

# SMART CITY

The Lagos potential

## Abstract

Author(s) Apanishile Johnson	Type of publication Bachelor's thesis	Published Spring 2019
	Number of pages 32	
Title of publication <b>Smart City, The Lagos potential</b>		
Name of Degree Bachelor of Business Administration		
Abstract <p>Smart city initiatives have seen a rise in the years as a methodology to identify the problems that comes with a growing urban population. The 21<sup>st</sup> century has witnessed massive urbanization with major cities seeing double its population. This has its effects on the city with pollution, environmental change amongst a list of many challenges being faced. With new technological advantages at hand many cities are turning to smart solutions as a way of handling this growing population now and in the future. This paper examines the concept as a development approach to city challenges and reviews one of its domain 'smart mobility' in the light of transportation challenges in Lagos city It is discovered that application of the concept in Lagos, Nigeria will be limited by the level of ICT infrastructure, absent of a national policy guideline and poor investment in transport infrastructure. The paper recommends development of a national guideline for integrated transport development; establishment of a city structure that will coordinate and promote stakeholders and investment with innovative funding that will support ICT-infrastructure.</p>		
Keywords Smart city, Lagos, Transportation, urbanization		

## CONTENTS

1	INTRODUCTION .....	1
1.1	Research approach .....	1
1.2	Research questions.....	1
1.3	Research method .....	2
1.4	Thesis structure.....	2
2	SMART CITY.....	4
2.1	What is a Smart City?.....	4
2.2	Types of Smart cities.....	5
2.3	Subdivision of a smart city.....	5
2.4	Smart city keywords .....	8
2.5	Why Smart city? .....	10
3	FRAMEWORK.....	12
3.1	Smart Cities Project ideas template .....	12
3.2	Identifying city challenges .....	13
3.2.1	Mobility Challenges .....	14
3.2.2	Governance Challenge .....	14
3.2.3	People Challenge.....	15
3.2.4	Living Challenges.....	16
3.2.5	Environmental Challenges .....	17
3.2.6	Economic Challenges .....	17
3.2.7	Relevance Dimension table .....	18
3.3	Projects development Principles and Guidelines .....	20
3.4	Stakeholders Involvement.....	23
4	CASE STUDY: LAGOS, NIGERIA .....	24
4.1	Lagos Transportation .....	24
4.2	Mobility Solution .....	25
4.2.1	Introducing electric transportation .....	25
4.2.2	Utilising data and IoT in transportation networks .....	26
5	CONCLUSIONS .....	29
	LIST OF REFERENCES.....	30
	APPENDICES.....	33

# 1 INTRODUCTION

The world as we know it is evolving rapidly. One big name when it comes to this evolutionary growth is urbanization. More than half of the world's population, 3.5 billion people, live in urban areas and by 2030 this will see a 60% rise (UN, 2015). Cities has seen a rise in population and a projected increase soon, this is due to the high economic growth and for a better life in general as compared to rural settlements. This increase in population has its advantages but its down sides are hard to shy away from, an increase in traffic congestion, pollution, lack of housing amongst a list of others. Historically humans have always searched for several ways to boost information, make it faster, simplified, easier to move around for human satisfaction thus creating the era of information and with that smart devices. These devices form a connection between themselves wherever they are setup whether at home, in the office, the streets or in a cities transport system. Solutions have been introduced by technology companies to provide city sustainability and make living better for citizens through the idea of a smart city.

This thesis discusses the concept of a smart city and based on several projects and frameworks examining how to identify smart challenges and guidelines to implementation of smart city projects. This study is specifically on Lagos and its challenges in the mobility sector and suggested smart solutions.

## 1.1 Research approach

Lagos in Nigeria is facing an uncomfortable growth in population due to urbanization. As much as the population growth in a region projects economic advantage with Lagos being one of the top economies in Africa, this growth tends to create problems which have probably been in existence. This study aims to highlight the importance of smart city and smart city solution in a city's core structure.

