Histograms etc.

Discrete data are data which deals with precision in measurement. Using a scale that considers changes in units of discrete, each case is enforced to take one of a finite number of values to achieve this purpose (Saunders *et al*., 2009). The data being considered for this study can be said to comprise of nominal, ordinal and discrete data. Analytical tools for discrete data include: Pareto Chart, Pie Chart, Bar Diagram, Goodness of Fit and Test for independence etc.

Table 3.2 Analytical Tools for different types of Data

SN.	Type of Data	Analytical Tool	Source
1.	Categorical Data i. Nominal ii. Ordinal	Chi-Square Measures of Central Tendencies (Mean, Mode, Median, Standard Deviation	Brown and Saunders (2008); Saunders *et al*. (2009)
2.	Numerical Data i. Continuous ii. Discrete	Multiple Regression, Correlation, Path Analysis, ANOVA, ANCOVA, MANCOVA, MANOVA, Box Plots, Pareto Chart, Pie Chart, histogram etc.	Dancey and Reidy (2008); Saunders *et al*. (2009)

Source: Author's Construct (2019)

3.8.2 Questionnaires Development

In adopting quantitative research approach, most researcher tends to favour the use of survey questionnaires as their data collection tool (Sarantakos, 2005). Survey questionnaires, mostly used in social sciences researchers are adopted in collecting all sorts of data (Creswell, 2005). Questionnaires are mostly in two forms: either open-ended or close-ended questionnaires (Sarantakos, 2005). The questionnaires were formed in such a way that they help in answering the research objectives of this study (Oppenheim, 1996). A good questionnaire would be unique, and contribute to generating several kinds of information from the respondents (Gall *et al*., 2003). It should be clear, concise, precise, and straight to the point; not requiring further enquiry or deliberations in case of a close-ended type. Sarantakos (2005) opined that survey questionnaires should follow these four main criteria: good categorisation, easily comprehended wording, generally acceptable and easy to code variables. In the questionnaire format, one key thing is to explain to your respondents the direction or research being studied (Salant and Dillman, 1994). A good questionnaire will lead to the attainment of a valid and reliable primary data (Fowler and Floyd, 1995).

Reviewing literature on questionnaire formation, it became overt that questionnaires should be presented on an A4 sheet (preferably white) and it should not exceed eight or nine pages (Oppenheim, 2000; Fellows and Liu, 2003; Naoum, 2012). The presentation of questionnaires generally has an effect on the quality of responses the researcher is deemed to receive from the survey (Wahab, 1996). Hence, a researcher must try as much as possible to use clear words or jargon which the average respondent can relate (Fowler and Floyd, 1995).

Piloting of the questionnaires were undertaken before the main survey. Yin (2009) is of the view that pre-testing your questionnaires is very necessary, and could help in obtaining real value facts with inputs from experts about how easy and familiar they could be with your questions. Lietz (2010) said that pre-testing of questionnaires is very pertinent in obtaining reliable and valid data, it also creates room for correction of any ambiguity in the questions asked.

3.8.3 Data Collection Method Adopted

Pragmatic research philosophy gives the freedom to the researcher to choose between either quantitative or qualitative research methods, or the combination of both for the study. Hence, it is of the view that the researcher should choose the method that best fit in answering the problem at hand (Tashakkori and Teddlie, 1998). Therefore, this study adopted the use of structured survey questionnaires as the primary data collection tool to obtain the expert views of respondents on the sustainable development factors of smart cities in developing countries. The mixed method approach provides a more robust set of results as it combines both the quantitative and qualitative research approaches, which ensures that the study has an in-depth and wider research scope. The questionnaire was divided into two main parts: part A and part B. The part A covered the background questions which needs to be identified to validate the respondents of the study. The part B was divided into four main sections, with each section targeting the objectives of the study; except the section one which was formed to help in determining the smartness level of Kumasi city.

3.9 POPULATION AND SAMPLE FRAME

Naoum (2012) is of the view that the population of the study consists of all the various individuals or groups which fall under the study and can, or are supposed to give, or needs to be assessed to help in achieving the purpose of the study. The population of the study encompasses several agencies of state who have direct influences on the urbanisation of our cities. Hence, considering the Kumasi Metropolis, and looking at the smart city concept, it becomes evident that this survey is to be answered by various professionals who have experience in the several systems which are used in classifying a smart city. Kumasi city is under the auspices or control of the Kumasi Metropolitan Assembly (KMA) in relation to the city's development. At KMA there are several sub units or agencies which look at the various systems in the city. However, in as much as this study targeted KMA, it also considered adding up some of the main institutions who majorly undertake infrastructural projects in the cities (Urban Roads, Town and Country Planning, Architectural and Engineering Services Limited (AESL)); those who are involved in business and finance; targeting experience educationalist (lecturers and professors) for their views and other environmentalist outside the KMA to ensure a rich base for obtaining the necessary data for further analysis and achieving the purpose of the study.

Hence, considering the agglomeration of several areas or facets which make up the population, identifying a finite population becomes very difficult. Hence, leading the study to tag its population as infinite. When the situation turns this way, the best point estimate is the population's sample mean (Cochran, 1977). The sample frame consists of the targeted population from the lot which this study considered. Hence, it can be said to the operational definition of the population (Passer, 2014). Kothari (2004) defined a sample frame to consist of a list of items from which the sample is to be taken. Ritchie *et al*. (2013) opined that for any study the researcher can identify the sample frame specifically to the study or it could be obtained from secondary information. Therefore, considering relevant literature on the subject understudy (Giffinger *et al*., 2007; Hall, 2010; Dahiya, 2012; Anthopoulos, 2019 etc.) this study strategically determined its sample frame to consists of KMA, and other majorly institutions which have direct influence on the improvement of systems in our city conurbations.

3.10 SAMPLING TECHNIQUE AND SAMPLE SIZE

After identifying the population and sample frame of the study, the next step was to determine how the population would be targeted and the sample size which would be used to represent the entire population (so as to obtain an accurate assessment of the whole population). This next stage of research methodology is presented in the sub-sections below.

3.10.1 Sampling Techniques

In research, collection of data from the entire population appears as costly and time wasting. Therefore, several measures have been formulated to enable us to target a part of the population in a careful but impressive manner which will still represent characteristics of the entire population. Saunders *et al*. (2009) defines these approaches as the sampling technique. Sampling techniques have been grouped into two main broad areas, namely: the probability sampling technique and the non-probability sampling techniques.

Probability sampling techniques are those cases whereby each individual in the population has an equal chance or likelihood of being selected. It is mostly used when the population is known. Probability sampling technique gives us the opportunity to calculate for confidence interval and margin of errors (Bryman, 2004). Though this approach is flout as being very costly and time consuming, it is seen to be superior to the non-probability sampling technique because of the odds of any unit to be selected can be calculated, but they do not have to be the same though. Examples of probability sampling techniques are, cluster sampling, simple random sampling, systematic sampling, stratified random sampling, and multi-stage random sampling (Saunders *et al*., 2009).

Non-probability sampling techniques are those cases whereby it is impossible for each individual in the population to be selected by chance. Non-probability sampling technique does not give us the opportunity to calculate confidence interval and margin of errors, but this approach is seen as very easy and cost-effective (Bryman, 2004). Example of non-probability sampling techniques are: quota sampling, convenience sampling, purposive sampling, self-selection sampling and snowball sampling. Though researchers who adopts quantitative research approach may see the use of this technique as inferior, it comes out to be very useful for exploratory researches where we prove a theory whose existence have already been confirmed in literature. This is the case for this study. Thus, this study adopted the use of purposive sampling technique, which is a non-probabilistic sampling tool.

3.10.2 Purposive Sampling Technique (Sampling Technique Used for this Study)

Purposive sampling technique relies on the judgement of the researcher in selecting the group, class or organisation which is to be studied. Hence, it can be referred to as the selective, subjective or judgemental sampling technique (Saunders *et al*., 2009). This study adopted purposive sampling technique because it based its reasons on the avowal of Babbie (2013) who purported that purposive sampling techniques should be used when it is almost impossible to list the actual number of the population, though one can easily identify several clusters or organisations who could give him the necessary data. In purposive sampling technique, based on the specific goal of the researcher and the purpose in mind, we can have several examples like expert sampling, case sampling, total population sampling, homogenous sampling etc. (Saunders *et al*., 2009). Nonetheless, one can select or use any of the several types based on the objective of the study or the criteria imposed by the researcher. This study adopted purposive sampling technique because of the nature of the study which is contemporary with few experts having informed knowledge on it. Hence, to enable us obtain real-value data, the purposive sampling technique was deemed as the best approach to use for a study of this kind. The inclusion criteria to be considered for this study was that any member of the sample should have an experience in urban development or the formation of smart cities and understand urban sustainability and its integration into the concept. However, the exclusion criteria were that a respondent who does not have any idea of urban development or smart city formation should not be considered for this study.

3.10.3 Determination of Sample Size

Now that the sampling technique which will be used for the study has been determined, the next focus is to try and figure out a sample size for the study. It must be reiterated that the population of the study is unknown, and moreover, the technique adopted is the purposive sampling technique. Notwithstanding, Cochran (1977) was of the view that in determining the sample size for an unknown population some few things can be taken into consideration to enable us come out with the study's sample size. These are the level of precision and the desired confidence level. However, these are mainly for probability sampling approaches as already explained above. Therefore, since this study adopted a non-probability sampling technique, the sampling size could not be determined by any of the probabilistic approaches. Notwithstanding the precedence statement, in case the study would have adopted a probability sampling technique, the study would have kept the confidence level at 95% (the most used level for quantitative probabilistic studies) and a margin of error of +/- 5%. Using the Cochran (1977) formula for calculating sample size when population is infinite $N_0 = \frac{\Sigma^2 pq}{e^2}$ where N_0 is the sample size, ***z*** is the selected critical value of desired confidence level, ***p*** is the estimated proportion of characteristics in the population, ***q*** is the inverse of ***p*** and ***e*** is the level of precision desired.

Inferring from Table 3.3 which has been calculated by using the formula above we could easily identify the sample size for an infinite population.

Table 3.3: Sample Size for Different Confidence Interval and Precision

Confidence level	Sample Size (N_0)		
	e = .03	e = .05	e = .1
95%	1067	384	96
99%	1849	666	166

Source: Calculated from Cochran (1977).

This study could consider the sample size to be within the same range of 384, but for purposive sampling technique the actual sample size will be determined on field. However, it must be noted that after obtaining our sample size from the field survey, the researcher can now determine the confidence level and margin of error with reasons for further analysis.

3.11 DATA PROCESSING AND ANALYSIS

Data analysis is mainly done to see whether the data is able to provide answers to the research question set out in achieving the purpose of the study (Saunders *et al*., 2009). Kwofie (2015) opined that this process generally refers to how data are organised, examined, categorized, tabulated, interpreted and tested. There are several ways in which data is tested statistically. The decision to use one method over the other depends on the type of analysis, accuracy of work and the kind of information which the researcher want to get from the primary data. The various methods are also influenced by the research design, data distribution and type of variable. Mostly, normally distributed data uses the parametric tests while the non-normally distributed data adopts the non-parametric tests (Saunders *et al*., 2009). The next sections below provide information on the several tools which was used in analysing the primary data which obtained from the survey.

3.11.1 Entering and Organisation of Data

In order to obtain quality data which would be a good snapshot of the entire population, Yin (2003) is of the viewed that data obtained from surveys should be sorted and organised. After sorting out the questionnaires and making sure that there were no incomplete questionnaires or taking note of missing values, the data were strategically coded and entered into the Statistical Package for Social Sciences (SPSS). Missing Values (MV) and incomplete questionnaires were checked because, Bentler (2005) is of the view that MV are frequent in surveys, and one must make sure that such missing values do not affect the quality of the analysis which would be carried out. It is noteworthy to point out that the questionnaires of this study had no missing values. After successfully inputting the data into SPSS, the data was analysed by using descriptive statistics for the demographic questions, correlation for the first section of part B, Exploratory Factor Analysis for the second section of part B, Relative Importance Index and Chi-Square test for the next sections (3 and 4) respectively.

3.11.2 Data Presentation Using Tables and Figures (Descriptive Statistics)

After collecting the data and analysing them, there is the need to make meaningful conclusions and present it to the audience. Descriptive statistics enables us to do this by allowing the presentation of findings in tables and figures for easy acculturation. Ryan (2004) opined that descriptive statistics enables us to present our findings in easy ways which is audience friendly and communicates easily to the audience.

Presentation of findings in tables and figures have been expatiated by researchers like (Kapadia-Kundu and Dyalchand, 2007; Carpio *et al.*, 2007, UN, 2009 etc.) as a pertinent way of showing findings to audience. Tables and figures have been tagged as useful medium in showing large quantity text in simplified modules for easy understanding. UN (2009) was of the view that all tables should contain these five main criteria in presenting their findings to respondents. These are: table title, column headers, row stubs, footnotes and source line.

3.11.3 Inferential Analysis: Hypothesis Testing

Gabrenya (2003) assayed that when we want to make generalisation from a sample to a large population, then one must resort to the use of inferential analysis. Hugely dependent on the use of statistical techniques, the inferential analysis approach can be grouped into two main types (parametric and non-parametric) (Babbie and Halley, 1995). Examples of parametric inferential analysis includes t-test, ANOVA, and Pearson Product Moment Correlation Coefficient. Examples of non-parametric test also includes the chi-square test, the Mann-Whitney U test, Wilcoxon matched pairs singed-ranks test and asymmetrical test (Adeyemi, 2009). As explained under the data processing and analysis section and confirmed by Adeyemi (2009) the type of inferential analysis to be adopted in a study depends on the sampling method used, the instruments adopted for collecting data, the sample size and independent variables. Mostly, non-parametric tests are used for non-normally distributed data while parametric tests are used for normally distributed data (Saunders *et al*., 2009).

Hypothesis testing is used to make useful conclusions on the population of interest by inferring from the results of the collected data (Deveries, 2007). Hun (2010) asserted that we use hypothesis testing to make assumption about the population of interest. Hun (2010) also stated that a quality hypothesis would be easy and capable of being tested. Deveries (2007) listed some of the procedures for hypothesis testing to encompass z-test, t-test, correlations, analysis of variance and chi-square test.

There are two types of hypothesis testing statements; the null hypothesis H_0 and the alternative hypothesis H_1. The null hypothesis means that there is no significant difference between a parameter and a specific value, or that there is no difference between two parameters. H_0: U = K. Alternative hypothesis on the other hand comes in the form of left tail, right tail or two tail tests. Greater than are always right tail test (positive or increase) while less than are always left tail test (negative or decrease). When we cannot determine whether the variable would be greater than or less than the hypothesised mean, the two-tail test is used (Anglim, 2007). In hypothesis testing, one must set the confidence interval (either 0.01 or 0.05). *p*-value on the other hand is used to represent the statement of values which did not occur in the analysis by conducting a test statistic (Anderson *et al*., 2000). To show that a test is highly significance (a true alternative hypothesis) *p*-values should be less than 1%. Moreover, p-value shows that the degree of risk of rejecting the null hypothesis (Hun, 2010). Generally, do not reject the alternative hypothesis for a p-value which is less than critical value (for example .05) (Anglim, 2007).

Hypothesis testing consist of five main steps. Deveries (2007) and Hun (2010) specified and explicated these steps to encompass of; stating the hypotheses (the null and alternative hypotheses); identifying the test statistics (whether it is a type I error or type II error); Setting your confidence interval; Making a decision on the analysis whether to reject or not to reject the hypothesis, and drawing conclusions from the analysis.

3.11.3.1 ANOVA, Correlation and Regression Analysis

According to Tang *et al*. (2008) analysis of variance is adopted in testing the perception of respondents in relation to a phenomenon being explored. ANOVA deals with *F* values, and the higher the F value the significant the difference in viewpoints of the various respondents. Underwood (1997) opined that when one to identify the interactions between experiments, then one must opt for the use of ANOVA as the statistical tool. Using the ratio of *F*-statistic, the analysis of variance allows us to compare the degree of variability within groups versus variability among different groups (Anderson, 2006).

Correlation on the other hand is defined as the analytical tool which enables us to measure the relationship between two or more variables (Varalakshmi *et al*., 2005). Explicating further, correlation enables us in understanding the inter-dependency between two set of variables. For instance, measuring the relationship between supply and demand, cash price and amount of good bought, cash in and cash out etc.

Varalakshmi *et al*. (2005) also explained regression as the measure of the average relationship between two or more variables in relation to their original units of a data. Sykes (2000) opined to determine the causal effect of one variable in relation to another, one can adopt the regression analysis statistical tool. In regression, one cannot do away with the formulation of hypothesis about the relationship which exist between the variables (Sykes, 2000). Multiple analysis simply means adding more independent variables to machinate the outcome of the dependent variable (Varalakshmi *et al*., 2005). Regression is used in establishing practical connection between variables; mostly used in economics and business researches; and it helps in predicting values of dependent variables from one or several independent variables (Varalakshmi *et al*., 2005).

3.11.4 Factor Analysis for Framework Development

In factor analysis, one must have about twenty to fifty variables before one can use this powerful statistical tool (Chang and Chen, 2004). To improve measures, check validity of variables, test hypothesis, develop and improve scales, reducing variables and understanding of inherent characteristics of variables, the factor analysis is used (McCauley *et al*., 1994; Conway and Huffcutt, 2003; Williams *et al*., 2012). Williams *et al*. (2012) listed other several uses or importance of factor analysis which consist of, but not limited to the following: reduction of variables, finding links between variables, identifying and assessing the unidimensional of a hypothetical concept, appraising scales validity; ensuring easy and accurate analysis and interpretation; addressing phenomenon of high correlation between two or more variables and developing theoretical framework, confirming or rejecting theories.

According to Chang and Chen (2004), factor analysis consists of these various procedures: The Bartlett's Test of Sphericity (*finding the existence of common factors which could aid the use of factor analysis*); estimation of common factors (*to understand the aptness of the sampled questionnaire for factor analysis)*; extraction of components (*identifying variable to form frameworks, used to extract common factors – mostly two types: the common factor model and component factor model also called the Principal Component Analysis)*, and Identifying commonalities (*using the value of 1 as a benchmark).*

3.11.5 Relative Importance Index (RII)

The RII helps in identifying the relative importance of variables, and informing the researcher in making a choice one out of the several variables which best explains or is critical to achieving the objective at hand (Carpio *et al*., 2007). RII was proposed by Soofi *et al*. (2000) as a tool for determining the relative significance of quantities through the formulation of indexes from which the various characteristics are ranked (hence, understanding the contribution of each variable to a response variable). Kapadia-Kundu and Dyalchand (2007) opined that adopting a five-point Likert scale is very good in measuring statement which would be solved using the RII tool. Hence, this study adopted a similar approach in its questionnaire formation.

RII has been used by several scientists in their analysis in variant factions (for example see Johnson, 2000; Jeyamathan and Rameezdeen, 2006; Antwi-Afari *et al*., 2018; Owusu-Manu *et al*., 2018 etc.). Therefore, adopting the use of RII for this study proves worthy because it has been used and adopted in identifying the relative significance of variables in works as shown in the citations above. One more reason for adopting RII in on the avowal of Capiro *et al*. (2007) who said that RII is best for group of variables, and the questionnaires of this study was formulated as such (see Appendix). In Summary, Relative Importance Index was adopted to identifying the militating factors of sustainable development of smart cities of developing countries.

RII was calculated based on this formula; RII = $\frac{\sum \boldsymbol{W}}{\boldsymbol{A*N}}$ where $\boldsymbol{W}$ is the weight given to each factor by respondent ranging from 1 – 5, $\boldsymbol{N}$ is the total number of respondents, and $\boldsymbol{A}$ is the highest response integer (5 in this case).

3.11.6 Chi-Square Test for Hypotheses Testing

In the usage of Chi-square test, there are two main assumptions: the sample should not be less than 5 and the samples must be obtained through an independent observation (Champion, 1970; Adeyemi, 2009). Adeyemi (2009) asserted that there are three main kinds of Chi-square test: Goodness of Fit test, One-dimensional and two independent sample tests. As an example of non-parametric test, Scheaffer and Yes (1999) asserted that Chi-square test is used to show the connection between data. Mostly, Chi-square is used to identify the probability of association of independent facts (Zibran, 2007). In conducting an analysis using the Chi-square test, one must have a population, a sample, a parameter which is derived or applied to a population; a variable which can be coded, nominally scaled variable and contingency tables (Zibran, 2007). Chi-Square can be calculated using the following formula; $\mathbf{X^2} = \frac{(\boldsymbol{O_i - E_i})}{\boldsymbol{E_I}}$ where O_i = observed frequencies; E_i

= expected frequencies; i = 1, 2, 3, 4, ……n and n = number of cells in the contingency table. Considering the above literature, the Chi-square test was adopted for this study because of the ordinal scale of measurement which was adopted in this study. Hence Chi-square would be used for determining the probability of association of the various critical success for sustainable considerations of smart cities in developing countries.

3.11.7 One-Sample T-test

One-sample T-test is a nonparametric analysis which is done to compare means. This analysis is done to compare the sample mean of population to the hypothesised population means. The hypothesis is always set. Thus, the null hypothesis could be that the observed sample mean is equal to the test value input for the hypothesised mean. Hence, any value less than or greater than the test value must be rejected. In explaining the one-sample statistics, one will consider the significance value. If at 95% confidence interval, then the null hypothesis would be accepted if the significance value is greater than 0.05. Thus, it means that the probability of obtaining a mean equal to or around the null hypothesis is greater than 0.05 or around that figure. Hence, we will reject the null hypothesis whenever the significance value is less than 0.05 for a 95% confidence interval. Moreover, the difference in means should be equal to zero if the hypothesised mean is equal to the sample mean. Where this is not the case, a positive would mean that they sample mean is more than the hypothesised mean and vice versa for a negative value. In addition, the upper and lower limits would also help in understanding and explaining whether or not to reject or do not reject the null hypothesis. For instance, if zero falls outside the upper and lower limits, then the null hypothesis must be rejected. Hence, there is not enough evidence to conclude that the sample mean is equal to the hypothesised mean of the population (Anderson *et al*., 2000).

3.11.8 Internal and External Validity

Validity simply means, achieving what the study intends to attain. Proposed by Kelley (1927), validity is used in evaluating the importance of a research study or the procedures used. Generally, we have two main types of validity; internal and external validity. Internal validity considers how the dependent variable(s) is/are well explained by the independent variable(s). Hence, there should be no confounding variables between the independent variables in enabling the correct prediction of the dependent variables (Gay and Airasian, 2000). Internal validity is affected by eight main threats as proposed by Campbell and Stanley (1963). These variables are history, testing, selection preconception, experimental mortality, statistical regression, development (maturing or improving from one state to the other), instrumentation and research reactivity (ibid).

External validity on the other hand looks at how the research can be generalised to reflect the entire population. Hence, one could ask, does the same thing happens in variant settings other than this one? Smith and Glass (1987) also came out with some threats to external validity which includes; validity affecting the population of the study; ecological validity, and external validity of operations. By recapitulation, one must note that a study with internal validity, does not automatically confirms that the study will also have an external validity (Onwuegbuzie, 2000).

In assessing the validity of a test McLeod (2013) suggested two main methods of measurement which are content-related validity and criterion-related validity. Under content related validity, we have two main sub-sections; face validity and construct validity. Nevo (1985) opined that face validity considers the face value of what the study intends to measure. For instance, this study was on sustainable consideration of smart cities. Therefore, face validity would be achieved when the constructs reflects the aim of the study. However, face validity is considered a weak approach to test validity (McLeod, 2013). Construct validity looks at the extent to which the constructs explain the theoretical underpinning of the study. For example, this study on sustainability should have constructs which should at least touch on the triple bottom line of sustainable development (social, environment and economy). Therefore, attaining this would mean the study has a good construct validity (Cronbach and Meehl, 1955).

Criterion validity measurement technique is concerned with how one study is correlated to other measurements (variables). Criterion validity is grouped into several types based on the approach adopted. First, one type of criterion validity is concurrent validity. As the name suggests, concurrent validity measures the rate at which the test relates to another construct concurrently (McLeod, 2013). For instance, in this study, it has been purported that smart cities could lead to urban sustainability. Hence, constructs in smart cities for improving any city in becoming smart should also have linkages which could lead the city to urban sustainability. Predictive validity is when after some point in time we can predict the scores of a future outcome from the test. Convergent validity on the other hand relates to how new findings and previous findings still leads to the same concurrent outcome on the study (Petty *et al*., 2009).

3.12 ETHICAL ISSUES

Ethics is an ancient Greek word which was used to differentiate between good and bad morals. Hence, it can be dubbed as the branch of philosophy which deals with the phenomenon of right and wrong in decision making (Johnstone, 2015). Since the use of scientific enquiry somewhere as back in time even before the 18th century, ethics became a formalised part of research only until recently; after the Nazi experiments with the Nuremberg code published in 1947. The code is seen to be the mother of all research codes from which the other codes emanated from (Fouka and Mantzorou, 2011). The Nuremberg code focused on freedom to partake or withdraw from research, informed consent of respondents' protection from physical and mental harm, risk-benefit balance and protection from suffering or death (Oddi and Cassidy, 1990).

Ethical issues are very important in research now, because ethical standards eschew falsification of data and promotes the formulation of real value facts and truth in promoting knowledge (Riddell and Burgess, 1989). Ethical issues also provide good grounds for collaborative research because it spells out the rules and duties of each member, and it enables the easy formation of co-authorship, copyright guidelines and confidentiality of each member (Dich *et al*., 2013). Moreover, in order to increase the integrity of research, ethical issues are harnessed in that regards and also for increasing confidence of the public in research. Thus, does the study protects human right, ensures animal welfare, safeguard the environment, complies to the laws, safety and available standards etc. (Riddell and Burgess, 1989). Examples of ethical issues considered in research includes but not limited to the following:

Beneficence – Thus, the study must be of immense benefit to the world or the scientific domain without having any harm whatsoever on the population of the study or the world (Beauchamp and Childres, 2001).

Informed Consent – this is when the respondent without any reservations whatsoever gives his/her consent to conduct the study or provide information to the questions being asked in the data collection tool (Armiger, 1997).

Respect for confidentiality and anonymity – the type of research method adopted would mostly influence the choice between anonymity and confidentiality. However, if the researcher is unable to provide anonymity (in case of a qualitative research), then at least the confidentiality of the respondent should be kept (Levine, 1976).

Respect for privacy – Levine (1976) opined that privacy is when an individual decides when to share, distribute, discuss or withheld his/her private information from others. When the researcher shares the private information of a respondent without informed consent, there is a breach of privacy (Kelman, 1977).