## 1.2 Research questions

The thesis focuses on answering the following research questions:

- What is a smart city?
- What does the concept of the smart city mean to city urbanization?
- How can knowledge from smart city frameworks provide a solution to challenges in Lagos, Nigeria?

### 1.3 Research method

There are two frequently used research approaches:

- Quantitative method
- Qualitative method

Quantitative research methods deal with numerical variables, findings and statistical type of data analysis which could be obtained through surveys polls and its major goal is determining between several factors.

Qualitative research method focuses on understanding a research problem, this usually requires in-depth study and a view of the problem from several perspectives with a common example being interviews.

This thesis combines both methods due to its wide context and complexity, the qualitative aspect required study of several smart cities and frameworks for identifying challenges and solutions. The thesis collects quantitative data through a survey sent to citizens of Lagos. The survey asks the respondents to rate the severity of certain problems identified based on the qualitative part of the research. The survey was constructed via Google Forms and sent and links and responses are statistically recorded.

### 1.4 Thesis structure

This thesis is divided into the following six (6) chapters:

- Introduction
- Research method
- Smart city
- Framework
- Lagos Nigeria
- Conclusion

The introduction briefly discusses urbanization, smart city problems and solutions. The second chapter discusses its research method, its research question and how the rest of the thesis will be structured and written. The third chapter discusses smart city as a concept and what it entails, why it should be considered by possibly every major city and place. The fourth chapter looks at frameworks from several smart projects and how to identify smart

challenges and guidelines to smart implementation. Chapter five shows Lagos Nigeria as a case study and highlight a few suggested smart solutions. The sixth chapter concludes the thesis. Figure 1 illustrates the structure of this thesis and its stages.

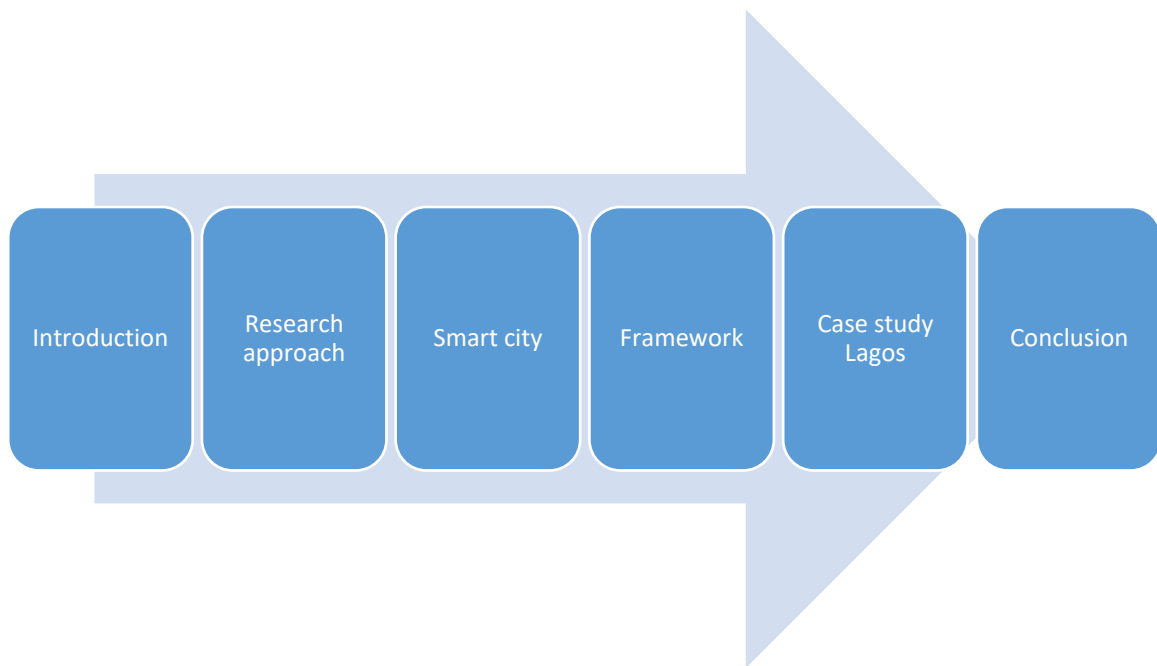


Figure 1 Thesis structure.

As depicted in Figure 1, the thesis consists of six sections: Introduction, Research approach, Smart city, Framework, Case study Lagos, Conclusion.

## 2 SMART CITY

### 2.1 What is a Smart City?

The common use of smart devices in recent time gives an idea of its importance in everyday activities, with the press of a button you could communicate with people miles away, get the fastest route to a location and lots more. This tells us to a level why it is labeled as smart. So, what makes a city to be called a smart city?

To get to the root of what a smart city is or what it entails we must understand what smart technology means. These are physical or logical application system of all formats which accepts and provide data with a purpose of analyzing and learning thus, making it capable to adapt and modify its behavior to fit its environment (IGI global dictionary 2019). There are known to be several perspectives for what a smart city is and what its focuses are, there are no specific definitions, an idea with unlimited possibilities and no end point just continuous processes. According to Rode (2017) *“The smart city concept has been in use since the 90’s. then it was mainly about ecologically sensitive and human oriented urban development and was closely linked to the environment agenda. This changed in 2008 when we began to use the word “smart” in the context of digital technology”*. The Centreforcities (2014) classified smart city definitions into three as follows:

- Broad definition

“The effective integration of physical, digital and human systems in the built environment to deliver sustainable, prosperous and inclusive future for its citizens” (BSI 2014)

- Data-driven definition

“One that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources” (Cosgrove & AI 2011).

- Citizen focused definition

“A ‘smart city’ means ‘smart citizens’ – where citizens have all the information, they need to make informed choices about their lifestyle, work and travel options” (MDDA 2019)

A general definition of a Smart city is any location rural or urban which (tries to) identifies and solve current and future issues using technological aids with a general purpose of sustainability for its residents.

## 2.2 Types of Smart cities

According to Cohen (2015), smart cities can be divided into three major categories

- Technology driven (Smart cities 1.0)

This are smart cities which focuses on a technology centered environment which appeals to urban technology innovators. They are built based on technology solutions from technology organization aiming on providing a competitive advantage in the technology growing industries.

- Technology enabled (Smart city 2.0)

Technology enabled smart cities focuses on solutions which should improve quality of living and usually introduced by city government bodies. They are infrastructure centered cities. Most leading cities tend to fall under smart city 2.0.

- Citizen co-creation (Smart cities 3.0)

Smart city 3.0 introduces a new category which focuses more on creating smart models based on its citizens needs and improving quality of living. Providing more environmentally friendly and cost-efficient solutions.

## 2.3 Subdivision of a smart city

Smart city projects consist of many factors and implementation. This are better simplified based on frameworks and subdivision for easy progression tracking and identifying good starting points. Smart city frameworks consist of six (6) major areas (Giffinger et al. 2007, 11):



- Smart people

Smart people comprise and focuses directly on its residence, its health care system, population sensors, education system, security, housing (Somayya & Ramaswamy, 2014, 40).

- Smart economy

Smart economy put the cities economic growth in constant check, easily tracking any declines and pointing out its sources. Smart economy provides an economic competitiveness as well as green environment (Somayya & Ramaswamy, 2014, 39).

- Smart environment

Smart environment consists of a city's all-round infrastructure, its physical components from street lights, buildings, waste management system, water and power supply system. With key concept such as IOT and a good information system structure connecting them its evident that this would provide good living conditions in numerous ways (Deleawe 2010, 145-152; Somayya & Ramaswamy, 2014, 39-40)

- Smart governance

Smart governance is "the capacity of employing intelligent and adaptive acts and activities of looking after and making decisions about something" (Scholl & Alawadhi 2016, 22). smart implementations also assist governance in so many ways making information communication systems as a framework for transparent decision making which is based on improving the general quality of living (Somayya & Ramaswamy 2014, 41).