Protecting the vulnerable in the society – vulnerable group are those who do not have what it takes to protect their rights and welfare, for example the poor, children, the sick, pregnant women, aged, lunatics, very ill or dying people etc. (Fisher, 1993). Therefore, studies relating to these people should have a highly informed ethical consideration.

3.13 CHAPTER SUMMARY

The chapter presented in details the several methods available for use in research methods as well as reasons to choose one method over the other. This chapter in a nutshell provides the research structures or background to which the entire study lingers on. Hence, it is one of the main aspects which cannot be overemphasised in ensuring that a good and novel study is conducted. From this chapter, it can be deduced that the study used the pragmatic research philosophy which favours the use of both deductive and inductive research approaches, and either qualitative or quantitative or both research strategies. Though this research is a case study, close-ended questionnaires were used as the data collection tool. The study was also conducted within a short time frame (cross-sectional). Moreover, the purposive sampling technique was adopted invoking the use of non-parametric test for analysis of the study.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

This chapter basically presents the analysis of the data retrieved from the survey, and the discussion of the analysis thereof i.e. supporting the analysis with literature and reasons where necessary. The tool for data collection was structured close-ended questionnaire with only one question been open-ended in the demographic (see Appendix). After distributing the questionnaire personally and online to the target respondents using purposive sampling techniques, seventy-six (76) of the questionnaires were retrieved out of a total of 95 questionnaires distributed which represent a response rate of 80%. The response rate was considered appropriate for analysis, because according to the avowal of Moser and Kalton (1979), the results of a survey could be considered as insufficient and biased if the return rate is lower than 30 – 40% of the totals distributed or sampled.

Cronbach's Alpha co-efficient test was adopted to check the internal consistency of the variables and reliability of the scale. Howland and Wedman (2004) asserted that Cronbach's Alpha Co-efficiencies of 0.700 or more are considered to be those with very high reliable scale, and such co-efficiencies should be aimed at by deleting items where necessary to improve the scale. After checking the reliability of the scale, several tools like visualisation tools (tables and figures); descriptive statistics (measures of central tendencies (for example, means, frequencies, standard deviation and standard error mean etc.); Principal Component Factor Analysis, Mean Score Ranking, One-Sample T-test and Relative Importance Index were employed in analysing the several parts of the questionnaires as determined and deemed fit for use with reasons and citations.

The questionnaire was divided into two main sections (see Appendix). Section one was about the respondent's background information. The respondent background information is mostly added to the study to check the validity of the data obtained. Hence, confirming that the data was obtained from the requisite experts or target population which the study identified in literature or from experts view to be in good position to answer or provide information on the researcher's questions. The section two was divided into four main parts. Part A dealt with the posteriori of the study. Hence, a section which is considered to be very important in providing a solid background for carrying out the entire research in the identified case study area. Part B captured the key sustainable development factors of smart cities, Part C dealt with the militating factors of sustainable development of smart cities in developing countries while the last set of questions (Part D) touched on the critical success factor of sustainable development of smart cities.

Software used for the analysis include the Statistical Package for Social Sciences (SPSS) windows version 21; Microsoft Excel 2019; Google Forms (for distributing questionnaire online); Microsoft Visio 2019 for diagrams, and Microsoft Word 2019 for the writeup.

4.2 DESCRIPTIVE ANALYSIS OF RESPONDENTS BACKGROUND INFORMATION

This section was mainly added to the questionnaire to validate the responses that would be obtained. The data obtained was principally primary data from the retrieval of distributed questionnaires online and personally. Hence, there is the need to provide a screen – to limit or abhor incompetent respondent from carrying out the survey. Thus, giving out the purpose for strategically adding up this section and purposefully asking the questions which were set out under this section. It must be reiterated that, if the response is validated, then there is no wrong or right answer to the response that the expert gave, but it would merely show the characteristics or features of the target population who took up the survey. The demographic analysis of the respondents is analysed in the sections under section 4.2 below in descriptive tables and figures.

4.2.1 Area of Expertise

This question was the only open-ended question in the entire questionnaire. It also acts as the validation screen where the answer provided by the respondent will determine whether he/she has the requisite knowledge or expertise in answering the rest of the questionnaire. At best option, the questionnaire is supposed to be answered by experts in the following various fields of expertise: Governance, Environment, Education, Health, Business and Finance, Infrastructure etc. Hence, since this section was open-ended, the respondents were allowed to write up their current profession as they would describe it in words. After retrieving the 76 questionnaires from the population, and by doing manual transcribing, it became appropriate to group the responses of the respondents under five key areas of expertise which are Governance, Environment, Education, Business and Finance, and Infrastructure. The analysis to this question is presented in Figure 4.1.

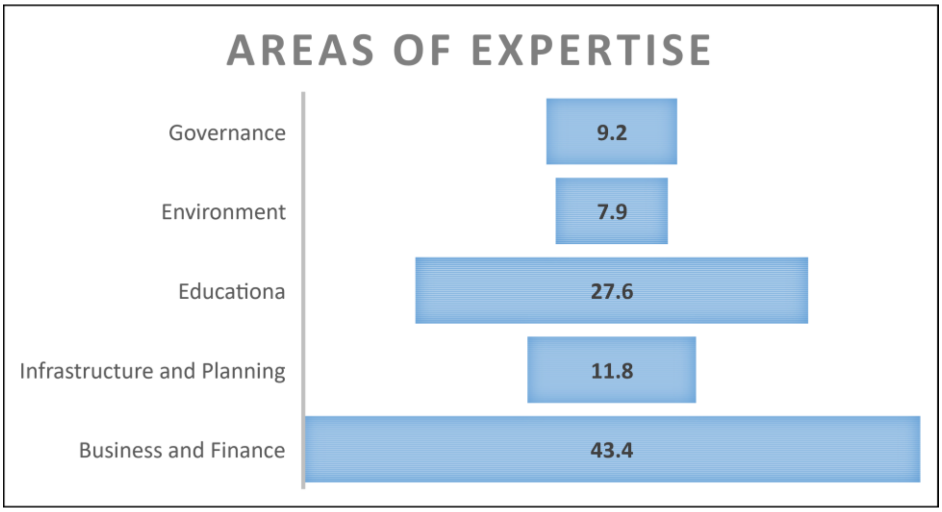

Figure 4.1 Areas of Expertise

Source: Field Survey (2019)

From Figure 4.1, it can be deduced that 9.2% of the 76 respondents were having jobs which could be related to the governance area of expertise. 7.9% of the respondents were in the environmental section. 27.6% of the respondents fell within the educational sectors when considering the areas of expertise of the respondents. In relation to infrastructure and planning, 43.4% of the respondents identified themselves in this area, while 11.3% of the respondents were found to have jobs which can be generally be categorised in the business and finance sectors. Smart cities consist of several actors of city officials coming together to ensure that they perform their duties with an engrained touch of technology, innovation and smartness to improve our urban conurbations in one way or the other (Winter, 2011; Vanolo, 2014; Sadowski, 2016). Hence, it would require the expertise of officials who are related to the six dimensions of smart cities to each put out their best in doing their duties to see to the realisation and fruition of the smart city concept in developing countries (Kamar and Dahiya, 2017).

4.2.2 Years of Experience

The respondents were also entreated to provide how long they have worked in their current position. This question was asked to understand the characteristics of the population in terms of employment. Here, the main focus is not on actually working for so long or becoming experienced for this much. Smart city is a new concept, and it would not matter entirely if you have so much experience and does not know or have no idea of the concept. However, the question was provided generally to help in considering the responses the respondents gave in a general view from their years of working. Though we would still expert experienced workers to assess the concept based on their experience whether it is feasible in Kumasi city based on how they have known and worked with the system. Notwithstanding, in Figure 4.2, the years of experience of the respondents are presented.

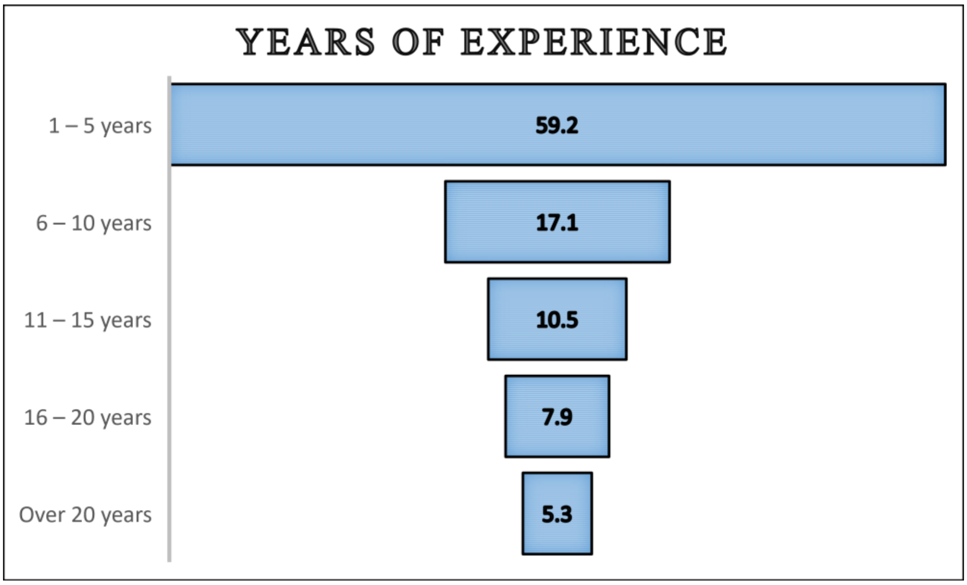

Figure 4.2: Years of Experience

Source: Field Survey (2019)

From Figure 4.2, it could be deduced that majority of the respondents have experiences between the years of 1 – 5 years. Hence, representing the majority of them with a percentage of 59.2% of the total respondents of this survey. The years of experience of our respondents decreased chronologically downwards as the years increases. Thus, only 5.3% of our respondents recorded that they have worked over 20 years, while 17.1% reported to have worked between 6 – 10 years while 10.5% of the respondents were seen to have their experience between 11 – 15 years.

4.2.3 Familiarity with the Smart City Concept

It was deemed necessary to note the level of familiarity of the respondents to the smart city concept. This was considered important, so that we can cross-check whenever necessary, the kind of respondent who gave us the responses whether they had an idea of the smart city concept or not. This is very necessary in also validating the responses given to improve the credibility of the data collected. However, it must be stated that a somewhat familiar respondent is one who knows of the smart city concept, how it is obtained, its benefits and challenges, but have not experienced it before, or have not taken ample time to get to know the concept in-depth. The analysis of this section is presented in Figure 4.3.

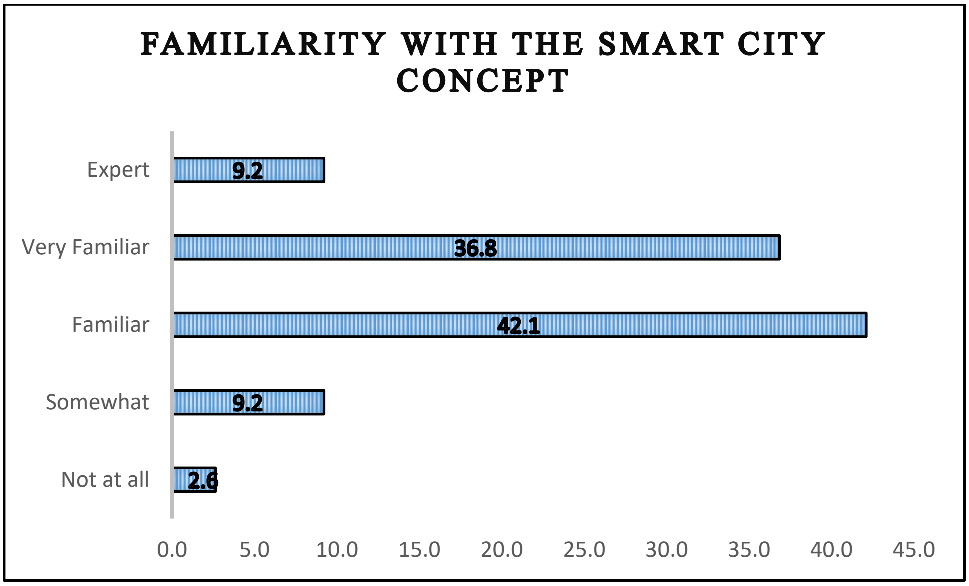

Figure 4.3: Familiarity with the Smart City Concept

Source: Field Survey (2019)

Considering Figure 4.3, it can simply be deduced that 9.2% of the 76 respondents identified themselves as experts in the smart city concept. As experts, they could be seen as individuals who have ideas, experiences or even policies about the implementation, benefits and challenges of smart cities, and could easily provide recommendation for improvement in the concept. Hence their input to this study cannot be overemphasised. On the lower side too, only 2.6% of the respondent did not know about the smart city concept in its usage, thus, they could be seen to know of city innovations and improvement in cities systems in general, but they were incognisant of the knowledge that such processes and concept could simply be dubbed as a smart city. Notwithstanding, majority of the respondents were familiar (42.1%) and very familiar (36.8%) with the smart city concept. Hence, they know the concept as generally, using ICT and technologies to improve our cities to ensure more security, improve movement by reducing traffic, create avenue for business growth and enhance the economy of the city

(Anthopoulos, 2019), and as a familiar respondent they could also provide credible data on the sustainable development considerations of smart city concept.

4.2.4 Observatory Condition of the Kumasi City

Now, the respondents were asked to state based on their observations and their knowledge of the implementation of smart cities elsewhere, or its formation and usage in other developed countries whether they think that if Kumasi City is not smart now, it can also be smart city one day. The analysis of this question is presented in Figure 4.4.

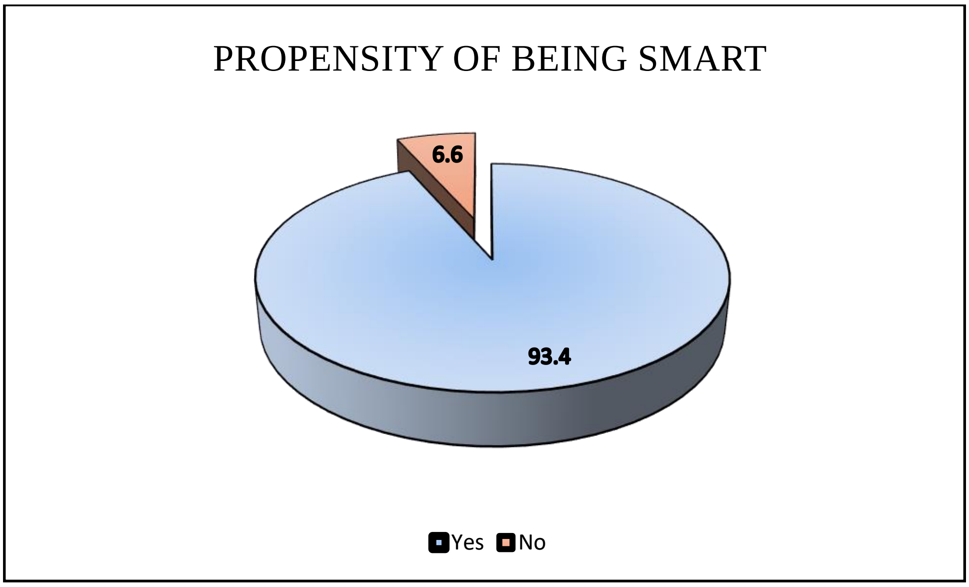

Figure 4.4: Propensity of Kumasi City Becoming Smart

Source: Field Survey (2019)

Figure 4.4 shows the tendency of Kumasi city becoming smart according to the respondents based on their observations and experiences. It can be deduced that 93.4% of the 76 respondents are of the view that Kumasi city has the propensity of becoming smart and being ranked among the current smart cities like Rio De Janeiro in Brazil, Songdo in South Korea and the Masdar City in Abu Dhabi (Singer, 2012). However, 6.6% of the respondents said No, Kumasi city cannot become smart. They must have their reasons, and further questioning could review why they think Kumasi city cannot be smart like other smart cities in developed and developing economies.

4.2.5 Respondents Attitude Towards Smart City Projects

One main challenge to the formation of smart cities is the cost involved in the process, notwithstanding, if well effected, the smart city concept can lead to sustainable development, reduced unemployment and increased economic value of cities and countries in general (Alusi *et al*., 2011). Therefore, this question was basically provided to see if respondents agrees generally to this notion of smart cities, being expensive initially, but having long term benefits of reduce unemployment, sustainability, and economic benefits. These three options are the right answers which was expected of respondents to provide. The multiple-choice data analysis of this question is provided in Table 4.1 and 4.2.

Table 4.1 All three correct answers for positive attitude towards smart city projects

	Frequency	Percent	Cumulative Percent
Selected	34	100.0	100.0

Source: Field Survey (2019)

Table 4.1 shows the number of respondents who selected all three responses which Alusi *et al*. (2011) consider as positive attitude towards smart city formation. These are: smart city projects could be expensive initially, but long-term benefit would outweigh its initial cost; in the short-term smart cities' formation could reduce unemployment in cities and neighbouring towns, and in the long term increase the economy of the city; smart cities could also lead to sustainable development of our cities, and therefore it should be highly encouraged and undertaken.

Table 4.2 shows the general response set of the whole sample. Thus, it depicts the number of responses who selected each choice, the percentage of the selected choice in comparison to the whole choices selected, and the percentage of respondents who selected a particular case in the study.

Table 4.2 Attitude Towards Smart City Projects

Attitude Towards Smart City Projects	Responses		Percent of Cases
	N	Percent	
1. It would be expensive; we should not endeavour	1	.6%	1.3%
2. It would not change things anyway	1	.6%	1.3%
3. It could be expensive initially, but have long term benefit	66	40.2%	86.8%
4. In the short term, will reduce unemployment, increase economy	41	25.0%	53.9%
5. It could lead to urban sustainability, so we should endeavour	55	33.5%	72.4%
Total	**164**	**100.0%**	**215.8%**

Source: Field Survey (2019)

Deducing from Table 4.2, it can be seen that majority of the respondents were around the three most correct answers which shows a positive attitude of the sample towards smart city projects. Thus, this study can conclude that professionals in the Kumasi city conurbations are generally positive or very interested to patronise the formation and development of Kumasi city into a smart city whenever the need arises. Inferentially, the study can surmise that the professionals are aware of the huge initial cost which could be involved with smart city projects, but are more positively skewed towards considering the long-term and life cycle benefits of such projects to the development and improvement of Kumasi city.

4.2.6 Respondents View on Sustainability of the Smart City Concept

It has been purported in literature that one of the benefits of smart cities is its ability to making our cities very sustainable. This sustainable development can be seen in the context of environmental, social and economic perspectives in the urban areas (Nam and Pardo, 2011; Caragliu *et al*., 2011; Lazaroiu and Roscia, 2012; de Jong *et al*., 2015; Aletà *et al*., 2016 etc.). Therefore, this question was strategically formulated to find out from the respondents whether they agree or otherwise to the idea of cities becoming sustainable through implementation smart cities. The analysis of this question is presented in Figure 4.5.

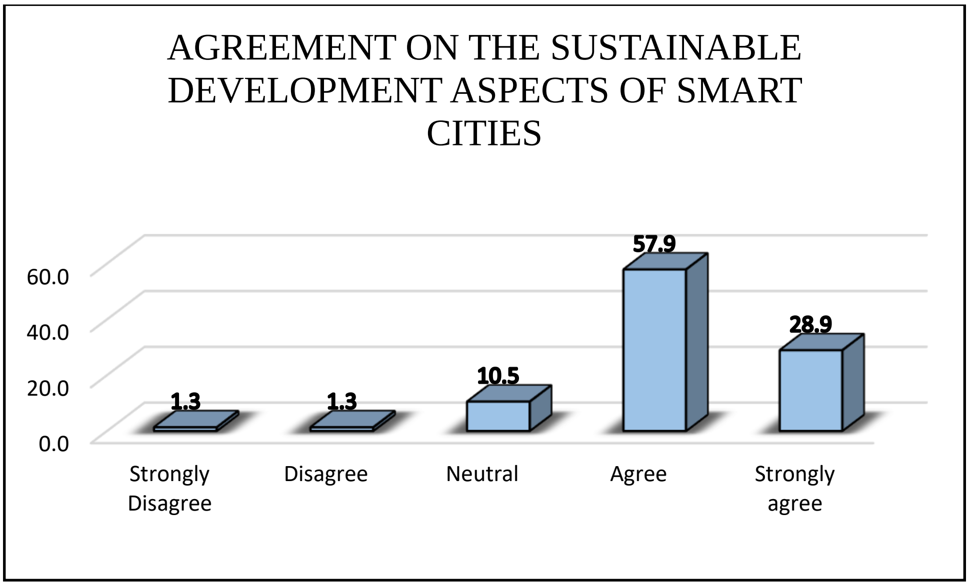

Figure 4.5: Agreement on the Sustainable Development Aspects of Smart Cities

Source: Field Survey (2019)

Inferring from Figure 4.5, it can be deduced that majority of the respondents agree (57.9%) that smart cities have the propensity of reducing urban problems and increasing sustainable development in all spheres (social, environmental and economical perspectives). 28.9% of the 76 respondents also strongly agree to this fact. However, cumulatively only 2.6% of the respondents either disagree or strongly disagree with the notion explicated above.

4.3 RELIABILITY ANALYSIS FOR ALL THE PARTS IN SECTION TWO

This section presents the reliability analysis of all the parts under section two of the questionnaire (see Appendix). Howland and Wedman (2004) asserted that before analysing data from a survey, one must check the internal consistency of the variables and the reliability of the scales used. The Cronbach Alpha's Co-efficient test is mostly used in checking the reliability of scales (see for example Giffinger and Gudrun, 2010; Antwi-Afari *et al*., 2018; Owusu-Manu *et al*., 2018 etc.). The Cronbach Alpha's Co-efficient of 0.700 or more is mostly asserted to be very reliable. In a case where one gets a co-efficient less than 0.700, then some items could be deleted in improving the scale (those which did not make it above 0.700 in the item-total statistics table under the Cronbach's Alpha if item deleted column). The reliability analysis of all the parts in section two of the questionnaire is presented in tables below.

Table 4.3 Reliability Statistics of Posteriori of the Study

Cronbach's Alpha	N of Items
.978	48

Source: Field Survey (2019)

From Table 4.3, it can be seen that the Cronbach's Alpha co-efficient is greater than 0.700 hence, we can conclude that there is a very good internal consistency among the variables which were used in determining the six dimensions of smart cities (the posteriori of the study). Also, with a Cronbach's Alpha of 0.978 we can resolve that the scale used is extremely reliable. Thus, we can now subject the data under this part to further analysis. It must be noted that since the Cronbach Alpha was more than 0.700, the study did not include the item-total statistic table, because it would not merit the study anyway now.

Table 4.4 Reliability Statistics for Part B – D of the Questionnaire of Study

SN.	Questionnaire Parts	Cronbach's Alpha	N of Items
1.	PART B – Key Sustainable Development Factors of Smart Cities	.956	27
2.	PART C – Militating Factors of Sustainable Development of Smart Cities	.889	17
3.	Part D – Critical Success Factors of Sustainable Development of Smart Cities	.960	25

Source: Field Survey (2019)

Deducing from Table 4.4, it could be seen that the Cronbach Alpha co-efficient of all the dimensions in the several parts in section two were all above 0.700. Hence, attesting to the fact that there is a very good consistency among all the variables under each part. Also, according to Howland and Wedman (2004) a Cronbach's Alpha coefficient which exceeds 0.700 depicts a high reliability of the scale used. Hence, the study can confidently attest to the fact that the scales used for the data collection were highly reliable. Therefore, we can subject the several sections in part two of the questionnaire to further analysis.

4.4 POSTERIORI FOR THE STUDY

As a means of validation for the study, it was very imperative to first, identify the level of smartness of Kumasi City. However, there is no universally agreed approach in measuring smart cities in the world (Giffinger *et al*., 2007; Holland, 2008; Winters, 2011). Hence, in the bid of measuring Kumasi City's smartness, the study intended to fall on indexes like the Global Innovation Index, Green City Index, Network Readiness Index etc. which are being used by several organisation (see for example World Economic Forum, World Intellectual Property Organisation, Economist Intelligence Unit etc.) in ranking cities in the world. However, Al-Nasrawi *et al*. (2015) strongly avowed that the use of these indexes cannot bring the true reflection of the city's smartness, because these indexes do not consider the entire dimensions at once stance. For instance, Green City Index would be entirely focused on smart environment while Global competitiveness index would also harness the smart economy aspect only. Moreover, the methodologies which these organisations use in coming out with their city rankings are not made public. Thus, making it very difficult for replication and adoption (Al-Nasrawi *et al*., 2015).

Therefore, this study adopted a strategic decision-making approach similar to the one used by Giffinger and Gudrun (2010) in their smart city ranking studies. Giffinger and Gudrun (2010) used score tables where each dimension was given a score based on a four ordinal metric scale. This study also used a Likert scale based on a five ordinal metric scale where 1 – Poor, 2 – Good, 3 – Better, 4 – Excellent and 5 – Champion (see Appendix) in ranking the various variables under each dimension. From a systematic review of literature, each dimension was also given a rating based on how that particular dimension contributes to the formation of smart city. Smart People was given a rating of 10/10; Smart Economy, 9/10; Smart Mobility, 8/10; Smart Environment, 7/10; Smart Governance, 6/10 and Smart Living 5/10. The tables below show how the smartness of Kumasi City was determined in this study.

Table 4.5 Mean Score Ranking of Variables Under Each Dimension

SN.	THE SIX DIMENSIONS OF SMART CITIES	Mean	Std. Error Mean	Std. Dev.	Skewness	Kurtosis	Rankings
D 1	**SMART PEOPLE**	**2.99**					**4th**
1.	Excellent schools and training institutes in the city	3.29	0.121	1.056	0.088	-1.002	1st
2.	Level of creativity in the urban sector	3.13	0.122	1.063	0.347	-0.935	2nd
3.	Willingness to learn and dedication to education	3.13	0.123	1.075	0.260	-0.847	3rd
4.	Better understanding and usage of computers	2.95	0.127	1.106	0.531	-0.872	4th
5.	Ability to manipulate and utilise data	2.93	0.123	1.075	0.597	-0.885	5th
6.	Availability of soft skills in the region	2.91	0.123	1.073	0.587	-0.443	6th
7.	Good reporting, reading and writing skills	2.84	0.116	1.007	0.567	-0.637	7th
8.	Good language skills of the citizens (English, Twi, French etc.)	2.76	0.111	0.964	0.772	-0.481	8th
D 2	**SMART ECONOMY**	**3.03**					**3rd**
1.	The ability to innovate, and the spirit of entrepreneurialism and creativity	3.36	0.121	1.055	-0.132	-1.06	1st
2.	Flexibility of the labour market and high productivity	3.29	0.112	0.977	0.175	-0.976	2nd
3.	Ability to transform into the international market	3.16	0.120	1.046	-0.110	-0.888	3rd

4.	Resourceful in making most of its assets while finding solutions to problems	3.11	0.118	1.027	0.087	-0.948	4th
5.	Transformation from an urban economy to a smart economy	3.04	0.116	1.012	-0.001	-0.591	5th
6.	Foreign/Domestic direct investment in the region	2.84	0.120	1.046	0.253	-0.797	6th
7.	Destination that people want to visit (tourism)	2.83	0.121	1.051	0.069	-0.534	7th
8.	High standard of living	2.64	0.110	0.962	0.406	-0.447	8th
D 3	**SMART MOBILITY**	**3.04**					**2nd**
1.	High density living; promoting high-speed mobility	3.09	0.123	1.073	0.078	-0.945	1st
2.	Integrated high-mobility, linking areas together (residential to work places to recreational, to transport notes e.g. bus/railway stations and airports)	3.08	0.127	1.105	0.023	-0.992	2nd
3.	Improved walkability or cycling in the region	3.05	0.131	1.142	0.005	-0.675	3rd
4.	Seamless mobility for differently-abled people	3.04	0.133	1.16	0.132	-0.811	4th
5.	Reduced or no traffic thronging	3.04	0.137	1.194	-0.029	-1.086	5th
6.	Sustainable transport systems (for people and goods)	3.00	0.127	1.108	0.121	-0.628	6th
7.	Mass rapid transit system (locally and internationally accessible)	3.00	0.130	1.131	0.113	-0.796	7th
8.	Accident reduction on roads in the sector	3.00	0.136	1.189	0.391	-0.795	8th
D 4	**SMART ENVIRONMENT**	**2.97**					**5th**
1.	Upholding natural heritage and a strong sense of place rooted in a natural setting	3.30	0.131	1.143	0.201	-1.399	1st
2.	Greenness and vegetation concerns of the place (practice afforestation and restrict deforestation)	3.12	0.14	1.222	-0.007	-0.971	2nd
3.	Energy usage and controls in the city region	3.11	0.145	1.26	0.207	-1.32	3rd
4.	Efficiently manages it natural resource base (water, land, and other resources)	3.01	0.15	1.311	0.157	-1.271	4th

5.	Preserving ecological system and sustaining biodiversity in the city region	2.95	0.149	1.295	0.214	-1.157	5th
6.	Promoting outdoor living and green spaces	2.83	0.157	1.37	0.254	-1.226	6th
7.	Practising good sewage and waste disposal systems	2.82	0.156	1.363	0.246	-1.255	7th
8.	Warning system for natural disasters e.g. Earthquakes, Flooding etc.	2.58	0.151	1.319	0.218	-1.272	8th
D 5	**SMART GOVERNANCE**	**2.80**					**6th**
1.	Practising urban and regional planning and integration	2.92	0.133	1.163	0.314	-1.22	1st
2.	Incorporating citizens in its operations	2.87	0.122	1.063	0.406	-0.406	2nd
3.	Smart Urban Collaborations (Government, Businesses/Industry and Academia)	2.86	0.135	1.174	0.086	-0.922	3rd
4.	Smart Governance and management policies	2.83	0.138	1.204	0.339	-0.972	4th
5.	Smart Decision Making (Adopting spatial decision support systems, big data and geospatial technologies)	2.79	0.130	1.135	0.316	-0.77	5th
6.	Smart Administration (focusing on sustainable urban development)	2.76	0.137	1.199	0.283	-1.016	6th
7.	Openness to the public (Accountability, Responsiveness and Transparency)	2.74	0.139	1.215	0.296	-0.881	7th
8.	Constantly innovating practicing e-governance and e-democracy to achieve better development outcomes	2.66	0.156	1.362	0.292	-1.147	8th
D 6	**SMART LIVING**	**3.20**					**1st**
1.	Celebrating local history, festivals, promotes art, culture and has a ritual event	3.29	0.106	0.921	0.226	-0.745	1st
2.	Promoting a strong and shared values	3.29	0.112	0.977	0.175	-0.976	2nd
3.	Plenty and healthy foods	3.28	0.118	1.028	0.173	-1.141	3rd
4.	Personal safety and security of the place	3.26	0.132	1.147	0.278	-1.371	4th
5.	Availability of public amenities and a vibrant downtown 24/7	3.22	0.140	1.218	0.148	-1.363	5th

6.	Good and satisfying social services	3.14	0.135	1.174	-0.187	-0.869	6th
7.	Good health system	3.05	0.124	1.082	0.088	-0.838	7th
8.	Promotes quality living	3.04	0.122	1.064	0.397	-0.748	8th

Source: Field Survey (2019)

4.4.1 Mean Score Ranking

The mean score rankings of the various variables under each dimension is well-displayed in Table 4.5. The variables are arranged in descending order of means, with the highest mean being ranked first and the next highest following suit chronologically under each dimension. Overall too, the mean of each dimension is provided and ranked in Table 4.5. Ahadzie (2007) opined that where two or more variables have the same mean, the one with the lowest standard deviation is given the highest priority in terms of ranking. This is because standard deviation measures the consistency of agreement between the respondents' interpretation, and hence, the lower the standard deviation number the better (Owusu-Manu *et al*., 2018). Yi (2011) was of the view that a standard deviation less than 2.000 is considered as the best, because it shows a small degree of variation, but a high level of agreement between how the respondents interprets the variables. Inspecting Table 4.5, it can be concluded that all the variables had a standard deviation less than 2.000, hence depicting and confirming that the respondents of this survey clearly interpreted all the variables analogously.

Also, the standard error mean of all the variables were also closer to zero. Ahadzie (2007) opined that a standard error closer to zero typifies that the sample used is closer in characteristics to the population of the study. Hence, from Table 4.5, this assertion can be said to be entirely true for this study. Also, the normality of the data was checked by using univariate skewness and kurtosis in the analysis. Kline (2015) opined that the normality of data could be confirmed by using univariate skewness and kurtosis if the absolute value of the skewness and kurtosis is less than 3.0 and 8.0 respectively. Inspecting Table 4.5, it can be confirmed that the study had a good normality of data. Hence, all the skewness and kurtosis had an absolute value less than 3.0 and 8.0 respectively.

From Table 4.5, it can be deduced that under smart people, the highest variable which the respondents agreed to be contributing to the development of the smart people dimension of Kumasi City is the availability of excellent schools and training institutes in the city. Obtaining a mean of 3.29, it recorded the highest mean of this dimension. The second highest variable was the acknowledgement of the creativity in the Kumasi city which had a mean of 3.13. The third ranked variable under smart people was the willingness to learn and dedication to education (mean of 3.13). The findings under the smart people dimension conform to what researchers agreed to be an important paradigm in making smart cities, thus, the availability and incorporation of excellent school and training institutes in the city (see for example Shapiro, 2006; Winters, 2011; Kumar and Dahiya, 2017).

Inferring from Table 4.5, under the smart economy dimension the most important variable which leads to the realisation of a smart economy according to the study is the ability of citizens to innovate and the experience of the spirit of entrepreneurialism and creativity in the city; obtaining the highest mean of 3.36. Flexibility of the labour market and high productivity in Kumasi City as well as the ability of markets transforming into an international market were all considered as important paradigms in the smart economy dimension recording means of 3.29 and 3.16; and being ranked 2nd and 3rd respectively. These three main variables correlate with how Giffinger *et al*. (2007) and Lombardi *et al*. (2012) defines or envisioned what a smart economy to be. Hence, these variables have also being ranked in their studies in the machinating of the smart economy dimensions of smart cities.

Under the smart mobility dimension in Table 4.5, Kumasi city is recognised as a place where there is high density living at particular regions and hence promoting high-speed mobility. Moreover, the city is quite integrated – linking several areas together. Lastly the third ranked variable in this section was the acknowledgement of improved walkability in the region. These variables were ranked 1st, 2nd and 3rd, with means of 3.09, 3.08 and 3.05 respectively. Inferring from Table 4.5 again, under the smart environment dimension, it can be seen that Kumasi City upholds natural heritage and shows a strong sense of a place rooted in natural settings. Also, the place could be dubbed as one that promotes greenness and vegetation as well as having sufficient energy usage and controls available in the region (Giffinger *et al*., 2007; Komninos, 2009; Lee *et al*., 2013). Hence, generating alternative sources of energy like solar and hydro etc. These variables had means of 3.30, 3.12, 3.11 and were ranked from 1st to 3rd respectively.

Deducing from Table 4.5, under the smart governance dimension, practicing urban and regional planning and integration is seen to be held in high regards in the Kumasi city, as well as incorporating citizens into its operation with the third ranked variable being smart urban collaboration (between government, business, industry and academia). Though these variables were highly ranked under this section, they all had means less than 3.0 which signifies that generally, smart governance is not a well-practiced dimension of Kumasi City. The last dimension on Table 4.5 is smart living. Under smart living, the highest ranked variable is celebrating local history, festivals, promoting art, culture and ritual events. This is entirely true of the Kumasi people who upholds cultural values and ancestral tradition in high regards. This variable was ranked first with a mean of 3.29. The second and third ranked variable under this dimension were the promoting a strong and shared value, and the availability of plenty and healthy foods (3.29 and 3.28 means respectively), all these variables are a true reflection of the city, and hence, we can say that at least, the city is on the verge of achieving something substantial in the smart living dimension of smart cities.

The rankings provided for each dimension in the smart city formation was obtained from the means of each of the variables under it. From Table 4.5, it could be seen that Kumasi City has a better living condition (smart living – ranked first); followed by Smart mobility – ranked second (3.04); Smart Economy was ranked third (3.03); Smart People was ranked fourth (2.99); Smart Environment was ranked fifth (2.97) and lastly smart governance ranked 6^{th} (2.80). These rankings can be used by far and could be seen as true reflection of the population in predicting the dimensions which contributes to the development of smartness level of Kumasi City. Smart Living taking the first place is not surprising, because this dimension is seen as an agglomeration and achievement of all the other dimensions (Shapiro, 2006).

However, before drawing any further conclusions from the study, the ratings given to each dimension through systematic review of literature of smart city formation and ranking should be employed to the means and the total weighted score calculated. Only after this exercise could the study clearly determine the smartness level of Kumasi city and the important dimensions which are contributing to this cause. The calculation of the weighted score is presented in Table 4.6. Moreover, the attained weighted score of Kumasi city would be compared with the smartness box in Table 4.7 in determining the smartness level of Kumasi City.

The smartness box was created through a systematic literature review of how a perfect advanced smart city should portray. Hence, a perfect advanced smart city should obtain means of 5.00 from all its six dimensions. Multiplying these means by the ratings of each dimension gives a total weighted score of 225. With a five-point interval or level of improvement of cities from a Zilch city to the Advanced Perfect Smart City, the smartness box provides a span of 45 points from one level to the other. This was simply done by dividing the total weighted score of an advanced perfect smart city by the level of improvements (5). Alternatively, using a success criterion of 3.5 on a five-point Likert scale for showing significance, by prorating, a weighted score of 158 of any city which followed this approach could be considered as smart. The limitation of using the prorating is that it has only two sides. Thus, either it is 158 and above (smart city) or below 158 (not smart city).

Table 4.6: Weighted Score of Kumasi City

SN.	Dimensions	Means	Ratings	Weighted Score	Rankings
1.	Smart People	2.99	10	29.90	1st
2.	Smart Economy	3.03	9	27.27	2nd
3.	Smart Mobility	3.04	8	24.32	3rd
4.	Smart Environment	2.97	7	20.79	4th
5.	Smart Governance	2.80	6	16.80	5th
6.	Smart Living	3.20	5	16.00	6th
			Total	**135.08**	

Source: Field Survey (2019)

Table 4.7: The Smartness Box

Proposed Names	Zilch City	Diminutive Smart City	Substantial Smart City	Attained Smart City	Advanced Perfect Smart City
Weighted Score Range	0 – 45	46 - 90	91 – 135	136 – 180	181 – 225

Source: Author's Construct (2019)

Deducing from Table 4.6, it could be seen that the weighted score of Kumasi city based on the analysis was 135.08, hence approximately 135 weighted score. Comparing this weighted score to the smartness box means that Kumasi is a substantial smart city. Hence, Kumasi has not attained the smart city level yet, but it is in the process, and with the proper procedures and approaches in formulating smart cities, Kumasi can become smart easily. Now that we have identified the smartness level of Kumasi city, it is now overt for the study to move on with the other sections of the analysis. Thus, identifying the key sustainable development factors of smart cities, challenges or militating factors of sustainable development of smart cities and the critical success factors of sustainable development of smart cities. All these objectives are very imperative to policy development and aiding in the transformation of Kumasi city into a smart city, so that in the process of becoming smart, it would also incorporate these identified sustainable development factors, harness and reduce the challenges and follow through the critical factors which are very essential in making a city become smart and sustainable.

Lastly, by prorating based on the 3.5 level of significance, Kumasi city is simply not a smart city because its weighted score of 135.08 is below the prorated score for a smart city of 158 and above. Nonetheless, it is better to use the smartness box to get a full grasp of the whole idea of how far Kumasi has reached in the effort of becoming a smart city.

4.5 KEY SUSTAINABLE DEVELOPMENT FACTORS OF SMART CITIES

The key sustainable development factors of smart cities are those factors which were determined from literature which through empirical studies have been labelled to be aspects of smart cities which ensures or leads the concept in achieving sustainable development. What this objective intends to achieve here is to rank the various factors which were determined from literature, to see those which can easily be applicable to developing countries like Ghana. Hence, the study intended to find out from the respondent the importance of these factors in ensuring sustainable development of Kumasi City. Alternatively, it was targeted to know which factors are important in ensuring that smart cities through their formation leads to sustainable development.

One sample t-test was adopted for analysing the data obtained for this part of the survey. Since intuitively all the variables under this objective could lead to smart city, and would have some linkages benefit to sustainable development. The study used one sample t-test to find evidence to back the statement that this particular sample was not sampled from a population such that the mean equal to 3.5. Hence, becoming the null hypothesis for the study. Thus, the alternative hypothesis was that the mean of any of the variable should not be equal to 3.5. Which means it is a two-tail test, and it could go either way, less than or greater than the hypothesised mean. Nonetheless, since we want important variables which could combine as key sustainable development factors, a mean greater than 3.5 would be preferred.

H_0: $U = U_0$ $U_0 = 3.5$, therefore H_0: $U = 3.5$

H_1: $U \neq U_0$ which implies H_1: $U \neq 3.5$

Where H_0 is the null hypothesis; U is the population mean; U_0 is the hypothesised mean, and H_1 is the alternative hypothesis.

The question the study is asking is that does the sample means of the key sustainable development factors of smart cities deviate from the population means, such that we can conclude that the population parameter is different from 3.5? The one-sample analytical tool from SPSS was used in analysing the data in this part of the questionnaire, and the analysis (one-sample statistics and one-sample t-test tables) are presented in Table 4.8 and 4.9 respectively.

Table 4.8: One – Sample Statistics of Key Sustainable Development Factors

SN.	Key Sustainable Development Factors of Smart Cities	Mean	Std. Deviation	Std. Error Mean	Rankings
1.	Improved recyclable and reusable water treatment systems	4.51	.757	.087	1st
2.	Adopting renewable energy sources (Solar, Wind mill, Geothermal etc.), and reducing GHG emissions	4.38	.711	.082	2nd
3.	Good, quality and affordable education and training for all	4.33	.855	.098	3rd
4.	An integrative, efficient and easily accessible transport systems	4.30	.766	.088	4th
5.	Enhanced health access, but at reduced cost	4.30	.966	.111	5th
6.	Efficient and planned management of natural resources and biodiversity	4.25	.768	.088	6th
7.	Efficient and working telecommunications networks and other utilities	4.25	.819	.094	7th
8.	The adoption of smart waste disposal	4.24	.798	.092	8th
9.	Planned greenness and sustainable environment	4.22	.826	.095	9th
10.	Encouraging the use of public transport systems through an enhanced and efficient mobility within the city	4.22	.842	.097	10th
11.	Smart construction to reduce energy and waste during construction	4.21	.943	.108	11th
12.	Creating an enabling environment for business growth	4.17	.823	.094	12th
13.	Empowering citizens participation	4.16	.749	.086	13th
14.	Adopting holistic approaches which nurtures income and employment opportunities for citizens	4.14	.905	.104	14th
15.	Enhancing the achievement of highly technological and creative industries in the long term	4.14	.919	.105	15th
16.	Enabling the development of business models, and maximising social and relational capital	4.09	.734	.084	16th
17.	Encouraging the usage of security cameras, imbedded sensors and checkpoints	4.09	.941	.108	17th
18.	Adopting smart homes and encouraging Net Zero Energy buildings	4.05	.965	.111	18th
19.	Provision of an open, transparent and efficient governance	4.01	.902	.103	19th
20.	Measures in place to improving the quality of life of citizens e.g.: recreational and social services	4.00	.800	.092	20th

21.	Measures and initiatives to combating and controlling climate change	3.99	.825	.095	21st
22.	Promoting the development of culture through network infrastructures and enabling social inclusion of several different cultures	3.91	.897	.103	22nd
23.	Promoting the availability of cheaper products and empowering consumption levels in cities	3.87	.838	.096	23rd
24.	The scalability of smart energy grids usages	3.87	.914	.105	24th
25.	Equality in the sharing of benefits of common good	3.87	1.050	.120	25th
26.	The usage of smart metering	3.84	.817	.094	26th
27.	Diversified policies for managing spatial distribution of population and internal migrations	3.76	.950	.109	27th

Source: Field Survey (2019)

Table 4.9: One – Sample T-test of Key Sustainable Development Factors

SN.		Test Value = 3.5					
		t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
1.	Improved recyclable and reusable water treatment systems	11.667	75	.000	1.013	.84	1.19
2.	Adopting renewable energy sources (Solar, Wind mill, Geothermal etc.), and reducing GHG emissions	10.806	75	.000	.882	.72	1.04
3.	Good, quality and affordable education and training for all	8.456	75	.000	.829	.63	1.02
4.	Enhanced health access, but at reduced cost	7.241	75	.000	.803	.58	1.02
5.	An integrative, efficient and easily accessible transport systems	9.131	75	.000	.803	.63	.98
6.	Efficient and planned management of natural resources and biodiversity	8.512	75	.000	.750	.57	.93
7.	Efficient and working telecommunications networks and other utilities	7.988	75	.000	.750	.56	.94
8.	The adoption of smart waste disposal	8.052	75	.000	.737	.55	.92

9.	Encouraging the use of public transport systems through an enhanced and efficient mobility within the city	7.491	75	.000	.724	.53	.92
10.	Planned greenness and sustainable environment	7.636	75	.000	.724	.53	.91
11.	Smart construction to reduce energy and waste during construction	6.572	75	.000	.711	.50	.93
12.	Creating an enabling environment for business growth	7.110	75	.000	.671	.48	.86
13.	Empowering citizens participation	7.655	75	.000	.658	.49	.83
14.	Adopting holistic approaches which nurtures income and employment opportunities for citizens	6.212	75	.000	.645	.44	.85
15.	Enhance the achievement of highly technological and creative industries in the long term	6.113	75	.000	.645	.43	.85
16.	Security cameras, imbedded sensors and checkpoints	5.488	75	.000	.592	.38	.81
17.	Enabling the development of business models, and maximising social and relational capital	7.037	75	.000	.592	.42	.76
18.	Smart homes and encouraging Net Zero Energy buildings	4.994	75	.000	.553	.33	.77
19.	Provision of an open, transparent and efficient governance	4.961	75	.000	.513	.31	.72
20.	Measures in place to improving the quality of life of citizens e.g.: recreational and social services	5.449	75	.000	.500	.32	.68
21.	Measures and initiatives to combat and control climate change	5.148	75	.000	.487	.30	.68
22.	Promoting the development of culture through network infrastructures and enabling social inclusion of several different cultures	3.964	75	.000	.408	.20	.61
23.	The scalability of smart energy grids usages	3.513	75	.001	.368	.16	.58
24.	Equality in the sharing of benefits of common good	3.059	75	.003	.368	.13	.61

25.	Promoting the availability of cheaper products and empowering consumption levels in cities	3.832	75	.000	.368	.18	.56
26.	The usage of smart metering	3.649	75	.000	.342	.16	.53
27.	Diversified policies for managing spatial distribution of population and internal migrations	2.414	75	.018	.263	.05	.48

Source: Field Survey (2019)

4.5.1 Findings and Discussions of Key Sustainable Development Factors

Deducing from Table 4.8, it can be concluded that all the variables had a mean greater than 3.5 which shows a high importance of the variables in conceptualising collectively as key factors of sustainable development of smart cities. Improving recyclability and reusability of water through the use of treatment systems was the first ranked key sustainable development factor of smart cities. Hence, the respondents agreed that a smart city should have mechanisms in place which treat the waters in the city (grey water, yellow water, black water etc.) and feed them back to the system for other household purposes, use them for irrigation, or allow them to flow freely containing no harm onto water bodies nearby (Harvey, 2011; Vanolo, 2014; Manville *et al*., 2014). This variable had a mean of 4.51, standard deviation of 0.757 and standard error mean of 0.087.

Adopting renewable energy sources (for example the use of solar energy, wind mills, geothermal energy etc) in an effort of reducing GHG emissions was the second highly ranked variable as a key sustainable development factor with a mean of 4.38, standard deviation of 0.711 and standard error mean of 0.082. GeSI (2008) and Manville *et al*. (2014) opined that a sustainable smart city must involve renewable energy usage in its design, and assist in lowering the effects of greenhouse gas emissions in our cities. The goal of smart cities is to ensure the reduction of greenhouse gases by 40 percent by improving energy efficiency of building and implementing the usage of smart energy grids (Vanolo, 2014).

Good, quality and affordable education and training for all was the third ranked variable as a key sustainable development factor of smart cities. It must be noted that sustainable development consists of social, economic and environmental principles, and this variable relates well with meeting the social aspect of sustainable development. Ranking third with a mean of 4.33, standard deviation of 0.855 and standard error mean of 0.098, this independent variable is viewed as one of the top three important variables which a smart city proffers in meeting the sustainable development aspect of the concept. Ratti and Townsend (2011) consented with the assertion that smart cities improves quality education, while Vanolo (2014) even stressed the notion that a city cannot be labelled sustainable if citizen's education are not ingrained in the smart cities' formation. Winters (2011) also argues that city officials must concentrate on promoting higher education in their urban space, and in the process would lead to their cities becoming smart. This is because people are considered as a very important aspect of smart cities formation, and the availability of educated individuals in cities would boost the smartness level while attaining social sustainable development principles (Kumar and Dahiya, 2017). The importance of this factor to developing countries cities is viewed in the avowal of Cairney and Speak (2000) who opined that cities can become smart if the lag in education particularly digital illiteracy is improved.

An integrative, efficient and easily accessible transport systems will surely improve the economy of a city and leads to the sustainability of the smart city concept. An integrative mobility will promote the predilection of the public to mass transport as compared to private individual vehicles. This is because an efficient and easily accessible transport systems would be fast, cheap and sustainable (in terms of energy consumption and release of GHG into the atmosphere). Coming out as the fourth ranked variable with a mean of 4.30, standard deviation of 0.766, and standard error mean of 0.088, this independent variable appears as one of the key sustainable development factors of any smart city. Hence, Harvey (2011) opines that a smart city would be particular about how to shift people from personal cars to public transport. Vanolo (2014) and Höjer and Wangel (2015) also added their contributions that a smart city would enhance transportation within its urban areas and accelerate movement of the general public, thus reducing traffic thronging. Liu and Peng (2013) provided the benefits of this variable in leading the smart city concept to sustainable development by harnessing on the use of sensors in our transport system, and the adoption of sustainable green energy for public vehicles.

The mean, standard deviation and standard error means of the rest of the variables are presented below as seen in Table 4.8. Enhanced health access, but at reduced cost was the 5th ranked variable with a mean of 4.30, standard deviation of 0.966 and standard error mean of 0.111; Efficient and planned management of natural resources and biodiversity ranked 6th with a mean of 4.25, standard deviation of 0.768, and standard error mean of 0.088. The rest of the variables follows this approach chronologically as depicted in Table 4.8. The last three ranked variables as read from Table 4.8 are equality in the sharing of benefit of common good, which came 25th with a mean of 3.87; standard deviation of 1.050 and standard error mean of 0.120; the usage of smart metering which ranked 26th on the table with a mean of 3.84; standard deviation of 0.817 and standard error mean of 0.094; diversified policies for managing spatial distribution of population and internal migrations was the last ranked variables under the key sustainable development factors of smart cities with a mean of 3.76, standard deviation of 0.950 and standard error mean of 0.109.

It can be deduced that all the means of the variables under this dimension were all greater than 3.5 which shows how important all these variables are in leading smart cities to achieving sustainable development. It is worthy of mentioning that the standard deviation of all the variables were also less than two. Hence, as stated by Yi (2011) a standard deviation less than two shows a high level of agreement between the respondents on the variables, and a small degree of variation thereof. Also, the standard error means of all the variables were closer to zero, and according to Ahadzie (2007), a standard error mean closer to zero shows that the sample was a true representation of the population. Lastly, inferring from Table 4.8, it could be seen that some of the variables were having the same mean, but their rankings were different, this is because of the avowal of Ahadzie (2007) that where variables have the same mean, the one with the lowest standard deviation should be given the highest priority.

4.5.2 T-test Findings and Discussions

Ahadzie (2007) opined that in conducting a t-test for any analysis, one must present in tables the t-statistics, the degree of freedom (df), the p-value or significance value, the mean difference (the difference between the population mean and the hypothesised mean) and the lower and upper limits of the confidence interval. Each of these key items are important in explaining and understanding the one sample t-test analysis. At 95% confidence interval, the significance level was set. Thus, a variable would be considered as significant if it has a p-value less than 5% (0.05). In other words, reject the null hypothesis for any variable if the p-value is less than 0.05. Inspecting Table 4.9, it can be deduced that all the variables had significance value less than 0.05. Hence, the null hypothesis that the population mean is equal to the hypothesised mean can be rejected for all the variables under this dimension. Inferring, it means that all the variables had means greater than 3.5 (U_0). The p-value statistically explains the probability of obtaining a t-statistic for a particular variable or even more extreme under the null hypothesis. Hence, reject the null hypothesis if that probability is less than 0.05.