- Smart living

This involves creating an improved standard of living for its citizens everyday lives, from residence to working environment and even movement (transportation). This concept doesn't just involve mega structures but building cost, energy efficient and green based infrastructures. With the increasing population of residence in cities smart living solutions are essential in preventing a residential melt down (Somayya & Ramaswamy 2014, 40).

- Smart mobility

This could also be referred to as smart transportation system or intelligent transportation system (ITS), it involves all known transportation such as railway networks, road systems, airline as well as water transportation. Smart mobility gives room to create and manages each system individually as well as connecting with other networks and

infrastructure (e.g. vehicle to vehicle and railway to traffic light). A primary aim of implementing smart transportation system should be to reduce the use of private vehicles thereby reducing air pollution and risk of accidents. (Somayya & Ramaswamy, 2014)

A view into this different dimension of smart city makes it less bulky by giving an option to set focus on one or two of this area depending on the major goal or solution in which the smart city program is set up to solve in the first place.

Figure 2 shows the subdivisions of smart city and the technological connection that binds them together. This subdivision collectively represents the list of other termed smart subdivisions but usually classified under one of the following below.

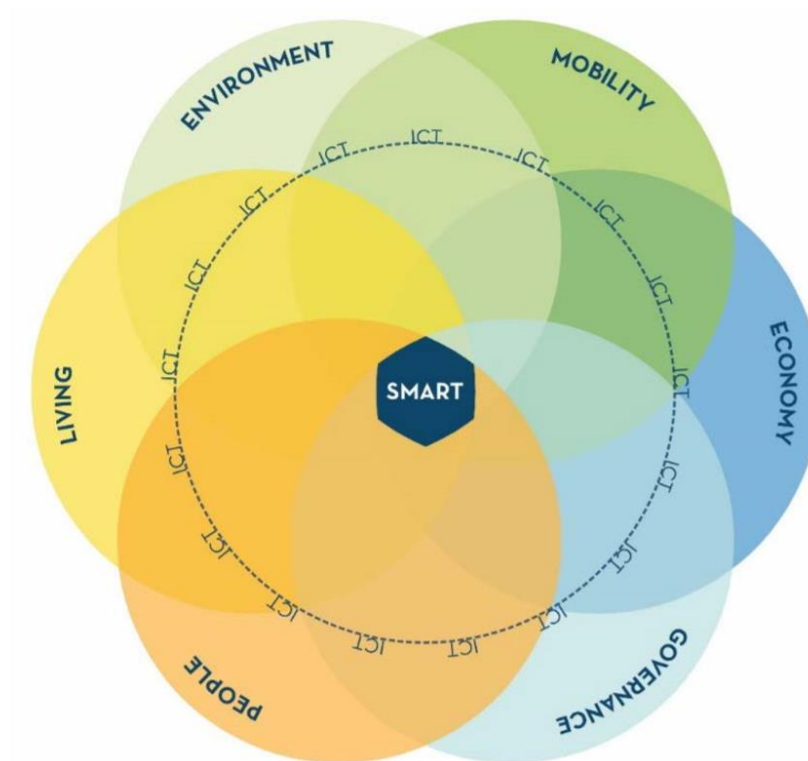


Figure 2 Smart city subdivision (ASCIMER, 2016)

As shown in Figure 2, the subdivision collectively represents the list of other termed smart subdivisions but usually classified under one of the following above.