Also, under the null hypothesis, the t-statistic should be equal to zero. Hence, do not reject the null hypothesis if any variable has a t-statistic equal to zero. However, considering Table 4.9, all the variables had a t-statistics greater than zero. Thus, all the variables under this dimension were positively skewed (right tail test) with some as positive as 11.667. Hence, reject the null hypothesis and instead do not reject the alternative hypothesis that the population mean is not equal to the hypothesised mean. The degree of freedom in the tables are very important especially when conducting the t-test manually using t-tables. This is because the degree of freedom (n – 1; where n is the sample size) shows you which critical value to pick up from your t-tables in calculating for your t-statistic. However, for software like SPSS, this aspect is covered automatically. In addition, the mean difference shows the difference between the population mean and the hypothesised mean for each independent variable. Hence, do not reject the null hypothesis if the mean difference is equal to zero. However, by deducing from Table 4.9, it can be concluded that all the variables had mean differences greater than zero. This means that the null hypothesis is rejected while we fail to reject the alternative hypothesis.

Lastly considering the confidence intervals columns, one can still assess whether to reject or fail to reject the null hypothesis. Since we expect a mean difference of zero if the null hypothesis is true, we can check both the lower and upper band of the confidence interval and see if zero falls within the band. If zero falls within the bands (considering the lower and upper limits) then do not reject the null hypothesis; however, if zero falls outside the band of limits (the lower and upper bands given in the tables) then reject the null hypothesis, and fail to reject the alternative hypothesis. Hence, this study rejected the null hypothesis at 0.05 significance level (at 95% confidence interval) while the study failed to reject the alternative hypothesis. Also, the confidence interval can be explained as in 95% of samples drawn from the population, the upper and lower bands values will help in capturing the true population mean, while in 5% of these samples, it will not. In conclusion, there is enough evidence to suggest that all the key sustainable development factors of smart city were obtained from a population such that the sample population mean were not equal to the hypothesised mean of 3.5, hence, showing the significance of all the variables as key sustainable development factors of smart cities.

4.6 MILITATING FACTORS OF SUSTAINABLE DEVELOPMENT OF SMART CITIES

In an effort to realising the key sustainable development factors of smart cities in developing countries, some factors became evident from literature which influence, prevent or affect the realisation and scalability of the sustainable development factors of smart cities. These factors are called the militating or challenging factors of smart cities. Respondents were asked to ranked the variables under this dimension based on their level of agreement on a five-point Likert scale where 1 – Strongly Disagree, 2 – Disagree, 3 – Neutral, 4 – Agree and 5 – Strongly Agree.

Adopting Relative Importance Index (RII) as the tool of analysis for this section of the survey, the data retrieved from the respondents were analysed. RII was preferred for this section because of its ability of showing the relative importance of some variables over the others (Carpio *et al*., 2007). Since this section of the survey was about challenges of sustainable development of smart cities, it was very substantial in determining the important variables which should be taken into much consideration to enable in the reduction of those challenges, or the provision of measures to curb those challenges, and RII will help in identifying these variables by assigning indices to all the variables understudy.

Relative Importance Index was calculated for this study by using the formula below;

RII = $\frac{\sum \boldsymbol{W}}{\boldsymbol{A} * \boldsymbol{N}}$ where $\boldsymbol{W}$ is the weight given to each factor by respondent ranging from 1 – 5, $\boldsymbol{N}$ is the total number of respondents, and $\boldsymbol{A}$ is the highest response integer (5 in this case). The Relative Important Indices of the various independent variables of this section of the questionnaire are presented in Table 4.10. In Table 4.10, measures of central tendencies were also added to the table in order to cater for some of the weaknesses of RII like its inability to differentiate between variables in order of priority when two or more variables have the same indices after analysis. Also, measures of central tendencies were added to the analysis in order to act as a check on the indices which would be produced from the RII analysis. Thus, as a general rule of thumb, a high mean, should have a high index and vice versa.

4.6.1 Findings and Discussions

Deducing from Table 4.10, it can be concluded that the relative importance indices of the variables under the militating factors of sustainable development of smart cities were all greater than 0.700 which show a high importance of all the variables in explicating the challenges of sustainable development factors of smart cities (Ahadzie, 2007). As a priori, it can be deduced from Table 4.10 that all the variables also had means greater than 3.5. Hence, the means of this section were also greater than the test-value (3.5) of the one-sample t-test conducted for the dimensions in section 4.5 of this study. However, since one-sample t-test was not used for this particular section, the study cannot statistically determine that the population mean would be equal to the hypothesised mean or vice versa for the alternative hypothesis. Therefore, the study will stick to the use of RII in explaining the variables under this section.

Table 4.10 RII of Militating Factors of Sustainable Development of Smart Cities

SN	Militating Factors of Sustainable Development of Smart Cities	Mean	Std. Error Mean	Std. Dev.	Skewness	RII	Rankings
1.	Lack of preparedness on the side of government	4.11	.098	.858	-.467	0.821	1st
2.	The financial inclusiveness associated with the creation of smart cities	4.05	.084	.728	-.294	0.811	2nd
3.	Lack of practical application of some of the sustainable smart city concept (too focused on virtual environment)	3.99	.087	.757	-.167	0.797	3rd
4.	Improper plans for integrating sustainable development factors into smart city concepts	3.97	.097	.848	-.623	0.795	4th
5.	Difficulty in binding developers and users of sustainable development standards incorporated	3.97	.103	.894	-.293	0.795	5th
6.	Lack of requisite skills, research and innovation to improve the knowledge economy	3.95	.118	1.031	-1.091	0.789	6th
7.	Lack of proper plan, frameworks and validation of performance to global standards	3.93	.105	.914	-.728	0.787	7th
8.	The propensity of shifting towards post-politics	3.84	.086	.749	-.513	0.768	8th
9.	Lack of proper procurement route for smart city projects	3.84	.106	.925	-.820	0.768	9th
10.	Lack of technically and vocationally trained skilled workers	3.84	.120	1.046	-1.110	0.768	10th
11.	Balancing the three dimensions of sustainable development	3.83	.102	.885	-.364	0.766	11th
12.	Depoliticising the genuine concept of city improvement from cankerous ambitions of politicians	3.83	.110	.958	-.863	0.766	12th
13.	The propensity of becoming too technological without actually solving problems	3.82	.105	.920	-.572	0.763	13th
14.	Conflicting interest of several stakeholders in the sustainable smart city concept	3.80	.103	.895	-.514	0.761	14th
15.	Lack of scalability and documented transferability of the smart city concept	3.78	.109	.947	-.792	0.755	15th
16.	Reactions from cultural influences and backlog	3.74	.108	.943	-.619	0.747	16th
17.	The possibility for urban primacy in our urban space	3.63	.088	.763	-.552	0.726	17th

Source: Field Survey (2019)

Inferring from Table 4.10, it can be seen that the highest index after subjecting the variables to the Relative Importance Index tool was the lack of preparedness on the side of government to take up smart city projects or develop policies in creating or developing cities into becoming smart. This particular variable was the highest rank index by our respondent as the main militating factor which is preventing the implementation or development of smart cities in developing countries. Ranking first with an RII of 0.821, mean of 4.11, standard error mean of 0.098, standard deviation of 0.858, skewness of -0.467, this variable has also been determined in literature to be major barrier to reaping the sustainable development benefits of smart cities as seen in works by (Winters, 2011; Alkandari *et al*., 2012; Batty *et al*., 2012; Vanolo, 2014 etc.). Alkandari *et al*. (2012) specifically opined that government should be prepared and take charge of the smart city concept and mark up specific areas of priority for seeing the full benefit of the concept. Hence, the inability for government to do this shows a challenged to the realisation of the smart city concept. UN, Department of Economic and Social Affairs (2014) also presented a notion analogous to what Alkandari *et al*.'s studies assayed that government should be ready and prepared, the success of a sustainable smart city would depend ultimately on a competent, judicious and responsible government who can manage and control city expansion and conjure economic benefits from cities; being caught unawares would be very disastrous.

The financial inclusiveness associated with the creation of smart cities was also determined as the second most challenging factor of upscaling smart cities and ensuring sustainable development of the concept. This variable was ranked second as seen in Table 4.10 with and RII of 0.811, mean of 4.05, standard error mean of 0.084, standard deviation of 0.728 and skewness of -0.294. Alusi *et al*. (2011) purported that one of the militating factors with smart city formation or the sustainability of the concept thereof has to do with the creation of smart cities itself (especially the top-down approach) which is tagged to be very financially inclusive. In the demographic section of this study a similar question was posed to our respondents to generally find out how they perceive smart city projects. As it can be inferred from Table 4.2 of this study, 86.8% of the respondents of this study agreed that smart cities formation is expensive initially. Hence, instigating that the financial inclusiveness of the approach is really a militating factor to the formation of the smart cities concept and ensuring the sustainable development of concept.

The third ranked variable from Table 4.10 as a challenge to the sustainable development of smart cities is the lack of practical application of some of the sustainable smart city concepts (their propensity of becoming too focused on virtual environment). This variable was ranked third with an RII of 0.797, mean of 3.99, standard error mean of 0.087, standard deviation of 0.757, and skewness of -0.167. Smart cities have been so much focused on virtual environment instead of real time application, hence, one challenge to ensuring sustainable smart cities is to take advantage of urban sustainability and collaborate it with technologies and ICTs; implement it in real times and provide solutions to the lack of environmental sustainability approaches of the smart city concept (Ahvenniemi *et al*., 2017). The main focus of incorporating ICTs into urban systems is to enable real-time feedback and analytics (Washburn *et al*., 2010), situations whereby concepts put in place does not lead this realisation proves a challenge.

The fourth challenging factor of sustainable development of smart cities is improper plans for integrating sustainable development factors into smart city concepts. This variable took up the fourth highest index as seen in Table 4.10 of 0.795, it also had a mean of 3.97, standard error mean of 0.097, standard deviation of 0.848 and skewness of -0.623. The much-sought need of cities as they are improved with the use of technologies and innovations is that they must be sustainable in the process. Sustainable development however is seen fulfilled in three main principles (social, economic and environmental). Nonetheless, there are no laid down procedures or approaches in ensuring that smart cities through their formation or their operations leads to the attainment of these three main principles. Besides, attaining these three main principles equally have always being a challenge of the sustainability concept since its popularisation in 1987 through the Brundtland report (WCED, 1987; Elkington, 1998; Ahvenniemi *et al*., 2017).

Inferring from Table 4.10, it can be seen that difficulty in binding developers and users of incorporated sustainable development standards was the 5th ranked variable with an RII of 0.795, mean of 3.97, standard error mean of 0.103, standard deviation of 0894 and skewness of -0.293. Lack of requisite skills, research and innovation to improve the knowledge economy was the 6th ranked variable with an RII of 0.789, mean of 3.95, standard error mean of 0.118, standard deviation of 1.031 and skewness of -1.091. The rest of the variables follows the trend (highest mean or RII first) as shown in Table 4.10. The last three ranked variables, but still having indices greater than 0.700 are lack of scalability and documented transferability of the smart city concept (ranked 15th with an RII of 0.755, mean of 3.78, standard error mean of 0.109, standard deviation of 0.947, and skewness of -0.792); reactions from cultural influences and backlog (ranked 16th with an RII of 0.747, mean of 3.74, standard error mean of 0.108, standard deviation of 0.943 and skewness of -0.619); the last ranked independent variable in this dimension was the possibility for urban primacy in our urban space. Hence, presenting itself as the least index which the respondents of the survey regards as the least challenge to the sustainable development of smart cities. This variable was ranked 17th with an RII of 0.726, mean of 3.63, standard error mean of 0.088, standard deviation of 0.763 and skewness of -0.552.

Yi (2011) opined that in any study where the standard deviation of variables after analysis is less than two, one concludes that there is a high level of agreement between the respondents on the variables, and a small level of variation on the responses given. By inspection, all the variables in Table 4.10 had standard deviations less than two. Which shows that the respondents of this survey on this section of the questionnaire had a high level of agreement in choosing the militating factors of sustainable development of smart cities. Ahadzie (2007) was also of the view that at any given stance in a survey, if one wants to check whether the sample obtained is a true reflection of the population, then the standard error mean should be used. Thus, if the standard error mean is closer to zero, then the sample used was a true representation of the population. Inferring from Table 4.10, all the variables had standard error means closer to zero, hence, attesting to the fact that the sample used was a true reflection of the population of the study.

In controlling the weakness of the Relative Importance Index analytical tool, central tendencies (mean, standard deviation, standard error mean etc.) were calculated and added to the indices produced by the RII analysis as shown in Table 4.10. In any case where two or more variables had the same index, the one with the least standard deviation was given the highest priority and ranked above its counterparts of the same index. This was basically based on the assumption that, the level of agreement or consistency between the respondents which the standard deviation shows is high when the standard deviation is moving closer to zero. Hence, a low standard deviation is of high significance than a higher standard deviation if two or more variables are given out the same effect (same mean or RII). Lastly, Kline (2015) postulated that the normality of data can be checked by adopting the univariate skewness in your studies. Hence, inferring from Table 4.10, it could be deduced that all the variables were skewed towards the left (negative), however, Kline (2015) proposed that a data is said to be normalised if the absolute value of the skewness is less than 3, and this was true for this study.

4.7 CRITICAL SUCCESS FACTORS OF SUSTAINABLE DEVELOPMENT OF SMART CITIES

The critical success factors of sustainable development of smart cities are those factors which are very important and critical in ensuring that our urban conurbations become sustainable when the smart city concept is adopted. Hence, they are those few, but majorly significant areas which needs to be improved to ensure the success of achieving a sustainable smart city. There are twenty – five independent variables under this objective, and hence, it can be prescience that some of the variables might be related or leading to a similar finding. Besides, we have three main bottom line of sustainable development (Social, Economic and Environmental). Hence, if any factor is leading to sustainable development it should be seen at least hovering around some key dimensions in enabling the attainment of the triple bottom line of sustainable development.

Chang and Chen (2004) opined that factor analysis could be used as a dimension reduction tool if one has between twenty to fifty variables in an objective of one's studies. Therefore, considering the twenty – five variables under this objective, factor analysis could be employed in enabling the study reduce the variables for easy understanding and analysis, checking for any unidimensional of the hypothetical concept, addressing validity of scales used, and identifying correlation between two or more variable in developing, confirming or rejecting any theories (Williams *et al.*, 2012). The following procedures were followed in using factor analysis to achieve the purpose of this section of the study.

4.7.1 Initial Consideration, Bartlett's Test of Sphericity and KMO Test

In factor analysis, a large number of variables (25 in this study) are taken and used in explaining the correlation between the variables through a smaller number of factors or components. The variables have to be fairly large in number in order to obtain a stabilised parsimonious solution which could explain all the twenty – five variables (DeCoster, 1998). The Bartlett's test of sphericity was conducted to identify if there exist some common factors in the variables which could yield and help in the use of factor analysis (Field, 2005). The Kaiser-Meyer-Olkin (KMO) test value ranges from zero to one, with a zero-value signifying that the sum of the partial correlations is relatively large in comparison to the sum of correlations, hence factor analysis is not a good tool to use (Child, 1990). Alternatively, a value closer to one also signifies that variables are correlatively compact, and that factor analysis would yield real-value results. For Bartlett's Test of Sphericity to be significant it must be less than the significance value of 0.05, and for KMO test to be significant it must be more than 0.50 (Field, 2005; Coakes, 2007). These tests are spontaneously checking whether the twenty – five variables in the correlation matrix are correlating significantly different from zero or an identity matrix. The KMO and Bartlett's test of sphericity are presented in Table 4.11.

Table 4.11: Bartlett's Test of Sphericity and KMO Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.880
Bartlett's Test of Sphericity	Approx. Chi-Square	1487.915
	df	300
	Sig.	.000

Source: Field Survey (2019)

Considering Table 4.11, it can be deduced that the KMO sampling adequacy of this dimension of the study was 0.880. Hence, showing a high significance of these variables under this dimension in correlating with each other differently from zero or an identity matrix. Literally, it means that the samples used for the factor analysis is adequate and hence, using factor analysis will produce real-value results. The significance value is also less than 0.05. Hence, a value of 0.000 as seen in Table 4.11 provides the study with the confidence that the variables are significantly correlating with each other, and hence it is not an identity matrix.

4.7.2 Communalities

Chang and Chen (2004) opined that in any factor analysis studies, when the factors extracted for communalities are greater than 0.500, then one can say the factors are adequate for analysis. In a one-component solution, the extraction for each of the factors of the communalities are obtained by squaring the correlation values or component loadings on each of the components extracted. Hence, given the R^2 (the correlation square) similar to that of simple regression which indicates the total variance accounted for each of the factors under the components retained. The extraction under the communalities cannot be literally be the correlation square of the component matrix when a study produces more than one-component solution. Considering Table 4.13, it can be deduced that four (4) components were extracted for this study. Hence, the determination of the factors extracted for the communalities becomes a bit complicated, and not simply by squaring the correlation of the component matrix. Notwithstanding, the same conclusion can be drawn that the total variance of each factor accounted for in the components extracted is given in the extraction column of the communalities table below. Hence, in summary the extraction column values are simply measuring the amount of variance accounted for by the individual items by the components. Therefore, over 71.0% of the variance of incorporating resource efficiency from onset is accounted for in the components extracted. The rest of the factors follows analogous interpretations.

4.7.3 Factor Extraction Methods

In determining how many components to retain in the factor analysis solution, the factor extraction methods are used. Two main factor extraction methods are adopted in factor analysis: the Guttman-Kaiser eigenvalue rule published in 1960 and the Raymond B. Cattell's scree plot published in 1966 (Field, 2005). One can use either of them or both in determining the number of components to be extracted.

Table 4.12: Communalities of factors extracted

SN.	FACTORS	Initial	Extraction
1.	Implementing efficient, cleaner and sustainable operations to minimize environmental footprints	1.000	.637
2.	Incorporating resource efficiency from onset	1.000	.710
3.	Regenerating ageing districts and ensuring robustness of systems in urban space	1.000	.767
4.	Practising the sharing of growth equally and sustainably in urban areas	1.000	.705
5.	Transition to a carbon free economy	1.000	.568
6.	Enhancing the usage of sensors and actuators for improving smart mobility	1.000	.674
7.	Incorporating green technologies in the transformation of our urban space	1.000	.574
8.	Developing an effective Public Private Partnership which shape models, add value and incorporate emerging technologies in smart city systems	1.000	.660
9.	Incorporating design and planning in symphony with the environment	1.000	.812
10.	Obtaining and maintaining data (Big data analytics)	1.000	.755
11.	Developing policies to promote comprehensive and impartial urban and rural development	1.000	.727
12.	Adopting an efficient, reliable and low carbon technologies	1.000	.708
13.	Proper planning and management of the population within the limited environment	1.000	.643
14.	Enabling environment for continuous learning	1.000	.720
15.	Development of smart grids and usage of smart metering to ensure sustainable smart energy	1.000	.758
16.	Setting clear non-conflicting rules which differentiate urban government from politics	1.000	.684
17.	Creating mechanisms which lead to autonomous and administrative control of inhabitants in smart cities	1.000	.645
18.	Shaping value added business models, and integrating disparate technologies in a productive system	1.000	.580
19.	Intentionally going beyond or averse of the smart city concept on technology	1.000	.606
20.	Improving educational lag especially in relation to ICT and technology usage	1.000	.645
21.	Incorporating the Internet of Things (IOT) principle	1.000	.751
22.	Ensuring the use of technology, management and organisation, and development and implementation of policies	1.000	.690
23.	Involving citizens, and ensuring an efficient vibrant economy	1.000	.690
24.	Ensuring an open and transparent governance	1.000	.508
25.	Incorporating smart built infrastructures in general	1.000	.766
	Extraction Method: Principal Component Analysis.		

Source: Field Survey (2019)

In many times, when the number of components extracted are not many or the number of factors is not a lot, the scree plot and the Guttman-Kaiser eigenvalue rule tends to match up in their determination of components to be extracted. However, where they seem not to be case, preference is to the Guttman-Kaiser eigenvalue rule.

In Guttman-Kaiser's eigenvalue rule, the key item in this rule is the eigenvalue. Eigenvalues are fixed at one (1) such that components are retained in the analysis if the eigenvalue extracted is greater than one. Hence, reject all components with eigenvalues less than one. The Raymond B. Cattell's scree plot also suggests that all component after the eigenvalue of one in the scree plot should be retained as components which explains the relationship between the rest of the components in the analysis.

4.7.3.1 Findings

Considering Table 4.13, it can be deduced that four components have been extracted to explain the rest of the components in this dimension. In the components' column, all the number of components which are being considered for the study is listed as component one to twenty-five (for the 25 independent variables in this dimension). The total eigenvalues for each factor are shown in the total column under the initial eigenvalues. These eigenvalues sum up to 25 (equal to the total number of independent variables), since, each variable is given a variance of one (1). Deducing from the total column under the initial eigenvalues of Table 4.13, it can be inferred that component one accounted for almost thirteen (13) factors of variance of all the factors being considered in this dimension. Component two on the other hand explains nearly two factors' variance. Component three explains 1.283 factors of variance and lastly, component four explaining 1.099 factors of variance of all the factors being considered in this dimension.

Table 4.13: 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	**12.761**	**51.044**	**51.044**	**12.761**	**51.044**	**51.044**	**5.648**	**22.591**	**22.591**
2	**1.839**	**7.358**	**58.402**	**1.839**	**7.358**	**58.402**	**4.399**	**17.597**	**40.188**
3	**1.283**	**5.130**	**63.532**	**1.283**	**5.130**	**63.532**	**4.105**	**16.422**	**56.610**
4	**1.099**	**4.395**	**67.927**	**1.099**	**4.395**	**67.927**	**2.829**	**11.317**	**67.927**
5	.940	3.762	71.689						
6	.888	3.552	75.241						
7	.803	3.214	78.454						
8	.689	2.758	81.212						
9	.567	2.266	83.478						
10	.552	2.209	85.687						
11	.492	1.968	87.655						
12	.430	1.718	89.373						
13	.373	1.493	90.866						
14	.344	1.377	92.242						
15	.313	1.253	93.496						
16	.263	1.052	94.548						
17	.257	1.029	95.577						
18	.220	.881	96.458						
19	.208	.831	97.289						
20	.179	.716	98.005						
21	.155	.620	98.626						
22	.125	.501	99.127						
23	.098	.391	99.518						
24	.068	.274	99.792						
25	.052	.208	100.000						

Extraction Method: Principal Component Analysis.

Source: Field Survey (2019)

Since the eigenvalue was placed at one, four components were extracted for this study which could explain the other components in this dimension. Hence, the other twenty-one components are rejected. The next column is literally finding the percentage of variance retained by each of the components. By calculation, component one retained 51.044% of the total variance in this dimension. This percentage was obtained by simply dividing the total variance retained by component one by the number of variables and multiplying it by 100%. The percentage of variance retained is calculated in similar domain for the rest of the component. Therefore, adding up all the percentages under the percentage of variance retained under the initial eigenvalues section of Table 4.13 should be equal to a 100%, and this is exactly what the next column under the initial eigenvalues (cumulative percentage of variance retained) calculates.

The next section on Table 4.13 is the extraction sums of squared loadings. The extraction sums of squared loadings throw more light on only the four components retained by factor analysis in explaining the other components in this dimension. Hence, showing the variance of each of the components, the percentage of covariance accounted for by each of the retained components and their cumulative percentages. The last section of Table 4.13 also harnesses on the variance retained for each of the four components after rotation. Rotation is done to fairly distribute the variance well among the four components retained. Hence, from Table 4.13 under the rotation sums of squared loadings, it can be deduced that after rotation, component one now explains only 5.648 of variance of items worth in this dimension while component two explains 17.597% of variance of all the factors being considered in this dimension. The important key factor in Table 4.13 is actually the total variance explained by all the four components. It can be deduced that the four components extracted explains 67.927% of all the total variances for this dimension, which is very high and substantial based on the avowal of Field (2009) who asserted that factors extracted should explain at least 50% of the total variance in any dimension. Hence, in using these four components only 32.073% of the variance in this dimension is lost. It is noteworthy to mention that rotation does not decrease the number of variances explained by the four components, but rather helps in rotating the variables well in explaining the components better. Hence, after rotation, the total variance explained by the four components is the same as the total variance explained by the four components before rotation.

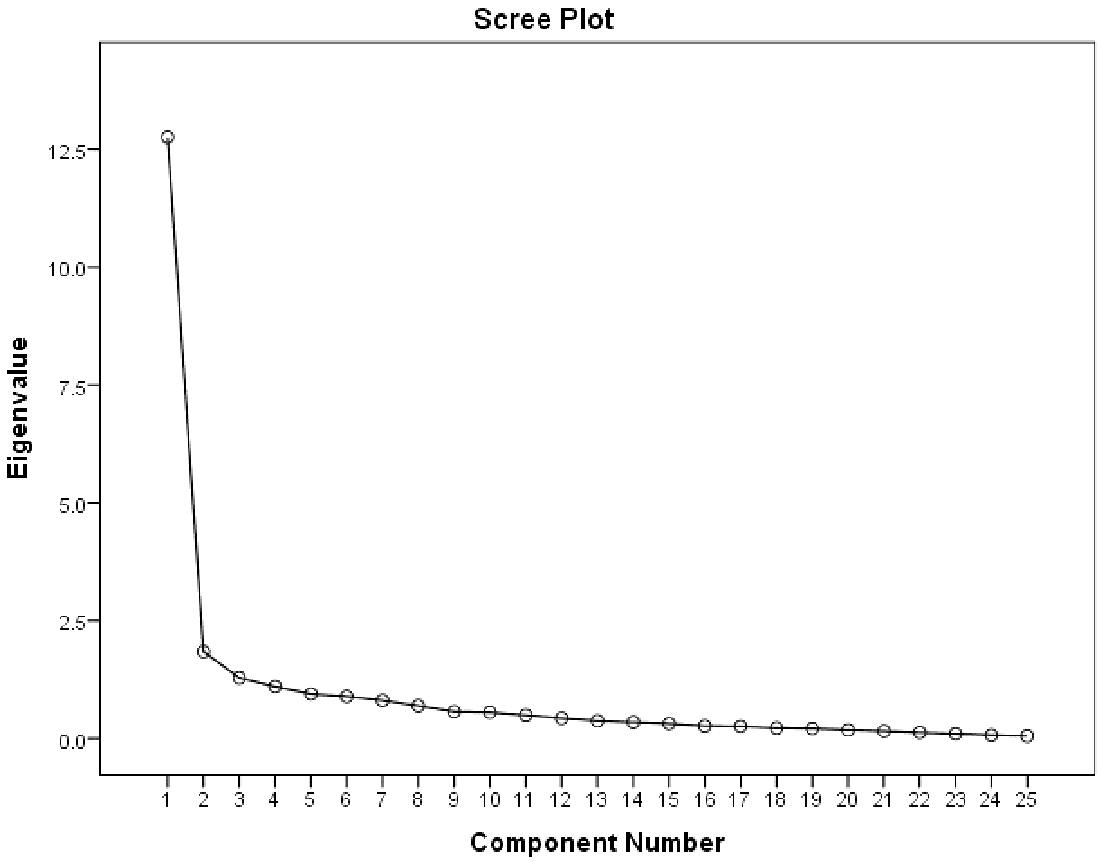

Figure 4.6: Raymond B. Cattell Scree Plot for Total Variance Explained

Source: Field Survey (2019)

The scree plot by Raymond B. Cattell plots the eigenvalues against the component numbers (25 for this study). As seen from Figure 4.5, and relating it substantially to Table 4.13, it can be deduced that each of the components total variance retained is being plotted by the scree plot. For instance, component one retained as much as 12.761 of the total variances, and so it is plotted in the scree plot. Component two retained 1.839 of the total variances, and it is precisely plotted on the scree plot as such. The rest of the factors are being plotted in similar manner. The scree plot is interpreted in two main ways, it is either one considers the eigenvalue and accept all components above the eigenvalue one, or by looking at your scree and rejecting all component from which the scree begins to flatten. Hence, using the eigenvalue one rule. The components one to four could be extrapolated to be above eigen value one. Thus, they are the extracted and retained components which can explains the rest of the components in this dimension.

4.7.4 Components Matrix and Rotated Components Matrix

The next section of factor analysis has to do with the four components extracted now. The component matrix and the rotated components matrix tables in Table 4.14 and 4.15 respectively depicts how the twenty-five variables are loading on each of the four components extracted. The difference between the two tables is the varimax rotation (orthogonal rotation) which was normalised with Kaiser normalization. The factors are rotated for easy interpretation and, rotation enables different factors to be explained by the four components extracted.

In the components' matrix and the rotated components matrix, the higher the absolute value of the loadings, the more that particular variable loads on a specific component. The rotated components matrix is used in this regard in selecting the variables which loads on the individual components. By inspecting Table 4.15, it can be deduced that ten factors load on component one alone, with the highest loading being 0.832 (incorporating the internet of things principle). The least loaded factor under component one was developing an effective Public Private Partnership which shape models, add value and incorporate emerging technologies in smart city systems. This factor loaded as low as 0.435. However, Field (2009) is of the view that factors loading 0.300 are those which should be considered as on the very low side. Hence, the least loaded factor on component one can still be considered as part of the variable under this component.

Table 4.14: Components Matrix

SN.	Variables	Components Extracted (4)			
		1	2	3	4
1.	Implementing efficient, cleaner and sustainable operations to minimize environmental footprints	.597	.515	.006	-.124
2.	Incorporating resource efficiency from onset	.665	.366	-.354	.090
3.	Regenerating ageing districts and ensuring robustness of systems in urban space	.584	-.164	.612	.158
4.	Practising the sharing of growth equally and sustainably in urban areas	.730	.099	.015	.402
5.	Transition to a carbon free economy	.648	.176	.056	.337
6.	Enhancing the usage of sensors and actuators for improving smart mobility	.723	-.362	-.096	.108
7.	Incorporating green technologies in the transformation of our urban space	.734	.168	.053	-.059
8.	Developing an effective Public Private Partnership which shape models, add value and incorporate emerging technologies in smart city systems	.806	.033	.075	.053
9.	Incorporating design and planning in symphony with the environment	.804	.246	-.322	-.015
10.	Obtaining and maintaining data (Big data analytics)	.760	-.390	-.052	-.148
11.	Developing policies to promote comprehensive and impartial urban and rural development	.762	-.373	.090	.006
12.	Adopting an efficient, reliable and low carbon technologies	.797	-.115	-.223	.096
13.	Proper planning and management of the population within the limited environment	.751	-.251	-.069	.107
14.	Enabling environment for continuous learning	.717	-.198	-.099	-.397
15.	Development of smart grids and usage of smart metering to ensure sustainable smart energy	.760	.184	.146	-.353
16.	Setting clear non-conflicting rules which differentiate urban government from politics	.680	-.311	-.150	.321
17.	Creating mechanisms which lead to autonomous and administrative control of inhabitants in smart cities	.663	.066	.440	.082
18.	Shaping value added business models, and integrating disparate technologies in a productive system	.733	.086	.094	-.162
19.	Intentionally going beyond or averse of the smart city concept on technology	.609	.367	.191	.252
20.	Improving educational lag especially in relation to ICT and technology usage	.644	.333	.253	-.238
21.	Incorporating the Internet of Things (IOT) principle	.655	-.559	.038	-.086
22.	Ensuring the use of technology, management and organisation, and development and implementation of policies	.805	-.058	.094	-.173
23.	Involving citizens, and ensuring an efficient vibrant economy	.696	.111	-.400	.183
24.	Ensuring an open and transparent governance	.689	.167	.069	.016
25.	Incorporating smart built infrastructures in general	.775	.028	-.245	-.322

Source: Field Survey (2019)

Table 4.15: Rotated Components Matrix

SN.	Variables	Component			
		1	2	3	4
1.	Implementing efficient, cleaner and sustainable operations to minimize environmental footprints	-.042	.636	.430	.215
2.	Incorporating resource efficiency from onset	.144	.415	.718	.028
3.	Regenerating ageing districts and ensuring robustness of systems in urban space	.376	.176	-.032	.770
4.	Practising the sharing of growth equally and sustainably in urban areas	.312	.139	.608	.467
5.	Transition to a carbon free economy	.204	.182	.540	.449
6.	Enhancing the usage of sensors and actuators for improving smart mobility	.715	.122	.324	.207
7.	Incorporating green technologies in the transformation of our urban space	.301	.506	.368	.304
8.	Developing an effective Public Private Partnership which shape models, add value and incorporate emerging technologies in smart city systems	.435	.403	.398	.386
9.	Incorporating design and planning in symphony with the environment	.328	.510	.665	.050
10.	Obtaining and maintaining data (Big data analytics)	.779	.315	.168	.142
11.	Developing policies to promote comprehensive and impartial urban and rural development	.732	.228	.180	.327
12.	Adopting an efficient, reliable and low carbon technologies	.583	.270	.523	.147
13.	Proper planning and management of the population within the limited environment	.641	.191	.366	.248
14.	Enabling environment for continuous learning	.633	.554	.115	-.005
15.	Development of smart grids and usage of smart metering to ensure sustainable smart energy	.320	.746	.177	.261
16.	Setting clear non-conflicting rules which differentiate urban government from politics	.637	-.035	.467	.244
17.	Creating mechanisms which lead to autonomous and administrative control of inhabitants in smart cities	.273	.360	.153	.646
18.	Shaping value added business models, and integrating disparate technologies in a productive system	.369	.545	.256	.285
19.	Intentionally going beyond or averse of the smart city concept on technology	.020	.324	.476	.523
20.	Improving educational lag especially in relation to ICT and technology usage	.108	.682	.181	.369
21.	Incorporating the Internet of Things (IOT) principle	.832	.148	.032	.188
22.	Ensuring the use of technology, management and organisation, and development and implementation of policies	.526	.524	.229	.294
23.	Involving citizens, and ensuring an efficient vibrant economy	.360	.242	.708	.021
24.	Ensuring an open and transparent governance	.265	.430	.376	.333
25.	Incorporating smart built infrastructures in general	.501	.621	.356	-.051
	Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
	a. Rotation converged in 11 iterations.				

Source: Field Survey (2019)

Component two had seven variables loading on it. Development of smart grids and usage of smart metering to ensure sustainable smart energy was the highest factor loading item under this component with a factor loading of 0.746. The least loaded item under component two was ensuring an open and transparent governance (0.430). Component three had five factors loading on it, but all the factors are considered as very high loading since they were all greater than 0.500 (Field, 2005). The highest factor loading on this component was incorporating resource efficiency from onset, with a factor loading of 0.718 and the least factor loading was a transition to a carbon free economy with a factor loading of 0.540. The fourth component had only three high factor loadings items on it. With the highest being regenerating ageing districts and ensuring robustness of systems in urban space (0.770) while the least loaded item had a factor loading of 0.523 on component four (intentionally going beyond or averse of smart city concept on technology). Since all the extracted components had at least one factor loading highly on it, the study intends of keeping all four inter-correlated extracted components for further discussions or analysis. In conclusion, 25 independent variables have been surmised into four main components or variables which does the work of explaining all the twenty-five variables at 67.927% variance with only 32.073% of information lost. The next step is to give the extracted components are genuine unique name which encapsulates all the variables under each of the components.

4.7.5 Component Extracted

The extracted components are grouped with each of the items loading on it as shown in Table 4.16. The variables under each component is arranged in descending order of factor loadings. The total variance explained for each component is also presented in Table 4.16.

Table 4.16: Extracted Components and their Variables

SN.	Extracted Components and their Variables	Factor Loadings	% of Variance Explained
C1.	**Component 1: Developing Smart Policies for Smart Living**		**22.591%**
1.	Incorporating the Internet of Things (IOT) principle	0.832	
2.	Obtaining and maintaining data (Big data analytics)	0.779	
3.	Developing policies to promote comprehensive and impartial urban and rural development	0.732	
4.	Enhancing the usage of sensors and actuators for improving smart mobility	0.715	
5.	Proper planning and management of the population within the limited environment	0.641	
6.	Setting clear non-conflicting rules which differentiate urban government from politics	0.637	
7.	Enabling environment for continuous learning	0.633	
8.	Adopting an efficient, reliable and low carbon technologies	0.583	
9.	Ensuring the use of technology, management and organisation, and development and implementation of policies	0.526	
10.	Developing an effective Public Private Partnership which shape models, add value and incorporate emerging technologies in smart city systems	0.435	
C2.	**Component 2: Applying Sustainable Principles for Sustainable Development**		**17.597%**
1.	Development of smart grids and usage of smart metering to ensure sustainable smart energy	0.746	
2.	Improving educational lag especially in relation to ICT and technology usage	0.682	
3.	Implementing efficient, cleaner and sustainable operations to minimize environmental footprints	0.636	
4.	Incorporating smart built infrastructures in general	0.621	
5.	Shaping value added business models, and integrating disparate technologies in a productive system	0.545	
6.	Incorporating green technologies in the transformation of our urban space	0.506	
7.	Ensuring an open and transparent governance	0.43	
C3.	**Component 3: Enforcing Sustainable Practices into Smart City Concept**		**16.422%**
1.	Incorporating resource efficiency from onset	0.718	
2.	Involving citizens, and ensuring an efficient vibrant economy	0.708	
3.	Incorporating design and planning in symphony with the environment	0.665	
4.	Practising the sharing of growth equally and sustainably in urban areas	0.608	

5.	Transition to a carbon free economy	0.54	
C4.	**Component 4: Developing Effective Plans for Continuous Improvement**		**11.317%**
1.	Regenerating ageing districts and ensuring robustness of systems in urban space	0.77	
2.	Creating mechanisms which lead to autonomous and administrative control of inhabitants in smart cities	0.646	
3.	Intentionally going beyond or averse of the smart city concept on technology	0.523	

Source: Field Survey (2019)

4.7.6 Discussions and Results Interpretations

This section mainly discusses the four principal components which were extracted by factor analysis in explaining the rest of the components in this dimension. After subjecting the components' matrix to orthogonal rotations (Varimax) which was normalised by Kaiser normalisation, it was identified that component one now has ten inter-correlated variables which explains or are related to a particular factor in achieving the dependent variable of this dimension. The dependent variable for this dimension is identifying critical success factors of sustainable development of smart cities. Hence, these critical success factors could be attained when these independent variables under this dimension are implemented.

Considering Table 4.16, it can be deduced that component one after rotation explained 22.591% of the total variance of the factors in this dimension. Under this component was ten independent variables which after critical consideration was collectively called developing smart policies for smart living. Component two also explained 17.597% of the total variance under this dimension, and it consisted of seven different but inter-correlated independent variables. After critical consideration, these seven independent variables under component two were altogether called the applying sustainable principles for sustainable development. Component 3 on the other hand had five independent variables loading on it. This component explained 16.422% of the total variance of this dimension. Collectively, the independent variables under this component was dubbed as enforcing sustainable practices into smart city concept. The last component extracted, (component four) had three independent variables loading on it, and they were seen to hinged on developing effective plans for continuous improvement, hence, this component was named as such. The discussion of these four principal components of critical success factors of sustainable development of smart cities are depicted below.

4.7.6.1 Component 1: Developing Smart Policies for Smart Living

Considering all the variables under component one, one single phrase or sentence which could cover all the ten variables loaded on this component is developing smart policies for smart living. It could be seen from the variables under component one that a critical success factor for ensuring sustainable development of smart cities is the availability of smart policies which are targeted to improving sustainable development of the concept. Smart policies consist of policies such as adopting an efficient, reliable and low carbon technologies in smart city concepts; ensuring that the smart city concept is implementing efficient use of technology, management and organisation of resources; incorporating the use of internet of things (linking several devices to the internet); adopting an efficient, reliable and low carbon technologies; developing policies which promotes comprehensive and impartial urban and rural development; policies which creates avenues for continuous learning in urban areas; setting rules straight, and differentiating between politics and improving lives of citizens, and properly putting smart policies in place to manage the population within its limited environment (Ling, 2005; Chen-Ritzo *et al*., 2009; Batty, 2013; Townsend, 2013; Vanolo, 2014; UN, Department of Economics and Social Affairs, 2014; Kumar and Dahiya, 2017). All these smart policies if well implemented would lead to smart living. Smart Living have been postulated in literature as the sum total of all the six dimensions of smart cities (Shapiro, 2006). Hence, it can simply be drawn that, a totality of all the smart policies as listed above could lead to ensuring the sustainability of the smart city concepts which will lead to smart living within urban conurbations.

4.7.6.2 Component 2: Applying Sustainable Principles for Sustainable Development

Inferring from Table 4.16, the second component was labelled applying sustainable principles for social equity and environmental integrity. After smart policies have been put in place, the second critical factor to consider is to ensure the application of sustainable principles. Policies without application cannot lead to any substantial change. Hence, the variables under this component are geared towards ensuring that the smart policies in component one is applied in the smart city concept in ensuring that cities become sustainable and meet the triple bottom line of sustainable development (social equity, environmental integrity and economic prosperity). Sustainable principles applications such as the development of smart grids and usage of smart metering to ensure sustainable smart energy would help reduce energy consumption and GHG emissions in our cities (Eremia *et al*., 2017; Chhava *et al*., 2018). Hence leading to environmental integrity of sustainable development. Improving educational lag especially in relation to ICT and technology usage would help in increasing the smartness of the people while attaining social equity factor of sustainable development (Cairney and Speak, 2000). Shaping value added business models and integrating disparate technologies in a productive system would also boost economic prosperity of our cities (Lee *et al*., 2013). The rest of the variable under this component are all geared towards applying principles in sustainability to help in the attainment of sustainable development of the smart city concept.

4.7.6.3 Component 3: Enforcing Sustainable Practices into Smart City Concept

Component three under Table 4.16 is collectively called enforcing sustainable practices into smart city concept. After developing smart policies, and applying the principles in sustainable development, the next step is to enforce the sustainable practices into the smart city concept. Hence, the variables under the third component of this dimensions leads to initiative. For instance, Canning and O'Dwyer (2019) opined that efficient use of resources while still meeting the demands of the population, and also moving into a carbon free economy where we do not use or generate carbons from our quotidian activities would lead to environmental sustainability of smart cities. Chourabi *et al*. (2012) also purported in their studies that ensuring an efficient and vibrant economy and involving citizens in urban operations could help boost the economic prosperity aspect of smart cities. All these sustainable practices under component three are significant in ensuring the sustainable development of smart cities.

4.7.6.4 Component 4: Developing Effective Plans for Continuous Improvement

Deducing from Table 4.16, it can be seen that the fourth component is called developing effective plans for continuous improvement. Amidst smart policies, principles and practices, the sustainability concept of smart cities cannot be maintained if there are no documented plans for continually improving the policies, principles and practices set. Hence, plans should be created in regenerating ageing districts and generally ensuring robustness of the system; creating mechanisms which lead to autonomous and administrative control of inhabitants in smart cities, and intentionally going against the concept on technology to see if new ideas and innovations can be formed in the creation of smart cities and ensuring sustainability of the concept thereof.

4.8 A NEW THINKING OF CONCEPTUALIZING SUSTAINABLE SMART CITY IN DEVELOPING COUNTRIES

After going through this study and reaching this point, it becomes imperative to revisit the conceptual framework proposed during the literature review and add up some of the identified critical success factors for sustainable development of smart cities; provide a clear information on the important militating factors which should be considered in the creation of smart city, upscaling and ensuring the sustainability of the concept, and lastly, list some of the key sustainable development factors of smart cities which promotes the institutionalisation and adherence of the smart city concept in the world. Figure 4.6 below shows the conceptual framework of improving the smartness level and sustainability of Kumasi City.

Considering Figure 4.6 below, it can be deduced that to ensure the formation of sustainable smart cities in developing countries one must first determine the smartness level of the city which is to undergo the formation. This is to provide a clear view of the already attained development and smartness of the city and, also bring to bare the militating factors and areas for improvement. After determining this, the next step is that of a stage of preparedness and taking action. Government, citizens and city officials should be ready to improve the several areas in the six dimensions which the city under consideration falls short in improving the smartness of the city thereof. For instance, providing good, quality and affordable education and training for all could enhance the smart people dimension; ensuring an integrative, efficient and easily accessible transport systems could advance the smart mobility dimension; whereas adopting renewable energy sources (solar, wind mill, geothermal etc.) and reducing GHG emissions could also augment the smart environment dimension among others.

Additionally, while improving the several sectors of the six dimensions, efforts should be made to ensure that the technologies implemented, corrections provided and innovations introduced meets the sustainable development criteria (social, environment, economic). Therefore, to ensure that these major criteria is achieved the study proposed four main components of sustainable development of smart cities, which when tread on cautiously could lead to the attainment of sustainability of smart city principles. These components are; developing smart policies for smart living; applying sustainable principles for sustainable development; enforcing sustainable practices into smart city concepts, and developing effective plans for continuous improvement. Improving the six dimensions and the sustainability of the smart city concept should be done consecutively until it can be identified through assessment that the city is now smart, and has attained some key sustainable development factors of smart cities. Whenever a city is assessed and there appears to be any shortfalls in the six dimensions, or challenges in any of the processes, the identified shortfalls or challenges should be passed through the overhaul factory (improving the six dimensions and sustainability of the smart city concept) again to improve upon them.

In attaining a sustainable smart city on a small scale, preferably one city in a country or some aspects of a lager city, there is the need to upscale the smart city concept. Upscaling the smart city concepts also has its own challenges like; lack of finances to enlarge the smart city concept to cover a large broad area, lack of practical application of some of the concepts on a large scale and lack of requisite personnel among others. The militating challenges of upscaling of smart city concepts should be determined and strategic measures provided to enable the upscaling of the smart city concept to be possible. Upscaling could be done in two major ways i.e. either through a top-down approach (creating a smart city from the scratch in a new area by using a giant ICT company, but adopting the principles and approaches from the previously established smart city) or through a bottom up initiative (this is when cities are left to citizens to improve the sectors of the dimensions thereof, but guiding them through the principles and approaches used in the already established smart city). When all these processes are followed chronologically without any challenges, or finding strategic measures to improve any identified challenges, and truly mitigating the identified challenges either in the formation, upscaling or sustainability of smart city concepts, then one can be assured of obtaining a sustainable smart city on a large scale.

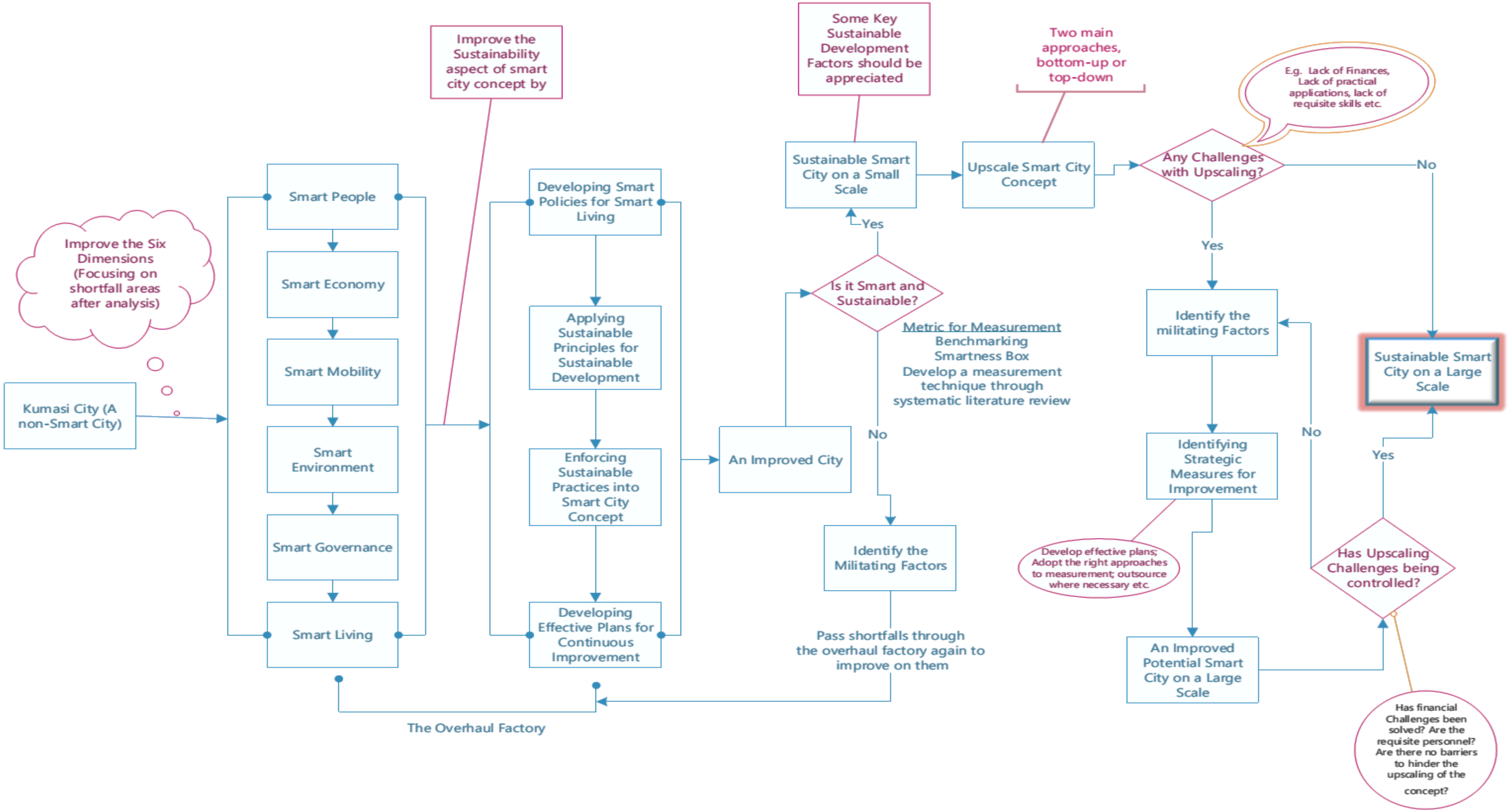

Figure 4.7: Conceptual Framework for Improving Smartness and Sustainability of Kumasi City
Source: Author's Construct (2019)

4.9 CHAPTER SUMMARY

This chapter presented on the findings of the data collected from the respondents and the discussions of the findings thereof. In this chapter, the respondent profile was analysed by using descriptive statistics as the tool of analysis. The respondents generally were familiar with the smart city concept, responded positively to smart city projects and agreed on the sustainable development linkages of smart cities. The reliability of the scale and internal consistency of the variables were checked by using the Cronbach Alpha Coefficient test. All the variables were reliable and efficient for further analysis. Posteriori was conducted for this study to determine the smartness level of Kumasi city. After analysis and comparison with the developed smartness box, it was concluded that Kumasi city is currently not smart, but fairly large has some key factors of a smart city. The next section was dedicated to identifying these key factors of sustainable development of smart cities. Using one-sample t-test as the tool of the analysis, the null hypothesis was rejected for this dimension and the alternative hypothesis was not rejected. Hence, there was enough evidence to support the claim that the independent variables which explains the key sustainable development factors of smart cities was drawn from a population such that the population mean was not equal to the hypothesised mean of 3.5. Using Relative Importance Index, the militating factors seen in literature as hindering the sustainable development of smart city concepts, upscaling of smart city projects and the creation of smart cities itself were ranked by giving each of the variable indices. After the analysis it was seen that lack of preparedness on the side of government, financial inclusiveness of the concept and lack of practical application of some of the smart city concept were the main militating factors to the smart city concept creation, upscaling and ensuring its sustainability in general. In order to fine tune and identify which factors in the smart city concept could be worked on easily to ensure the sustainability of the concept, the critical success factors of sustainable development factors of smart cities dimension were added to the questionnaire. This dimension was analysed using principal component analysis – a type of factor analysis. After analysis, four main components were extracted which explained 67.927% of the total variance in this dimension. The extracted components were rotated by using Varimax (orthogonal rotation) which was normalised with Kaiser normalisation. The four components were called component 1 – developing smart policies for smart living; component 2 – applying sustainable principles for sustainable development; component 3 – enforcing sustainable practices into smart city concept and component 4 – developing effective plans for continuous improvement. After this, a conceptual framework for improving the smartness level of Kumasi city and ensuring sustainable development of the concept was established.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This research was undertaken to explore the sustainable consideration of smart cities in developing countries by using Kumasi city as a case study. The main aim for this study was to explore measures for ensuring the sustainability of the smart city concept through identification of key sustainable development factors; assessing militating factors of sustainable development of smart cities, and determining critical success factors for sustainable development of smart cities. This dissertation was divided into five main comprehensive chapters which were strategically formulated in helping the study achieve its main objectives.

Chapter one was a general introduction to the study, and it shows a synopsis of the whole study. Some key aspects of this chapter was the background to the study which provided a summary of literature on the topic under consideration; the problem statement which harnessed on the gap in literature the study intended to fill; the research aim, and objectives of the study which set out the vision and purpose for the study, and the research methods and scope which provided guides for attaining the aim of the study. Chapter two was divided into two main parts; section one and section two. Section one dealt with the theoretical review, conceptual and empirical review of the smart city concept while section two covered critical and systematic review of sustainable consideration of smart cities. These two sections were geared towards providing literature on the research objectives and generally keeping abreast with literature in the study area. Chapter three focused on the research methodology of the study. This section of the study was considered as very key to the entire research because it determines how the research is to be conducted, and it influences the type of data which is to be collected and the analysis which must be used. Hence, a good review of methods stands at the core of the entire study and influences the several sectors of the study. The chapter four was left to the analysis of the findings of data retrieved from the survey and discussions of the findings thereof. In this study, the Relative Importance Index, one-sample t-test, principal component factor analysis and descriptive statistics were employed as the analytical tools.

This final chapter (Chapter five) presents a summary of the whole findings of the study, conclusions, limitations, recommendations and any directions for future researches in this area.

5.2 REVIEW OF RESEARCH OBJECTIVES

The aim of this study was to explore sustainable considerations of smart cities formation in developing countries by using Kumasi city as a case study. In order to achieve this aim, three strategic-smart objectives were formulated. The attainment of these three elating pertinent objectives are discussed below:

5.2.1 Objective One: To Identify Key Sustainable Development Factors of Smart Cities in Developing Countries.

Objective one was achieved by firstly reviewing extant literature on sustainable development and the concept of smart cities. Before this, the study considered several theoretical and conceptual review about these two main broad areas in the research topic. The research gap was overt, there was the need for a study to be conducted on developing countries on how they can enhance their cities to becoming smart by adopting the smart city concept. The benefits of smart cities are enormous among which include boosting city's economy, reducing unemployment and urban poor, reducing traffic thronging and urban primacy, increasing quality living and health, improving education and ensuring open governance among others. However, the crucial area which this objective was concerned with was to identify some key sustainable development factors from literature which developing countries can take note of, so that in their bid of making their cities smart they can adopt some of these key sustainable development factors from onset, so that they can attain the level of a sustainable smart city directly. Twenty-seven independent variables were obtained from literature which could help in attaining the dependent variable set out as the objective of this study. By inspection all the underlying sustainable development factors of smart cities touched on the triple bottom line of sustainable development (Social, Environment, and Economic factors). Respondents were asked based on their matchless experience on urban sustainability to rate the importance of these twenty-seven variables in their contribution to ensuring sustainable development of the smart city concept on a Likert scale of 1 – 5 where one was Not Important to 5 – Very Important (see Appendix). Adopting one sample t-test as the analytical tool for this section, the data retrieved was analysed. After analysis it was concluded that there was enough evidence to suggest that all these key sustainable development factors of smart city which were ranked by the respondents were obtained from a population such that the sample mean of the population was not equal the hypothesised mean of 3.5. Hence, showing how significant all the twenty-seven variables were as key sustainable development factors of smart cities, since the null hypothesis was rejected for each of the independent variables. Also, it must be known that posteriori was conducted before this objective to determine the smartness level of Kumasi City by using Giffinger *et al*. (2007) six city's dimensions. After using mean score ranking on the independent variables under each dimension and comparing it with the developed smartness box (see chapter four), it was deduced that Kumasi City has not reached the full status of a smart city yet, and hence, there is surely the need to upgrade the systems in the city and incorporate technologies and innovation into making Kumasi city smart.

Hence, setting out the basis for this study which tend to consider the sustainable consideration of smart cities formation in developing countries.

5.2.2 Objective Two: To Identify the Militating Factors of Sustainable Development of Smart Cities in Developing Countries

While reviewing literature to determine the key sustainable development factors of smart cities, it became pertinent to also critically examine some of the challenges which are being faced during upscaling of smart city concept, formation of smart cities and most importantly ensuring the sustainable development of the smart city concept in general. These militating independent variables (seventeen of them) which were identified from literature were strategically formulated into the research questionnaire which allowed respondents falling on their rich experience with policies, urban sustainability and urban development to determine based on level of agreement how they view each of the independent variables as a challenging factors to the sustainable development of the smart city concept. The respondents were asked to rate the variables on a Likert scale with 1 – strongly disagree to 5 – strongly agree (see Appendix). Engaging Relative Importance Index analytical tool, the data retrieved from the respondents were given indices in determining how the respondents agree on which factor is the most challenging to the sustainable development of the smart city concept. After analysis it was seen that lack of preparedness on the side of government, financial inclusiveness of the smart city concept, and lack of practical application of some of the smart city concept were the main militating factors to the smart city concept creation, upscaling and sustainability in general. Hence, leading to the attainment of the second objective of the research.

5.2.3 Objective Three: To Determine the Critical Success Factors of Sustainable Development of Smart Cities

Objective three was added to this study to identify the novel important areas on sustainability of smart city concepts which needs to be improved to ensure future success (the critical success factors of sustainable development of smart cities). This objective was attained by first reviewing extant literature on critical success factors, sustainable development and critical success factors of sustainable development of smart cities in developing economies. After the critical literature review, twenty-five independent variables were obtained from literature which were strategically compounded into close-ended questionnaire for the respondents to rate the significance of each of the variables, falling on their nonpareil experience in smart cities, urban sustainability and critical success factors identification, on a Likert scale of 1 – 5, where 1 – not significant to 5 – very significant (see Appendix). The retrieved data was analysed by using principal component factor analysis to reduce the variables for easy understanding and analysis, checking for any unidimensional of the hypothetical concept, and identifying correlation between two or more variables in developing, confirming or rejecting any theories (Williams *et al*., 2012). After analysis, four main components were extracted which explained 67.927% of the total variance in this dimension. The extracted components were rotated with Varimax with Kaiser normalisation. The four components were called component 1 – developing smart policies for smart living; component 2 – applying sustainable principles for sustainable development; component 3 – enforcing sustainable practices into smart city concept and component 4 – developing effective plans for continuous improvement. After achieving the objectives of the study, a conceptual framework of how to improve the smartness level of Kumasi city and the sustainability of the concept thereof was formulated as seen in Figure 4.6 (check chapter four).

5.3 FINDINGS OF THE RESEARCH

Apart from the findings which have been enlisted under the review of objectives in this chapter and those in the chapter four (data analysis and discussion of results), there were some key imperative findings which can be inferred from the analysis done, and generally by reviewed literature.

It can be deduced that smart city as a concept only became appreciable in the research community in the late 1990s, however before that several other similar names were used to refer to the same concept, like digitalised city, intelligent city, green city, cyber city etc. The main aim of smart city formation is to improve urban areas through the incorporation of ICTs, innovation and smartness into the urban systems and structures. In effort of making cities smart, the concept tends to improve the quality of life of citizens, improve health, reduce unemployment and urban poor, boost the urban economy and increase innovation and business creation, increase security and safety in urban space, enhance mobility, safeguard the environment and ensure an open and transparent governance.

The study identified that smart cities have been done or achieved by most of the cities of the developed economies, but the same cannot be said for developing economies like Ghana. Hence, it was identified that one of the main militating factors which is creating this difference is the lack of preparedness and financial inclusiveness of the concept. For example, the top-down approach which involves getting a giant ICT company to develop a city from the scratch is purported to be very expensive and not inclusive to citizens of the city. On the other hand, the bottom-up approach which involves leaving cities to citizens to lead it to becoming smart is also a long-road to tread on. This has been identified as the main challenge of this concept in addition to the non-practicality of some of the concept on large scale and improper plans for integrating sustainable development factors into the smart city concepts.

On the issue of sustainability, it could generally be identified that the central theme of smart city is to ensure sustainability (social, environmental and economic factors). Hence, most of the concepts or approaches implemented in the smart city formation directly or indirectly is focused on attaining urban sustainability. The study identified that smart cities itself is skewed towards social and economic factors of sustainable development more than environmental factors. Notwithstanding, approaches identified in the critical success factor of sustainable development of smart cities could lead the concept into achieving the triple bottom line of sustainable development substantially equally.

5.4 CONTRIBUTION TO KNOWLEDGE

This study made substantial contribution to knowledge in the field of smart cities and urban sustainability. In the field of smart cities, several pertinent literatures on smart city concept, theories and empirical observations were reviewed and research gaps identified and shaped towards developing a novel theory or concept in this area. For instance, the study was focused on exploring the sustainable consideration of smart cities in developing countries, which was a novel idea which has not been well-thought-out in developing countries and most importantly Ghana. Hence, leading to the conceptualisation of the smart city concept by identifying the smartness level of Kumasi City, and offering measures of improvement through the objectives of the study. In coming out with the smartness level of Kumasi city, the study proposed the formulation of a metric for measurement of smartness of cities called the smartness box. This metric was created through extensive literature review and experts' opinion on how the six dimensions of smart cities leads in conceptualising the smart city concept.

In the field of urban sustainability, after reviewing extant literature in this area, the study has made a substantial contribution to this sector by fusing sustainability into the smart city concept, and identifying ways in which the two can be achieved through some four components of critical success factors formulated in chapter four of this study. The study also made substantial contribution in identifying challenges or militating factors of sustainable development of smart cities in developing countries. In addition, key sustainable development factors of smart cities and linkages on urban sustainability has also been outlined in this study.

Adding up to these, the study also created three distinct conceptual frameworks which shows how researchers can conceptualise smart cities in developing countries; integrate sustainable development principles into the smart city concept; and improve the smartness and sustainability of smart cities of developing countries.

In summary, this research has made substantial contribution to the exploration of how to make cities in developing economies smart and sustainable. The approach to the study is novel, and it can be replicated for further researches. The findings, conceptual diagrams, reviews, analyses, methods, discussions and conclusions are all novel, and adds up immensely to the body of knowledge in sustainability and smart city concepts.

5.5 RECOMMENDATIONS AND POLICY IMPLICATIONS

After careful consideration of this study, it was pertinent to give out some recommendations and policy implications of the whole study. It is irrefutable that smart city is an upcoming concept and its benefits are enormous as seen in literature, but if policies are not developed at an early stage, and guidelines not provided to ensure that we recoup much benefits from this concept, most developing countries cities may never attain the smartness level much less enjoy the benefits which smart cities proffers to the economy, to quality living, to health and education, to environment, to mobility and to governance. In this vein, the study has listed below several scintillating and provocative recommendations which can help in achieving sustainable smart cities for developing countries like Ghana.

- Smart city is a nice concept which should be sought for, but government should be prepared and ready, and make provision for any financial implications which the implementation of this concept would come with.
- Also, government should set up policies to control some of the current bad aspects of cities. For instance, policies should be set out to reduce urban poor, urban primacy, unemployment, rural-urban migration among others, so that it lifts off some of the burden which might come on smart cities during and after their formation.
- Cities are the central hub of living, and making urban structures smart through the implementation of ICTs and technologies should be taken into high regards. However, in an effort of making cities smart one key aspect or dimension which can speed up the process and create an enabling environment for innovations and business models is ensuring the education, training and technological competence of the people in the city. Hence, smart people should be key on smart city agenda and creation.
- In an effort of making cities smart, attention should be paid to the innovations being introduced into urban areas. Such innovations or new approaches should be environmentally friendly, socially inclusive and create value for money. Thus, smart city formation should not be taken outside urban sustainability, but both approaches should be coherently be employed in machinating a desirable

sustainable smart city which meets the needs of the current generation without jeopardising the ability of future generations to meet their own needs.

- The key sustainable development factors which were identified in this study like improving recyclable and reusable water treatment systems; adopting renewable; adopting renewable energy sources; ensuring good, quality and affordable education and training for all; should be well integrated into the formation and development of smart cities in developing countries, because the nexuses of the study shows that such factors could easily leads to improving the smartness of cities in developing countries.
- The six dimensions of smart cities (smart mobility, smart economy, smart governance, smart people, smart environment and smart living) should be well considered in the formation of smart cities. From the conceptual framework of this study, when any city assesses itself through these six dimensions, it should be able to come out with measures for improving the several areas where it falls short in any of the dimensions and through that improve its processes in disposition of becoming smart.
- The four main critical success components developed in this study (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) should be considered in policy formations of ensuring the sustainable development of smart city concept in developing countries.
- The summaries, conclusions and findings drawn from this study should serve as stockpile for further probing into this area, and creating a myriad of studies into improving the sustainable considerations of smart cities in developing countries.

5.6 LIMITATIONS OF THE RESEARCH

The limitations of this study were seen in the newness of the smart city concept to the respondent of the survey. Most of the respondents were drawn back at the mention of the concept, only to become very interested after further explanations and deliberations. This prolonged the data collection stage and defeated the approach used for data collection. Also, since there was no universally agreed approach in classifying a city as smart, adopting the six dimensions of smart cities for determining the smartness of Kumasi City was not easy for the respondent, because of their unfamiliarity with the six dimensions.

Notwithstanding these two major limitations, since it was envisaged that such would be the case; thus, at one stance it would be important to involve yourself in the research through the interpretivist philosophy, while at a different stance, you would want to stay away from influencing the outcome of the results in obtaining real value facts (positivist) (Saunders *et al*., 2009), quickly implementing a pseudo (unplanned) focus group to explain and discuss the questionnaires with the respondents enabled in obtaining real, significant data from these experts which helped in conceptualising the smart city concept of Kumasi, and identifying the key sustainable development factors which could be incorporated into the concept thereof.

5.7 DIRECTIONS FOR FUTURE RESEARCH

When undertaking this research, i.e. as literatures were reviewed, research methods determined and analysis and discussions formulated, there were some pertinent areas which were noted and seen that this particular study could not cover, but can only list them out for further study and future researches in such lane. These directions for future research are listed below:

- Further study can be conducted in exploring strategic measures for the implementation of sustainable smart city concept in developing countries.
- Developing measurement tools for determining the smartness level of cities through case studies of smart cities and systematic review of smart city concepts.
- Identifying measures for improving upscaling challenges of smart city concepts: A systematic review of sustainable smart cities in developed economies.
- Identifying novel approaches for improving the dimensions of smart cities for policy formation and implementation. The case study of cities in developing countries.

5.8 CHAPTER SUMMARY

This chapter drew the curtains to the whole research study. It precis the entire study by reviewing the attainment of the research objectives; providing other findings of the research; listing the contribution of the study to knowledge; suggesting recommendations and policy implications from the research; bolding proclaiming the limitations of the study, and strategically formulating directions for future research. The culmination of the study is seen is this chapter, which has beautifully brought this particular study to a close.

REFERENCES

Adarkwa, K.K., 2012. The changing face of Ghanaian towns. *African Review of Economics and Finance*, *4*(1), pp.1-29.

Adeyemi, T.O., 2009. Inferential Statistics for Social and Behavioural Research, *Research Journal of Mathematics and Statistics*, 1(2), pp. 47-54.

Agbodjah, L.S., 2008. *A human resource management policy development framework for large construction companies operating in Ghana* (Doctoral dissertation, Ph. D. diss., Kwame Nkrumah University of Science and Technology, Kumasi).

Ahadzie, D.K., 2007. *A model for predicting the performance of project managers in mass house building projects in Ghana* (Doctoral dissertation, University of Wolverhampton).

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I. and Airaksinen, M., 2017. What are the differences between sustainable and smart cities? *Cities*, *60*, pp.234-245.

Akande, A., Cabral, P., Gomes, P. and Casteleyn, S., 2019. The Lisbon ranking for smart sustainable cities in Europe. *Sustainable Cities and Society*, *44*, pp.475-487.

Albino, V., Berardi, U. and Dangelico, R.M., 2015. Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of urban technology*, *22*(1), pp.3-21.

Aletà, N.B., Alonso, C.M. and Ruiz, R.M.A., 2017. Smart mobility and smart environment in the Spanish cities. *Transportation research procedia*, *24,* pp.163-170.

Alkandari A, Alnasheet M and Alshekhly IFT., 2012. Smart cities: Survey. *Journal of Advanced Computer Science and Technology Research*, 2(2), pp. 79–90.

Allam, Z., 2017. Building a conceptual framework for smarting an existing city in Mauritius: The case of Port Louis. *J. Biourbanism*, *4*, pp.103-121.

Allwinkle, S. and Cruickshank, P., 2011. Creating smart-er cities: An overview. *Journal of urban technology*, *18*(2), pp.1-16.

Alusi, A., Eccles, R.G., Edmondson, A.C. and Zuzul, T., 2011. Sustainable cities: oxymoron or the shape of the future? *Harvard Business School Organizational Behaviour Unit Working Paper*, pp.11-062.

Al-Hader, M., Rodzi, A., Sharif, A.R. and Ahmad, N., 2009, September. Smart city components architicture. In *2009 International Conference on Computational Intelligence, Modelling and Simulation* (pp. 93-97). IEEE.

Al-Nasrawi, S., Adams, C. and El-Zaart, A., 2015. A conceptual multidimensional model for assessing smart sustainable cities. *JISTEM-Journal of Information Systems and Technology Management*, *12*(3), pp.541-558.

Anderson, C.R., 1984. *Management: Skills, functions, and organization performance*.

Anderson, D.R; Burnham, K.P and Thompson, W.L., 2000. Null Hypothesis Testing: Problems, Prevalence and an Alternative, *Journal of Wildlife Management*, 64(4), pp 912-923.

Anderson, J. and Thornback, J., 2012. A guide to understanding the embodied impacts of construction products. *Construction Products Association*, *12*, pp.2013.

Anderson, M.J., 2001. A new method for non-parametric multivariate analysis of variance. *Austral ecology*, *26*(1), pp.32-46.

Angelidou, M., 2014. Smart city policies: A spatial approach. *Cities*, *41*, pp. S3-S11

Anglim, J., 2007. Cluster Analysis and Factor Analysis, 325-711 Research Methods. *Email: jkanglim@ unimelb. edu. au, Office: Room*, *1110*.

Anthopoulos, L., Janssen, M. and Weerakkody, V., 2019. A Unified Smart City Model (USCM) for smart city conceptualization and benchmarking. In *Smart Cities and Smart Spaces: Concepts, Methodologies, Tools, and Applications* (pp. 247-264). IGI Global.

Antwi-Afari, P., Owusu-Manu, D.G., Parn, E. and Edwards, D.J., 2018. Exploratory Investigation of Challenges and Expectations of Innovative Quantity Surveyors and Quantity Surveying Firms in Ghana. *International Journal of Technology*, *9*(7), pp.1480-1489.

Aoun, C., 2013. The smart city cornerstone: Urban efficiency. *Published by Schneider electric*.

Armiger, S.B., 1977. Ethics of nursing research: profile, principles, perspective. *Nursing Research*, *26*(5), pp.330-336.

Babbie, E. R., 1995. The Practice of Social Research, 7th Edition, *Belmont: Wadsworth* Publishing.

Babbie, E. R., 2013. *The logic of sampling, The Practice of Social Research,* 13th ed, Belmont, CA: Cengage Learning

Babbie, E.R., Halley, F. and Zaino, J., 2007. *Adventures in social research: data analysis using SPSS 14.0 and 15.0 for Windows*. Pine Forge Press.

Bakıcı, T., Almirall, E. and Wareham, J., 2013. A smart city initiative: the case of Barcelona. *Journal of the knowledge economy*, *4*(2), pp.135-148.

Baiden, B.K., 2006. *Framework for the integration of the project delivery team* (Doctoral dissertation, © Bernard Kofi Baiden).

Balakrishna, C., 2012, September. Enabling technologies for smart city services and applications. In *2012 sixth international conference on next generation mobile applications, services and technologies* (pp. 223-227). IEEE.

Bansal, P., 2005. Evolving sustainably: A longitudinal study of corporate sustainable development. *Strategic management journal*, *26*(3), pp.197-218.

Batty, M., Axhausen, K.W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G. and Portugali, Y., 2012. Smart cities of the future. *The European Physical Journal Special Topics*, *214*(1), pp.481-518.

Batty M., 2013. *The New Science of Cities*. M.I.T. Press, Cambridge.

Batty, M. and Marshall, S., 2009. Centenary paper: The evolution of cities: Geddes, Abercrombie and the new physicalism. *Town Planning Review*, *80*(6), pp.551-574.

Beauchamp, T.L. and Childress, J.F., 2001. *Principles of biomedical ethics*. Oxford University Press, USA.

Bentler, P. M., 2005. *EQS 6 Structural Equation Program Manual*, Encino. CA: Multivariate Software.

Bhatta, B., 2010. *Analysis of urban growth and sprawl from remote sensing data*. Springer Science & Business Media, pp. 17-36.

Blaikie, N., 1993. *Approaches to Social Enquiry*, 1st edition, Polity Press: Cambridge.

Bossé, M.J., 2006. The NCTM Standards from an axiological perspective. *Greenville, NC: East Carolina University. Online: http://www. cimt. plymouth. ac. uk/journal/bosse1. pdf*.

Boulton, A., Brunn, S.D. and Devriendt, L., 2011. 18 cyberinfrastructures and 'smart'world cities: physical, human and soft infrastructures. *International handbook of globalization and world cities*, pp.198.

Bourne, L. 2005. Project Relationship Management and the Stakeholder and the stakeholder circle. (PhD), *RMIT*, Australia.

Bowerman, B., Braverman, J., Taylor, J., Todosow, H. and Von Wimmersperg, U., 2000, September. The vision of a smart city. In *2nd International Life Extension Technology Workshop, Paris* (Vol. 28, No. 7).

Boynton, A.C. and Zmud, R.W., 1984. An assessment of critical success factors. *Sloan management review*, *25*(4), pp.17-27.

Bramley, G. and Power, S., 2009. Urban form and social sustainability: the role of density and housing type. *Environment and Planning B: Planning and Design*, *36*(1), pp.30-48.

Breuer, J., Walravens, N. and Ballon, P., 2014. Beyond defining the smart city. Meeting top-down and bottom-up approaches in the middle. *Tema. Journal of Land Use, Mobility and Environment*.

Brown, R.B. and Saunders, M.P., 2007. *Dealing with statistics: What you need to know*. McGraw-Hill Education (UK).

Bryman, A., 2004. *Social research methods*, 2nd edition, Oxford: Oxford University Press.

Bryman, A., 2012. *Social research methods*, 5th edition, Oxford: Oxford University Press.

Bryman, A., and Cramer, D., 2005. *Quantitative Data Analysis with SPSS 12 and 13: A Guide for Social Scientists*, Routledge Publisher.

Burns, N. and Grove, S., 2003. The Practice of Nursing Research: Conduct, Critique, & Utilization. 5th edn WB Saunders Company, *Philadelphia, PA.*

Cairney, T. and Speak, G., 2000. *Developing a 'Smart City': Understanding Information Technology Capacity and Establishing an Agenda for Change*. Centre for Regional Research and Innovation, University of Western Sydney.

Calderoni, L., Maio, D. and Palmieri, P., 2012. Location-aware mobile services for a smart city: Design, implementation and deployment. *Journal of theoretical and applied electronic commerce research*, *7*(3), pp.74-87.

Campkin, B. and Ross, R., 2013. Future & Smart Cities-Urban Pasmphleteer# 1 (Vol. 1). London: UCL Urban Laboratory.

Campana, J., 2010. *The soft Skills of Project Management: A view from Diploma graduates* (Doctoral dissertation, Queensland University of Technology).

Canning, M., O'Dwyer, B. and Georgakopoulos, G., 2019. Processes of auditability in sustainability assurance–the case of materiality construction. *Accounting and Business Research*, *49*(1), pp.1-27.

Castells, M., 2000. Urban sustainability in the information age. *City*, *4*(1), pp.118-122.

Catney, P. and Doyle, T., 2011. The welfare of now and the green (post) politics of the future. *Critical Social Policy*, *31*(2), pp.174-193.

Caragliu, A., Bo, C. Del, and Nijkamp, P., 2009. Smart cities in Europe. In *3rd Central European Conference on Regional Science - CER 2009*, pp. 45-59.

Caragliu, A., Del Bo, C. and Nijkamp, P., 2011. Smart cities in Europe. *Journal of urban technology*, *18*(2), pp.65-82.

Carpio, C.E., Sydorovych, O. and Marra, M.C., 2007. *Relative importance of environmental attributes using logistic regression* (No. 1367-2016-108330).

Champion, D.J., 1970. *Basic statistics for social research*, Tennessee, USA: Chandler Publishing Company.

Chang, P.Y. and Chen, W.T., 2004, July. Evaluating the performance of VE study using factor analysis and AHP. In *Proceedings of SAVE International 44th Annual Conference, Montreal, Canada*.

Chatterjee, S. and Kar, A.K., 2018. Readiness of Smart City: Emerging Economy Perspective. In *Emerging Markets from a Multidisciplinary Perspective* (pp. 221-232). Springer, Cham.

Chhaya, L., Sharma, P., Kumar, A. and Bhagwatikar, G., 2018. IoT-Based Implementation of Field Area Network Using Smart Grid Communication Infrastructure. *Smart Cities*, *1*(1), pp.176-189.

Chen, T.M., 2010. Smart grids, smart cities need better networks [Editor's Note]. *IEEE Network*, *24*(2), pp.2-3.

Chen, Q. and Jin, R., 2013. Multilevel safety culture and climate survey for assessing new safety program. *Journal of Construction Engineering and Management*, 139(7), pp. 805-817.

Chen-Ritzo, C.H., Harrison, C., Paraszczak, J. and Parr, F., 2009. Instrumenting the planet. *IBM Journal of Research and Development*, *53*(3), pp.1-1.

Child, D., 1990. The Essentials of Factor Analysis 2nd edition London: Cassel Educational Ltd.

Choe, K.A. and Roberts, B.H., 2011. *Competitive cities in the 21st century: Cluster-based local economic development*. Asian Development Bank.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J.R., Mellouli, S., Nahon, K., Pardo, T.A. and Scholl, H.J., 2012, January. Understanding smart cities: An integrative framework. In *System Science (HICSS), 2012 45th Hawaii International Conference on* (pp. 2289-2297). IEEE.

Christou, E., Valachis, I. and Anastasiadou, C., 2008. Research methodology in hospitality industry: The role of the inquiry paradigms. *Available on http://www. ul. edu. lb/fthm/papers/3rd% 20Axis/Methodology% 20greece. doc*.

Coakes, S.J., 2007. *Analysis without anguish: Version 12.0 for Windows*. John Wiley & Sons, Inc..

Cochran, W. G., 1977. Sampling techniques. 3rd edition. New York: John Wiley and Sons.

Collis, J. and Hussey, R., 2013. *Business research: A practical guide for undergraduate and postgraduate students*. Macmillan International Higher Education pp. 54.

Conway, J.M. and Huffcutt, A.I., 2003. A review and evaluation of exploratory factor analysis practices in organizational research. *Organizational research methods*, *6*(2), pp.147-168.

Conway, R., 2013. Are Smart Cities Just for Smart Arses. *Sensemaking Blog*, *25*.

Cosgrove, M., Harthoorn, W., Hogan, J., Jabbar, R., Kehoe, M., Meegan, J. and Nesbitt, P., 2011. Smarter cities series: Introducing the IBM city operations and management solution. *IBM Corporation*.

Creswell, J.W., 1994. *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*, 2nd edition. Sage Publications.

Cresswell, J.W., 2003. *Research Design: Qualitative, quantitative and mixed methods approach*, 2nd edition, Sage Publications.

Creswell, J. W., 2005. *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*, 2nd edition. Upper Saddle River, NJ: Prentice Hall.

Creswell, J. W., 2009. *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: SAGE Publications, Incorporated.

Creswell, J. W., 2013. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Crotty, M., 1998. *The foundations of social research: Meaning and perspective in the research process*. Sage Publications.

Cronbach, L.J. and Meehl, P.E., 1955. Construct validity in psychological tests. *Psychological bulletin*, *52*(4), p.281.

Dahiya, B., 2012. Cities in Asia, 2012: Demographics, economics, poverty, environment and governance. *Cities*, *29*, pp. S44-S61.

Dancey, C.P. and Reidy, J., 2008. *Statistics without Maths for Psychology: Using SPSS for Windows*. 4th edition, Harlow: Prentice Hall.

Davis, M., 2010. Who will build the ark? *New Left Review*, 61, pp. 29–46

Deakin, M. and Al Waer, H., 2011. From intelligent to smart cities. *Intelligent Buildings International*, *3*(3), pp.140-152.

DeCoster, J., 1998. Overview of Factor Analysis, *Department of Psychology*, University of Alabama.

Deloitte, M., 2015. Smart cities… Not just the sum of its parts. *Deloitte, Paris, France*.

Denzin, N. K., & Lincoln, Y.S., 1994. *Handbook of Qualitative Research*, 2nd edition, Thousand Oaks Publications, CA: Sage Publication.

Denzin, N.K., and Lincoln, Y. S., 1998. *Collecting and Interpreting Qualitative Material*, London: Sage Publication.

Denzin, N. K., and Lincoln, Y.S., 2003. *Strategies of Qualitative Inquiry*, Thousand Oaks, Calif: Sage Publication.

Department of Business Innovation and Skills (BIS), 2013. *Smart Cities: Background Paper*. London, BIS/13//1209.

Deveries, J., 2007. About Hypothesis Testing, University of Guelph.

De la Peña, B., 2013. The Autocatalytic City. In: T. E. D. Books (ed.), City 2.0: The Habitat of the Future and How to Get There (Ebook). *TED Conferences*.

De Jong, M., Joss, S., Schraven, D., Zhan, C. and Weijnen, M., 2015. Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. *Journal of Cleaner production*, *109*, pp.25-38.

Dhingra, M. and Chattopadhyay, S., 2016. Advancing smartness of traditional settlements-case analysis of Indian and Arab old cities. *International Journal of Sustainable Built Environment*, *5*(2), pp.549-563.

Dich, L., McKee, H.A. and Porter, J.E., 2013. Ethical issues in online course design: Negotiating identity, privacy, and ownership. *AoIR Selected Papers of Internet Research*, *3*.

Dipboye, R. L. and Flanagan, M. F., 1979. Research settings in industrial and organizational psychology: Are findings in the field more generalizable than in the laboratory? *American Psychologist*, 34(2), p. 141.

Dirks, S. and Keeling, M., 2009. A vision of smarter cities: How cities can lead the way into a prosperous and sustainable future. *IBM Institute for business Value*, *8*.

Dirks, S., Gurdgiev, C. and Keeling, M., 2010. Smarter cities for smarter growth: How cities can optimize their systems for the talent-based economy. *IBM Institute for Business Value*.

Doering DS, Cassara A, Layke C, Ranganathan J, Revenga C, Tunstall D, Vanasselt W. 2002. Tomorrow's Markets: Global Trends and their Implications

Easterby- Smith, M., Thorpe, R., Jackson, P. and Lowe, A., 2008. *Management Research,* 3rd edition, Sage: London.

Eger, J.M., 2009. Smart growth, smart cities, and the crisis at the pump a worldwide phenomenon. *I-WAYS-The Journal of E-Government Policy and Regulation*, *32*(1), pp.47-53.

Elden, S., 2016. *Space, knowledge and power: Foucault and geography*. Routledge.

Elkington, J., 1998. Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental quality management*, *8*(1), pp.37-51.

Entrop, A.G. and Brouwers, H.J.H., 2010. Assessing the sustainability of buildings using a framework of triad approaches. *Journal of Building Appraisal*, *5*(4), pp.293-310.

Eremia, M., Toma, L. and Sanduleac, M., 2017. The smart city concept in the 21st century. *Procedia Engineering*, *181*, pp.12-19.

European Commission. 2008. *Internet of Things in 2020 Road Map for The Future*. Technical Report. Working Group RFID of the ETP EPOSS.

Fellows, R., and Liu, A. M. M., 2003. *Research methods in construction,* 2nd edition. Oxford: Blackwell Science Ltd.

Ferguson, C.R. and Dickinson, R., 1982. Critical success factors for directors in the eighties. *Business Horizons*, *25*(3), pp.14-18.

Field, A., 2009. *Discovering statistics using SPSS*. Sage publications.

Fisher, C.B., 1993. Integrating science and ethics in research with high-risk children and youth.

Fisher, K.R. and Purcal, C., 2010. Effective personalised housing support for people with disabilities–case study analysis. *Australian Journal of Social Issues*, *45*(4), pp.527-542.

Fistola, R. and La Rocca, R.A., 2013. Smart City Planning: a systemic approach. In *the 6th Knowledge Cities World Summit, KCWS 2013* (pp. 520-529). Lookus Scientific.

Flick, U., 2015. *Introducing research methodology: A beginner's guide to doing a research project*. Sage.

Ford, K., 2010. The trouble with city planning. What New Orleans can teach us. Yale University Press (ISBN: 9780300127355).

Fouka, G. and Mantzorou, M., 2011. What are the major ethical issues in conducting research? Is there a conflict between the research ethics and the nature of nursing? *Health Science Journal*, *5*(1).

Fowler, J., and Floyd, J., 1995. *Improving survey questions: design and evaluation*, Vol.38, Thousand Oaks: Sage Publications.

Gabrenya, W.K., 2003. Inferential statistics: Basic concepts. *Research Skills for Psychology Majors: Everything You Need to Know to Get Started*.

Gall, M, Gall, J. and Borg, W., 2003. *Educational Research: An introduction*, 7th edition, Boston: Allwyn and Bacon.

Ganapati, S. and Reddick, C.G., 2012. Open e-government in US state governments: Survey evidence from Chief Information Officers. *Government Information Quarterly*, *29*(2), pp.115-122.

Gay, L.R. and Airasian, P., 2000. Education Research: Competencies of Analysis and Application (6th). *Collombus: Merrill Publishing Company*.

GeSI, 2008. SMART 2020: Enabling the Low Carbon Economy in the Information Age

Ghana Statistical Service, 2010. *Population and Housing Census*, Ghana*: Ghana Statistical service.*

Ghana Statistical Service, 2014. *Population and Housing Census Report: Urbanisation*, Ghana*: Ghana Statistical service.*

Gibson, D.V., Kozmetsky, G. and Smilor, R.W. eds., 1992. *The technopolis phenomenon: Smart cities, fast systems, global networks*. Rowman & Littlefield.

Giffinger, R., Fertner, C., Kramar, H. and Meijers, E., 2007. *Smart Cities: Ranking of European medium-sized cities*. Vienna, Austria: Centre of Regional Science (SRF), Vienna University of Technology., pp. 1-12.

Giffinger, R. and Gudrun, H., 2010. Smart cities ranking: an effective instrument for the positioning of the cities? *ACE: architecture, city and environment*, *4*(12), pp.7-26.

Goddard, W. & Melville, S., 2004. Research Methodology: An Introduction, 2nd edition Oxford: Blackwell Publishing.

Goodall, B., 1987. *The Penguin dictionary of human geography*. Puffin Books.

Government of Ghana, 2019. *Ghana Government of Ghana – Governance (Ministries)*, Viewed 28 January 2019, http://ghana.gov.gh/index.php/governance/ministries.

Government of Ghana, National Urban Policy Framework, 2012. Ministry of Local Government and Rural Development.

Graham, S. and Marvin, S., 2002. *Splintering urbanism: networked infrastructures, technological Mobilities and the urban condition*. Routledge.

Guba, E.G., 1990. *The Paradigm Dialog*, Sage Publications Inc., USA, Chapter 1.

Guba, E.G. and Lincoln, Y.S., 1994. Competing paradigms in qualitative research. *Handbook of qualitative research*, *2*(163-194), p.105.

Guba, E. and Lincoln, Y., 2004. Approaches to Qualitative Research Design: A Reader on Theory and Practice, New York: Oxford University Press.

Gunawansa, A., 2011. Contractual and policy challenges to developing ecocities. *Sustainable Development*, *19*(6), pp.382-390.

Hall, R. E., 2000. The vision of a smart city. *In Proceedings of the 2nd International Life Extension Technology Workshop*, Paris, France, September 28

Hancke, G., Silva, B. and Hancke Jr, G., 2013. The role of advanced sensing in smart cities. *Sensors*, *13*(1), pp.393-425.

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J. and Williams, P., 2010. Foundations for smarter cities. *IBM Journal of research and development*, *54*(4), pp.1-16.

Harvey, F., 2011. Green vision: the search for the ideal eco-city. *Financial Times, London*.

Henning, E., Van Rensburg, W. and Smit, B., 2004. *Finding your way in qualitative research* (pp. 19-22). Pretoria: van Schaik.

Heron, J., 1996. *Co-operative inquiry: Research into the human condition*. Sage.

Herrschel, T., 2013. Competitiveness and sustainability: can 'smart city regionalism'square the circle? *Urban Studies*, *50*(11), pp.2332-2348.

Hiremath, R.B., Balachandra, P., Kumar, B., Bansode, S.S. and Murali, J., 2013. Indicator-based urban sustainability—A review. *Energy for sustainable development*, *17*(6), pp.555-563.

Hittleman, D.R. and Simon, A.J., 1997. *Interpreting educational research: An introduction for consumers of research*. Prentice-Hall, Inc., One Lake St., Upper Saddle River, NJ 07458.

Hollands, R.G., 2008. Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*, *12*(3), pp.303-320.

Howland, J. and Wedman, J., 2004. A process model for faculty development: Individualizing technology learning. Journal of technology and teacher education, 12(2), pp.239-262.

Hun, M. P., 2010. Hypothesis Testing and Statistical Power of a Test, *University of Information Technology Services*, Indiana University.

Höjer, M. and Wangel, J., 2015. Smart sustainable cities: definition and challenges. In *ICT innovations for sustainability* (pp. 333-349). Springer, Cham.

IBM Corporation, 2009. A vision of smarter cities: How cities can lead the way into prosperous and sustainable future, IBM Corporation, Somers, NY (New York State)

IBM., 2013. *IBM's smarter cities challenge. Copenhagen Report*. Retrieved from http://smartercitieschallenge.org/scc/executive_reports/SCC-Copenhagen-Report.pdf

IDA Singapore, "iN2015 Masterplan" (2012) , http://www.ida.gov.sg/~/media/Files/Infocomm%20Landscape/iN2015/Reports/realisingthevisionin2015.pdf.

International Institute for Sustainable Development (IISD) (1995). Resources for Sustainable Development: Sustainable Development Principles, IISD. / http://www.iisd.org/sd/principle.asp.

IT Strategic Headquarters. i-Japan Strategy 2015[EB/OL]. [2013-05-22]. http://www.kantei.go.jp/foreign/policy/it/i-JapanStrategy2015_summary.pdf.

IUCN, UNEP, WWF. 1996. Caring for the earth: a strategy for sustainable living. In Principles of Environmental Conservation and Sustainable Development: Summary and Survey, Rockefeller SC (ed). Earth Charter Project, Earth Council: San Jose, Costa Rica; pp. 129-131

Jaykaran, C., 2010. How to Select Appropriate Statistical Test? *Journal of Pharmaceutical Negative Results*, Vol., No. 2, pp. 61-63.

Jean, K., 1992. Livelihood strategies among farm youth in Rwanda. *Michigan: Michigan State University*.

Jeyamathan, J. and Rameezdeen, R., 2006. Skills and competencies of quantity surveyors: the case of Sri Lanka. *Proceedings of Customizing the Quantity Surveyor to Face the Challenges in Year*, *2020*, pp.9-18.

Jin, J., Gubbi, J., Marusic, S. and Palaniswami, M., 2014. An information framework for creating a smart city through internet of things. *IEEE Internet of Things journal*, *1*(2), pp.112-121.

Johnson, B., 2008. Cities, systems of innovation and economic development. *Innovation*: *Management*, *Policy and Practice,10*(2-3), pp.146-155.

Johnson, P., and Duberly, J., 2000. *Understanding Management Research: An introduction of epistemology*, London: Sage Publications.

Johnstone, M.J., 2015. *Bioethics: a nursing perspective*. Elsevier Health Sciences.

Jolly, S., Raven, R. and Romijn, H., 2012. Upscaling of business model experiments in off-grid PV solar energy in India. *Sustainability science*, *7*(2), pp.199-212.

Kahn, M.E., 2007. *Green cities: urban growth and the environment*. Brookings Institution Press.

Kanter, R.M. and Litow, S.S., 2009. Informed and interconnected: A manifesto for smarter cities. Harvard Business School General Management Unit Working Paper, 09-141.

Kapadia-Kundu, N. and Dyalchand, A., 2007. The Pachod Paisa Scale: A numeric response scale for the health and social sciences. *Demography India*, *36*(2), pp.303-313.

Kelly, D., 2009. Methods for evaluating interactive information retrieval systems with users. *Foundations and Trends® in Information Retrieval*, 3(1-2), pp. 1 - 224.

Kelley, T. L. 1927. *Interpretation of educational measurements. New York*: Macmillan.

Kelman, H.C., 1977. Privacy and research with human beings. *Journal of Social Issues*, *33*(3), pp.169-195.

Kim, H.M., and Han, S.S., 2012. City profile: Seoul. *Cites*, 29(2), pp. 142-154.

Kitchin, R., 2014. The real-time city? Big data and smart urbanism. *GeoJournal*, *79*(1), pp.1-14.

Kline, R.B., 2015. *Principles and practice of structural equation modelling*. Guilford publications.

Knight, A. and Ruddock, L. eds., 2009. *Advanced research methods in the built environment*. John Wiley & Sons.

Komninos, N., 2009. Intelligent cities: towards interactive and global innovation environments. *International Journal of Innovation and Regional Development*, *1*(4), pp.337-355.

Kothari, C.R., 2004. *Research Methodology Methods and Techniques*, New Age International (P) Ltd, New Delhi.

Kourtit, K., Nijkamp, P. and Arribas, D., 2012. Smart cities in perspective–a comparative European study by means of self-organizing maps. *Innovation: The European journal of social science research*, *25*(2), pp.229-246.

Kramers, A., Höjer, M., Lövehagen, N. and Wangel, J., 2014. Smart sustainable cities–Exploring ICT solutions for reduced energy use in cities. *Environmental modelling & software*, *56*, pp.52-62.

Kroes, N., 2010. European Commissioner for Digital agenda, the critical role of cities in making the Digital Agenda a reality. *Closing speech to Global Cities Dialogue Spring Summit of Mayors Brussels*, *28*.

Kumar, T.V. and Dahiya, B., 2017. Smart economy in smart cities. In *Smart Economy in Smart Cities* (pp. 3-76). Springer, Singapore.

Kumar, T. V., 2014. Geographic Information System for Smart Cities, *Copal Publishing Group, New Delhi*

Kuper A., and Kuper J., 1996. The Social Science Encyclopaedia[M]. 2nd ed. Oxon: Routledge and Kegan Paul.

Kuyper, T., 2016. Smart City Strategy and Upscaling: Comparing Barcelona and Amsterdam.

Kwofie, E.T., 2015. *Contribution of unique features of mass housing projects to project team communication performance* (Doctoral dissertation).

Landry, C., 2000. The Creative City: A Toolkit for Urban Innovators (Earthscan, London).

Landry C. 2006. The Art of City Making. London: Routledge.

Lazaroiu, G.C. and Roscia, M., 2012. Definition methodology for the smart cities model. *Energy*, *47*(1), pp.326-332.

Lee, J.H., Phaal, R. and Lee, S.H., 2013. An integrated service-device-technology roadmap for smart city development. *Technological Forecasting and Social Change*, *80*(2), pp.286-306.

Leidecker, J.K. and Bruno, A.V., 1984. Identifying and using critical success factors. *Long range planning*, *17*(1), pp.23-32.

Levine, R.J., 1976. Preliminary papers prepared for the commission. *The Belmont Report: EPGPHSR (DHEW Publication No. OS-78-0013, pp. 2/1–4/103). Washington, DC: US Government Printing Office*.

Lietz, P., 2010. Research into questionnaire design. *International Journal of Market Research*, *52*(2), pp.249-272.

Lindsay, G., 2011. Not-So-Smart Cities. *New York Times*, *24*.

Ling, O. G., 2005. *Sustainability and Cities; Concept and Assessment, Institute of Policy studies.* s.l.:Singapore and Scientific Publishing Co. Pte. Ltd

Liu, P. and Peng, Z., 2013. Smart cities in China. *IEEE Computer Society*, *16*, p.7.

Lombardi, P., Giordano, S., Farouh, H. and Yousef, W., 2012. Modelling the smart city performance. *Innovation: The European Journal of Social Science Research*, *25*(2), pp.137-149.

Lu, W. and Tam, V.W., 2013. Construction waste management policies and their effectiveness in Hong Kong: A longitudinal review. *Renewable and sustainable energy reviews*, *23*, pp. 214 – 223.

Mabbitt, R., 2006. Lao Peoples' Democratic Republic Urbanization and Sustainability in Asia: Case Studies of Good Practice. B. Roberts and T. Kanaley, (eds). Manila: Asian Development Bank, and World Bank. *Cities Alliance*, pp.189-221.

Madakam, S., Holmukhe, R.M. and Tripathi, S., 2018. Rising of Yokohama, Keihanna, Kitakyushu, and Toyota Smart Cities in the Land of the Rising Sun. In *Smart Cities* (pp. 243-262). Springer, Cham.

Mahmood, Z., 2018. *Smart Cities: Development and Governance Frameworks*. Springer.

Malhotra, N.K., 2007. Review of marketing research. In *Review of Marketing Research* (pp. v-v). Emerald Group Publishing Limited.

Manville, Catriona, Rand Europe, Jeremy Millard, Danish Technological Institute, Andrea Liebe, and Roel Massink. 2014. "Mapping Smart Cities in the EU." *Industry, Research and Energy, European Parliament*.

Marceau, J., 2008. Introduction: Innovation in the city and innovative cities. *Innovation: Management, Policy & Practice*, *10*(2-3), pp. 136-145.

Marsal-Llacuna, M.L., Colomer-Llinàs, J. and Meléndez-Frigola, J., 2015. Lessons in urban monitoring taken from sustainable and livable cities to better address the Smart Cities initiative. *Technological Forecasting and Social Change*, *90*, pp.611-622.

Marsh, D. and Stoker, G., 2002. *Theories and methods in political science*. Palgrave, Macmillan, Basingstoke, UK.

Martens, M.L. and Carvalho, M.M., 2016. The challenge of introducing sustainability into project management function: multiple-case studies. *Journal of Cleaner Production*, *117*, pp.29-40.

Mayer, A.L., 2008. Strengths and weaknesses of common sustainability indices for multidimensional systems. *Environment international*, *34*(2), pp.277-291.

McCauley, C.D., Ruderman, M.N., Ohlott, P.J. and Morrow, J.E., 1994. Assessing the developmental components of managerial jobs. *Journal of applied psychology*, *79*(4), p.544-560.

McLeod, S. A. (2013). What is validity?. Retrieved from https://www.simplypsychology.org/validity.html

Meadows, D., 1999. Indicators and information systems for sustainable development. In the Earthscan reader in sustainable cities, pp. 1-78. London: *Earthscan.*

Meijer, A. and Bolívar, M.P.R., 2016. Governing the smart city: a review of the literature on smart urban governance. *International Review of Administrative Sciences*, *82*(2), pp.392-408.

Mitchell, W.J., 2000. e-topia. *Urban Life, Jim e but Not as We Know it.* The MIT Press, Cambridge Mass.

Mitchell, W.J., 2006. Smart city 2020, Metropolis Magazine [interaktyvus], [žiūrėta 2013 m. gruodžio 28 d.]. *Prieiga per internet: http://www. metropolismag. com/April2006/SmartCity2020*.

Moser, C.A., Kalton, G., 1979. *Survey Methods in Social Investigation.* 2nd Ed. Gower Publishing Company Limited, Aldershot, UK

Munro, M.C., 1983. An opinion... comment on critical success factors work.

Murphy, K., 2012. The social pillar of sustainable development: a literature review and framework for policy analysis. *Sustainability: Science, practice and policy*, *8*(1), pp.15-29.

Nagapan, S., Rahman, I.A., Asmi, A., Memon, A.H. and Latif, I., 2012, December. Issues on construction waste: The need for sustainable waste management. In *Humanities, Science and Engineering (CHUSER), 2012 IEEE Colloquium on* (pp. 325-330). IEEE.

Nam, T. and Pardo, T.A., 2011, September. Smart city as urban innovation: Focusing on management, policy, and context. In *Proceedings of the 5th international conference on theory and practice of electronic governance* (pp. 185-194). ACM.

Nam, T. and Pardo, T.A., 2011, June. Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times* (pp. 282-291). ACM.

Naoum, S., 2012. *Dissertation research and writing for construction students*. Routledge.

Nautiyal, L., Malik, P. and Agarwal, A., 2018. Cybersecurity System: An Essential Pillar of Smart Cities. In *Smart Cities* (pp. 25-50). Springer, Cham.

Nevo, B., 1985. Face validity revisited. *Journal of Educational Measurement*, *22*(4), pp.287-293.

Ng, P.T., 2011. Embracing emerging technologies: the case of the singapore intelligent nation 2015 vision. In *Regional Innovation Systems and Sustainable Development: Emerging Technologies* (pp. 115-123). IGI Global.

Oddi, L.F. and Cassidy, V.R., 1990. Nursing research in the United States: The protection of human subjects. *International Journal of Nursing Studies*, *27*(1), pp.21-33.

OECD. 2008. *Handbook on Constructing Composite Indicators: Methodology and User Guide* (Eds). Paris: European Commission Joint Research Center. https://doi.org/10.1787/9789264043466-en

Ofori-Kuragu, J.K., 2013. *Enabling world-class performance in Ghanaian contractors: A framework for benchmarking* (Doctoral dissertation).

Ojo, A., Dzhusupova, Z., and Janowski, T., 2012. *e-Macao Report 198 - Intelligent Governance of Smart Cities - State of Practice*. pp. 1–100.

Ojo, A., Curry, E. and Janowski, T., 2014. Designing next generation smart city initiatives-harnessing findings and lessons from a study of ten smart city programs.

Onwuegbuzie, A.J., 2000. Expanding the Framework of Internal and External Validity in Quantitative Research.

Oomens, I.I., 2016. How to upscale smart city initiatives? combining innovation ecosystem and transition theory.

Oppenheim, A., 1996. Questionnaire Design, Interviewing and Attitude Measurement, London, Pinter. pp 303.

Oppenheim, A. N., 2000. *Questionnaire Design, Interviewing and Attitude Measurement*, 2nd edition. London: Bloomsbury Publishing.

Orlikowski, W.J. and Baroudi, J.J., 1991. Studying information technology in organizations: Research approaches and assumptions. *Information systems research*, *2*(1), pp.1-28.

Osborne S.P., 2006. The new public governance? Public Management Review 8(3): pp. 377–387.

Owusu, G., 2005. Small towns in Ghana: justifications for their promotion under Ghana's decentralisation programme. *African Studies Quarterly*, *8*(2), pp.48-70.

Owusu-Manu D. G., Antwi-Afari P., and Edwards D. J. 2018. Expanding Understanding on Attributes of Innovation Champions: Firms and Individual Perspectives of Professional Quantity Surveying Firms. American Journal of Civil Engineering, 6(6), 178-184. doi: 10.11648/j.ajce.20180606.11

Owusu-Manu, D.G., Badu, E., Edwards, D.J., Adesi, M. and Holt, G.D., 2012. Conceptualisation of the consultancy pricing paradox. *Structural Survey*, *30*(4), pp.357-378.

Pancholi, V. S., 2014. Measuring decentralization in reforms era: A case of Kalyan-Dombivi, India. *Scientifi Research*, *2*(2), pp. 116–126.

Paskaleva, K.A., 2011. The smart city: A nexus for open innovation? *Intelligent Buildings International*, *3*(3), pp.153-171.

Passer, M. W., 2014. *Research Methods: Concepts and Connections*, Worth Publishers, Macmillan Learning, New York.

Pathirage, C.P., Amaratunga, D. and Haigh, R., 2005. Knowledge management research within the built environment: Research methodological perspectives.

Pearce, D., Markandya, A., Barbier, E.B., 1989. Blueprint for a Green Economy. Earthscan Publication Limited, London.

Petty, R.E., Briñol, P., Loersch, C. and McCaslin, M.J., 2009. The need for cognition. *Handbook of individual differences in social behavior*, pp.318-329.

Pike Research, 2011. Global Investment in Smart City Technology Infrastructure to Total $108 Billion by 2020, Navigant Research.http://www.navigantresearch.com/newsroom/global-investment-in-smart-city-technology-infrastructure-tototal-108-billion-by-2020

Piro, G., Cianci, I., Grieco, L.A., Boggia, G. and Camarda, P., 2014. Information centric services in smart cities. *Journal of Systems and Software*, *88*, pp.169-188.

Ratti, C., and Townsend, A., 2011. The Social Nexus. *Scientific American*, *305*(3), pp. 30 – 35.

Razaghi, M., 2016. *An action research inquiry into professional training and development for addressing complex urban problems* (Doctoral dissertation, Ecole Polytechnique Fédérale de Lausanne).

Riddell, S. and Burgess, R., 1989. The ethics of educational research. *Exploiting the exploited? The ethics of feminist educational research*.

Ritchie, J., Lewis, J., and Elam, G., 2013. *Qualitative Research Practice: A Guide for Social Science Students and Researchers, Designing and Selecting Samples, London:* Sage.

Roberts, B. and Kanaley, T. eds., 2006. *Urbanization and sustainability in Asia: Case studies of good practice*. Asian Development Bank.

Rockart, J.F., 1979. Chief executives define their own data needs. *Harvard business review*, *57*(2), pp.81-93.

Ryan, P., 2004. Introduction, Basics, Descriptive Statistics, University of Adelaide.

Sadowski, J., 2016. *Selling Smartness Visions and Politics of the Smart City* (Doctoral dissertation, Arizona State University).

Salant, P., and Dillman, D.A., 1994. *How to conduct your own survey*, New York: John Wiley & Sons. (No. 300.723 S3).

Sarantakos, S., 2005. *Social Research*, 3rd edition, Melbourne, Victoria: Palgrave Macmillan.

Satterthwaite, D., 1997. Sustainable cities or cities that contribute to sustainable development? *Urban studies*, *34*(10), pp.1667-1691.

Saunders, M., Lewis, P. and Thornhill, A., 2007. Research methods. *Business Students 4th edition Pearson Education Limited, England*.

Saunders, M., Lewis, P. and Thornhill, A., 2009. Research methods for business students 5th edition. *Perntice Hall*.

Sauer, S., 2012. Do smart cities produce smart entrepreneurs? *Journal of theoretical and applied electronic commerce research*, *7*(3), pp.63-73.

Scheaffer, R.L. and Yes, N., 1999. Categorical data analysis. *NCSSM Statistics Leadership Institute*.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M. and Oliveira, A., 2011, May. Smart cities and the future internet: Towards cooperation frameworks for open innovation. In *The future internet assembly* (pp. 431-446). Springer, Berlin, Heidelberg.

Schmidheiny, S. and Timberlake, L., 1992. *Changing course: A global business perspective on development and the environment* (Vol. 1). MIT press.

Schuurman, D., Baccarne, B., De Marez, L. and Mechant, P., 2012. Smart ideas for smart cities: investigating crowdsourcing for generating and selecting ideas for ICT innovation in a city context. *Journal of theoretical and applied electronic commerce research*, *7*(3), pp.49-62.

Sekaran, U., 2003. Research Methods for Business. New York: John Milley and Sons. Inc. *Semarang: Badan Penerbit Universitas Diponegoro.*

Sennett, R., 2012. No one likes a city that's too smart. *The Guardian*, *4*.

Seow, T. W., 2016. "Solid waste management scenario in Malaysia."

Shapiro, J.M., 2006. Smart cities: quality of life, productivity, and the growth effects of human capital. *The review of economics and statistics*, *88*(2), pp.324-335.

Shelton, T., Zook, M. and Wiig, A., 2015. The 'actually existing smart city'. *Cambridge Journal of Regions, Economy and Society*, *8*(1), pp.13-25.

Shin, D.H. and Kim, T., 2012, February. Enabling the smart city: The progress of u-city in Korea. In *Proceedings of the 6th International Conference on Ubiquitous Information Management and Communication* (p. 105). ACM.

Singer, N., 2012. Mission control, built for cities: IBM takes 'smarter cities' concept to Rio de Janeiro. *New York Times*, *3*.

Singla, A., Ahuja, I.P.S. and Sethi, A.P.S., 2017. The effects of demand-pull strategies on sustainable development in manufacturing industries. *International Journal of Innovations in Engineering and Technology*, *8*(2), pp.27-34.

Sinner, J., Baines, J., Crengle, H., Salmon, G., Fenemor, A. and Tipa, G., 2005. Key concepts in sustainable development part I: economics and ecology. *Public Sector*, *28*(3), pp.1-9.

Songsore, J., 2003. *Towards a better understanding of urban change: urbanization, national development and inequality in Ghana*. Ghana Universities Press.

Soofi, E.S., Retzer, J.J. and Yasai-Ardekani, M., 2000. A framework for measuring the importance of variables with applications to management research and decision models. *Decision Sciences*, *31*(3), pp.595-625.

Speer, S. A., 2002. Natural 'and contrived' data: a sustainable distinction? Discourse Studies, 4(4), pp. 511 -525.

Sprinthall, R.C., Schmutte, G.T. and Sirois, L., 1991. *Understanding educational research*. Prentice Hall.

Strauss, A. and Corbin, J., 1998. *Basics of qualitative research techniques*. Thousand Oaks, CA: Sage publications.

Stratigea, A., 2012. The concept of 'smart cities. Towards community development? *Netcom. Réseaux, communication et territoires*, (26-3/4), pp.375-388.

Sykes, A.O., 1992. An Introduction to Regression Analysis, The Inaugural Coase Lecture. *Unpublished online report. University of Chicago*.

Söderström, O., Paasche, T. and Klauser, F., 2014. Smart cities as corporate storytelling. *City*, *18*(3), pp.307-320.

Tang, W., Qiang, M., Duffield, C.F., Young, D.M. and Lu, Y., 2008. Incentives in the Chinese construction industry. *Journal of Construction Engineering and Management*, *134*(7), pp.457-467.

Tashakkori, A., Teddlie, C. and Teddlie, C.B., 1998. *Mixed methodology: Combining qualitative and quantitative approaches* (Vol. 46). Sage.

The Economist, 2013. Urban Dreamscapes: Starting from Scratch, The Economist, 7 September. http://www.economist.com/news/briefing/21585003-building-city-future-costly-and-hard-starting-scratch

Thomas, D.R., 2006. A general inductive approach for analyzing qualitative evaluation data. *American journal of evaluation*, *27*(2), pp.237-246.

Thurairajah, N., Haigh, R. and Amaratunga, D., 2006. Leadership in construction partnering projects: Research methodological perspective.

Tongco, M.D.C., 2007. Purposive sampling as a tool for informant selection. *Ethnobotany Research and applications*, *5*, pp.147-158.

Toppeta, D., 2010. The smart city vision: how innovation and ICT can build smart, "livable", sustainable cities. *The Innovation Knowledge Foundation*, *5*, pp.1-9.

Torfing, J., Peters, B.G., Pierre, J. and Sørensen, E., 2012. *Interactive governance: Advancing the paradigm*. oxford university Press on demand.

Torres, L., Pina, V. and Royo, S., 2005. E-government and the transformation of public administrations in EU countries: Beyond NPM or just a second wave of reforms? *Online Information Review*, *29*(5), pp.531-553.

Townsend, A.M., 2013. *Smart cities: Big data, civic hackers, and the quest for a new utopia*. WW Norton and Company.

Underwood, A. J., 1997. *Experiments in ecology: their logical design and interpretation using analysis of variance*, Cambridge: Cambridge University Press.

United Kingdom Secretaries of State for the Environment, 1994. Sustainable Development: The UK Strategy. HMSO: London.

United Nations, 2009. Making Data Meaningful Part 2: A guide to presenting statistics, United Nations Economic Commission for Europe, CE/CES/STAT/NONE/2009/3.

United Nations, 2011. *Population distribution, urbanization, internal migration and development: An international perspective*. New York: United Nations Department of Economics and Social affairs.

United Nations, Department of Economic and Social Affairs, Population Division, 2014. World Urbanization Prospects: The 2014 Revision, CD-ROM Edition.

United Nations Human Settlements Programme (UN-Habitat), 2012. "Habitat Issue Paper on Smart Cities", New York: United Nations Habitat.

United Nations, 2015. World urbanization prospects. The 2014 revision. New York: Department of Economic and Social Affairs http://esa.un.org/unpd/wup/Publications/Files/WUP2014-Report.pdf.

UNDP (United Nations Development Programme), 2015. Sustainable Development Goals 2030 targets. Viewed 8 March 2019, https://www.undp.org/content/undp/en/home.html.

United Nations Environment Programme (UNEP), 2013. City-Level Decoupling: UrbanResource Flows and the Governance of Infrastructure Transitions. Full report by the Working Group on Cities of the International Resource Panel (M. Swilling, B. Robinson, S. Marvin and M. Hodson). Nairobi: UNEP

Vallance, S., Perkins, H.C. and Dixon, J.E., 2011. What is social sustainability? A clarification of concepts. *Geoforum*, *42*(3), pp.342-348.

Vanolo, A., 2014. Smartmentality: The smart city as disciplinary strategy. *Urban studies*, *51*(5), pp.883-898.

Van Winden, W., 2016. Smart city pilot projects, scaling up or fading out? Experiences from Amsterdam. In *Regional Studies Association Annual Conference in Austria, Graz, 3rd–6th April*.

Varalakshmi, V; Sundaram, G.G; Indrani, B; Suseela, N and Ezhilarasi, S., 2005. *Statistics*, Higher Secondary, Tamilnadu Textbook Corporation College Road, Chennai- 600 006.

Wadsworth, Y., 1997. Do it yourself social research, 2nd edition, Sydney: *Allen and Unwin.*

Wahab, I.A., 1996. *Financing the growth of small manufacturing firms in developed and developing countries: a comparative study of the United Kingdom and Malaysia* (Doctoral dissertation, © Ismail Abdul Wahab).

Walravens, N., 2012. Mobile business and the smart city: Developing a business model framework to include public design parameters for mobile city services. *Journal of theoretical and applied electronic commerce research*, *7*(3), pp.121-135.

Washburn, D., Sindhu, U., Balaouras, S., Dines, R.A., Hayes, N. and Nelson, L.E., 2009. Helping CIOs understand "smart city" initiatives. *Growth*, *17*(2), pp.1-17.

WBCSD. 2002. The Business Case for Sustainable Development. WBCSD: Conches-Geneva, Switzerland.

WCED (World Commission on Environment and Development), 1987. Report of the world commission on environment and development: Our common future. United Nations. http://www.un-documents.net/our-commonfuture.pdf. Accessed 9 Feb 2017

Weber, R., 2004. The rhetoric of positivism versus interpretivism: a personal view, *MIS quarterly*, Vol. 28, No. 1, pp. 3-12.

Weisi, F.U. and Ping, P.E.N.G., 2014. A discussion on smart city management based on meta-synthesis method. *Management science and engineering*, *8*(1), pp.73.

Wenge, R., Zhang, X., Dave, C., Chao, L. and Hao, S., 2014. Smart city architecture: A technology guide for implementation and design challenges. *China Communications*, *11*(3), pp.56-69.

Williams, B., Brown, T., and Onsman, A., 2012. Exploratory factor analysis: A five-step guide for novices, *Australasian Journal of Par medicine*, 8(3), pp. 223-245.

Wilson, J., 2014. *Essentials of business research: A guide to doing your research project*. Sage.

Winters, J.V., 2011. Why are smart cities growing? Who moves and who stays? *Journal of regional science*, *51*(2), pp.253-270.

Yi, Y., 2011. *Supply chain flexibility and responsiveness: An empirical analysis of the Chinese textile and clothing industry* (Doctoral dissertation, The Hong Kong Polytechnic University).

Yigitcanlar, T. and Velibeyoglu, K., 2008. Knowledge-based urban development: The local economic development path of Brisbane, Australia. *Local Economy*, *23*(3), pp.195-207.

Yigitcanlar, T., 2016. *Technology and the city: Systems, applications and implications*. Routledge.

Yin, R.K., 2003. Case study research: design and methods, 3rd edition, Thousand Oaks, California: *Sage Publications, Inc.*

Yin, R.K., 2009. Case study research: Design and methods, 4th edition, London: *Sage Publications*.

Yin, R., 2010. Analytic generalization. *Encyclopaedia of case study research*, *1*, pp.20-22.

Zanella, A., Bui, N., Castellani, A., Vangelista, L. and Zorzi, M., 2014. Internet of things for smart cities. *IEEE Internet of Things journal*, *1*(1), pp.22-32.

Zibran, M.F., 2007. Chi-squared test of independence. *Department of Computer Science, University of Calgary, Alberta, Canada*.

Zygiaris, S., 2013. Smart city reference model: Assisting planners to conceptualize the building of smart city innovation ecosystems. *Journal of the Knowledge Economy*, *4*(2), pp.217-231.

APPENDIX

Kwame Nkrumah University of Science and Technology
Department of Construction Technology and Management
Kumasi.

QUESTIONNAIRE

RESEARCH TOPIC: Exploring Sustainable Considerations of Smart Cities in Developing Countries: The Case Study of Kumasi City

Dear Sir/Madam,

I am currently conducting a survey on Kumasi City to determine the smartness of the city, and the sustainable development factors which can be incorporated in the formation or transformation of Kumasi City into a sustainable smart city. This survey is a continuum of a research I am currently undertaking as part of the fulfilment of requirement of award of MSc Construction Management at Kwame Nkrumah University of Science and Technology, Ghana.

Some key objectives which this study strives to achieve are:

1. To identify key sustainable development factors of smart cities in developing countries.
2. To identify the militating factors of sustainable development of smart cities in developing countries.
3. To determine the critical success factors of sustainable development of smart cities.

I will enthusiastically appreciate your contribution to this research, by answering this questionnaire, by falling on your nonpareil experience in sustainability and/or your matchless observations and understanding of policies of Kumasi City.

Please, you can rest-assure that data collected from this survey would be used for academic purposes only, and as such **your confidentiality and discretion is highly guaranteed.**

From the pilot study, answering of this questionnaire **should not take more than 20 minutes** of your precious valued time. Therefore, with immense appreciation of your time, and anticipation of your contribution, I would be extremely grateful if I get feedback of this questionnaire **not more than 7 working days** from day of receipt.

Notwithstanding, if you wish to know the findings, recommendations or policy implementations of this study, kindly leave your email here……………………….………., or alternatively send further enquiries to the contact below.

Thank you so much for your unflinching support, contribution and assistance.
Yours Faithfully,
Mr. Prince Antwi-Afari
Email: antwi.afari@gmail.com / antwi.afari@yahoo.com Tel: 0501377540
Department of Construction Technology and Management (KNUST- KSI, GHANA)

Dr. DeGraft Owusu-Manu (Project Supervisor)

SECTION ONE

BACKGROUND INFORMATION

1. What is your current profession? Kindly write below

…………………………………………………………………………………….

2. How long have you worked in your current job or position?

a. 1 – 5 years ☐ b. 6 – 10 years ☐

c. 11 – 15 years ☐ d. 16 – 20 years ☐

e. Over 20 years ☐

3. Smart city can simply be defined as the innovation (not predominantly ICT-based) that coordinates and manages the six dimensions in the urban space (mobility, environment, economy, people, government and living) (Anthopoulos *et al.*, 2019). Please indicate below your familiarity with this concept. Kindly tick appropriately under each box.

1 – Not at all 2 – Somewhat 3 – Familiar 4 – Very Familiar 5 – Expert

SN		1	2	3	4	5
1	How familiar are you with the smart city concept?					

4. Considering Kumasi City now, do you think it has the propensity of becoming smart, and being dubbed a smart city?

a. Yes ☐ b. No ☐

5. What is your attitude towards smart city projects? (Tick as many as applies which are not conflicting) You think …

a. It would be so expensive, so we should not endeavor ☐

b. It would not change things anyway ☐

c. It could be expensive initially, but long-term benefit would outweigh its initial cost ☐

d. In the short term it will reduce unemployment, and in the long term increase the economy of the city ☐

e. It could lead to urban sustainability and should be strongly undertaken ☐

f. Others (Specify) ……………………………………………………

6. Smart City is mostly adopted because of its propensity of reducing urban problems and increasing sustainable development in all spheres (Social, Economic and Environmental), please do you agree or envisage this being the case?

a. Strongly Disagree ☐ b. Disagree ☐

c. Neutral ☐ d. Agree ☐

e. Strongly agree ☐

SECTION TWO

PART A: POSTERIORI FOR THE STUDY

As a validation for this study, it is important to first, identify the level of smartness of Kumasi City. However, there is no universally agreed approach in classifying a city as smart, notwithstanding, several researchers are of the view that using the six dimensions (characteristics) of smart cities could help in delineating the level of smartness, or the conceptualisation of the smart city concept.

Therefore, with your unrivalled personal experience and observations, please kindly rate these variables under each characteristic in contributing to making Kumasi City a smart city, by ticking where appropriately [√].

1 – Poor 2 – Good 3 – Better 4 – Excellent 5 – Champion

SN.	**SIX DIMENSIONS OF SMART CITIES**	1	2	3	4	5
1.0	***SMART PEOPLE (10/10 contribution)***					
P1	Good language skills of the citizens (English, Twi, French etc.)					
P2	Better understanding and usage of computers					
P3	Good reporting, reading and writing skills					
P4	Availability of soft skills in the region					
P5	Ability to manipulate and utilize data					
P6	Excellent schools and training institutes in the region					
P7	Willingness to learn and dedication to education					
P8	Level of creativity in the urban sector					
2.0	***SMART ECONOMY (9/10 contribution)***					
E1	High standard of living					
E2	Foreign/Domestic direct investment in the region					
E3	Destination that people want to visit (tourism)					
E4	The ability to innovate, and the spirit of entrepreneurialism and creativity					
E5	Flexibility of the labour market and high productivity					
E6	Ability to transform into the international market					
E7	Transformation from an urban economy to a smart economy					

E8	Resourceful in making most of its assets while finding solutions to problems					
3.0	***SMART MOBILITY (8/10 contribution)***					
M1	Sustainable transport systems (for people and goods)					
M2	Accident reduction on roads in the sector					
M3	Reduced or no traffic thronging					
M4	High density living; promoting high-speed mobility					
M5	Seamless mobility for differently-abled people					
M6	Improved walkability and cycling in the region					
M7	Mass rapid transit system (locally and internationally accessible)					
M8	Integrated high-mobility, linking areas together (residential to work places to recreational, to transport notes e.g. bus/railway stations and airports)					
4.0	***SMART ENVIRONMENT (7/10 contribution)***					
E1	Warning system for natural disasters e.g. Earthquakes, Flooding etc.					
E2	Practicing good sewage and waste disposal systems					
E3	Promoting outdoor living and green spaces					
E4	Greenness and vegetation concerns of the place (practice afforestation and restrict deforestation)					
E5	Efficiently manages it natural resource base (water, land, and other resources)					
E6	Upholding natural heritage and a strong sense of place rooted in a natural setting					
E7	Preserving ecological system and sustaining biodiversity in the city region					
E8	Energy usage and controls in the city region					
5.0	***SMART GOVERNANCE (6/10 contribution)***					
G1	Smart Administration (focusing on sustainable urban development)					
G2	Smart Urban Collaborations (Government, Businesses/Industry and Academia)					
G3	Smart Decision Making (Adopting spatial decision support systems, big data and geospatial technologies)					
G4	Smart Governance and management policies					
G5	Openness to the public (Accountability, Responsiveness and Transparency)					
G6	Incorporating citizens in its operations					
G7	Constantly innovating practicing e-governance and e-democracy to achieve better development outcomes					
G8	Practicing urban and regional planning and integration					
6.0	***SMART LIVING (5/10 contribution)***					
L1	Good health system					

L2	Promotes quality living					
L3	Celebrating local history, festivals, promotes art, culture and has a ritual event					
L4	Plenty and healthy foods					
L5	Good and satisfying social services					
L6	Personal safety and security of the place					
L7	Promoting a strong and shared values					
L8	Availability of public amenities and a vibrant downtown 24/7					

Note: The various dimensions of smart cities have been given ratings. These ratings were obtained through a qualitative literature review study of how several researchers agrees or evince of the individual dimensions to the creation of smart cities.

PART B: KEY SUSTAINABLE DEVELOPMENT FACTORS OF SMART CITIES

The key sustainable development factors are those factors which were determined from literature, that through empirical studies have been labelled to be aspects of smart cities which ensures or leads the concept in achieving sustainable development.

Therefore, falling on your matchless experience in urban sustainability, kindly rank these variables in their contribution to ensuring sustainable development of the smart city concept, by ticking where appropriately [√].

1 – Not Important **2 – Less Important** **3 – Moderately Important**
4 – Important **5 – Very Important**

SN.	SUSTAINABLE DEVELOPMENT FACTORS	Level of Importance				
		1	**2**	**3**	**4**	**5**
1.	The usage of smart metering					
2.	The adoption of smart waste disposal					
3.	The scalability of smart energy grids usages					
4.	Security cameras, imbedded sensors and checkpoints					
5.	Smart construction to reduce energy and waste during construction					
6.	Smart homes and encouraging Net Zero Energy buildings					
7.	Improved recyclable and reusable water treatment systems					
8.	Efficient and planned management of natural resources and biodiversity					
9.	Measures in place to improving the quality of life of citizens e.g.: recreational and social services					
10.	Creating an enabling environment for business growth					
11.	Enhanced health access, but at reduced cost					

12.	An integrative, efficient and easily accessible transport systems					
13.	Efficient and working telecommunications networks and other utilities					
14.	Measures and initiatives to combat and control climate change					
15.	Provision of an open, transparent and efficient governance					
16.	Equality in the sharing of benefits of common good					
17.	Good, quality and affordable education and training for all					
18.	Adopting renewable energy sources (Solar, Wind mill, Geothermal etc.), and reducing GHG emissions					
19.	Empowering citizens participation					
20.	Promoting the development of culture through network infrastructures and enabling social inclusion of several different cultures					
21.	Diversified policies for managing spatial distribution of population and internal migrations					
22.	Encouraging the use of public transport systems through an enhanced and efficient mobility within the city					
23.	Planned greenness and sustainable environment					
24.	Adopting holistic approaches which nurtures income and employment opportunities for citizens					
25.	Promoting the availability of cheaper products and empowering consumption levels in cities					
26.	Enhance the achievement of highly technological and creative industries in the long term					
27.	Enabling the development of business models, and maximising social and relational capital					
	Any Other, Please State and Rank					

PART C: MILITATING FACTORS OF SUSTAINABLE DEVELOPMENT OF SMART CITIES

In an effort to realising the key sustainable development factors of smart cities in developing countries, some factors became evident from literature which influences, prevents or affects the realisation and scalability of the sustainable development factors of smart cities. These factors are called the militating or challenging factors of sustainable development of smart cities.

Therefore, falling on your rich experience with policies, urban sustainability and urban development, kindly rank these variables in accordance to how they act as barriers to the realisation of sustainable development factors of smart cities, by ticking where appropriately [√].

1 – Strongly Disagree **2 – Disagree** **3 – Neutral** **4 – Agree**

5 – Strongly Agree

SN.	**MILITATING/CHALLENGING FACTORS OF SUSTAINABLE DEVELOPMENT**	**Level of Agreement**				
		1	**2**	**3**	**4**	**5**
1.	Lack of requisite skills, research and innovation to improve the knowledge economy					
2.	The propensity of shifting towards post-politics					
3.	Lack of proper procurement route for smart city projects					
4.	The possibility for urban primacy in our urban space					
5.	Lack of preparedness on the side of government					
6.	Lack of technically and vocationally trained skilled workers					
7.	The propensity of becoming too technological without actually solving problems					
8.	Depoliticising the genuine concept of city improvement from cankerous ambitions of politicians					
9.	Lack of proper plan, frameworks and validation of performance to global standards					
10.	Lack of scalability and documented transferability of the smart city concept					
11.	Improper plans for integrating sustainable development factors into smart city concepts					
12.	Lack of practical application of some of the sustainable smart city concept (too focused on virtual environment)					
13.	The financial inclusiveness associated with the creation of smart cities					
14.	Difficulty in binding developers and users of sustainable development standards incorporated					
15.	Reactions from cultural influences and backlog					

16.	Conflicting interest of several stakeholders in the sustainable smart city concept					
17.	Balancing the three dimensions of sustainable development					
	Any Other, Please State and Rank					

PART D: CRITICAL SUCCESS FACTORS OF SUSTAINABLE DEVELOPMENT OF SMART CITIES

The critical success factors of sustainable development of smart cities are those factors which are very important and critical in ensuring that our urban conurbations become sustainable when the smart city concept is adopted. Hence, they are those few, but majorly significant areas which needs to be improved to ensure the success of achieving a sustainable smart city.

Therefore, inferring from your nonpareil experience in smart cities, urban sustainability and critical success factors identification, please, kindly rank these identified variable in order of significance in ensuring the success of having a sustainable smart city if they are well effected and improved, by ticking where appropriately [√].

1 – Not Significant **2 – Less Significant** **3 – Moderately Significant**
4 – Significant **5 – Very Significant**

SN.	**CRITICAL SUCCESS FACTORS**	**Level of Significance**				
		1	**2**	**3**	**4**	**5**
1.	Implementing efficient, cleaner and sustainable operations to minimize environmental footprints					
2.	Incorporating resource efficiency from onset					
3.	Regenerating ageing districts and ensuring robustness of systems in urban space					
4.	Practising the sharing of growth equally and sustainably in urban areas					
5.	Transition to a carbon free economy					
6.	Enhancing the usage of sensors and actuators for improving smart mobility					
7.	Incorporating green technologies in the transformation of our urban space					
8.	Developing an effective Public Private Partnership which shape models, add value and incorporate emerging technologies in smart city systems					
9.	Incorporating design and planning in symphony with the environment					

10.	Obtaining and maintaining data (Big data analytics)					
11.	Developing policies to promote comprehensive and impartial urban and rural development					
12.	Adopting an efficient, reliable and low carbon technologies					
13.	Proper planning and management of the population within the limited environment					
14.	Enabling environment for continuous learning					
15.	Development of smart grids and usage of smart metering to ensure sustainable smart energy					
16.	Setting clear non-conflicting rules which differentiate urban government from politics					
17.	Creating mechanisms which lead to autonomous and administrative control of inhabitants in smart cities					
18.	Shaping value added business models, and integrating disparate technologies in a productive system					
19.	Intentionally going beyond or averse of the smart city concept on technology					
20.	Improving educational lag especially in relation to ICT and technology usage					
21.	Incorporating the Internet of Things (IOT) principle					
22.	Ensuring the use of technology, management and organisation, and development and implementation of policies					
23.	Involving citizens, and ensuring an efficient vibrant economy					
24.	Ensuring an open and transparent governance					
25.	Incorporating smart built infrastructures in general					
	Any Other, Please State and Rank					

Any further comments? Please, kindly indicate below

………………………………………………………………………………………………
………………………………………………………………………………………………
……………………………………………………………………………………………….

THANK YOU!