## 2.4 Smart city keywords

The concept of smart city has numerous factors and technological terms involved, with past and present implementations and evolution on various smart city build up there seem to be very clear bodies involved all connecting to each other like building blocks to the smart city wall (Ismail 2018; The open university 2018). The following are key terms related to the concept of the smart city:

- IOT (Internet of things): the concept of IoT just as smart city has evolved since it was first introduced in 1999 by Kelvin Ashton, the co-founder of the Auto-ID centre at MIT. This termed was incorporated to a once uprising term called the internet. IoT plainly deals with the creation, collection, analysis of data between devices (mechanical or digital) over a network without human interaction (human to human or human to device). A major concept and evolutionary view of this is the M2M communication (machine to machine communication), this required machines system to connect and manage data between themselves. IoT introduces a sensor-based network which provides data connection to smart devices. (Meola 2016)

Figure 3 depicts the IoT applications and its branches.

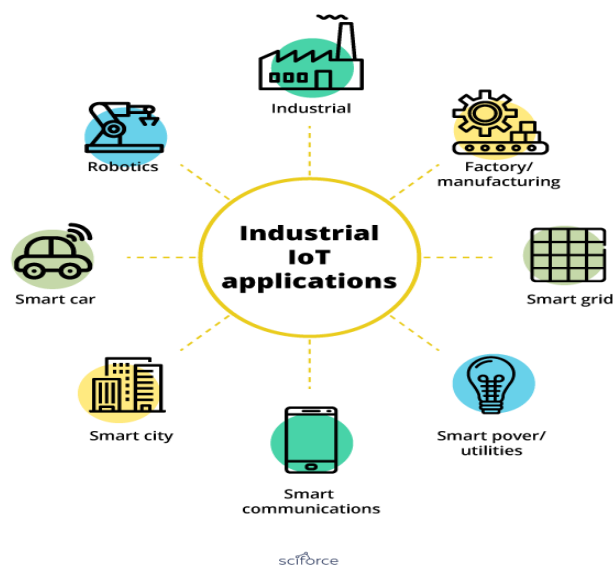


Figure 3. IOT direct connection to smart development (Sciforce 2019)

As illustrated in Figure 3, the connection between internet of things and smart devices and systems. Smart city most successfully implement working IoT system to manage a smart city.

- Data: this is a raw form of information, which is collected for analysis or review purposes. Data is an important factor for modernization or improvement thus used by huge range of institutions, organizations and research firms. Data is collected, measured, analysed and reported and can be used by both human processing and machine. Figure 4 shows two types of data distribution, open and closed.

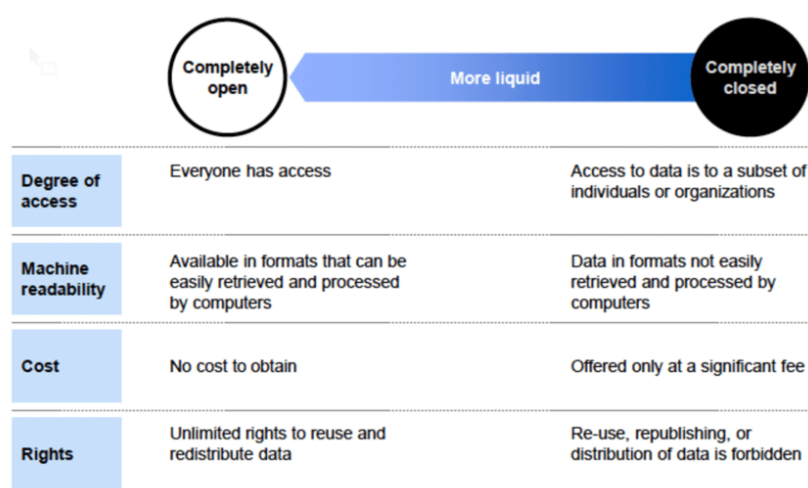


Figure 4. Types of data (McKinsey Global institute)

Figure 4 illustrates data and related access levels. Open and closed data are necessary in smart city development and its vital to understand how and why it should be accessed.

- Digitalization: this involves the conversation of information or processes into computer readable forms or formats (digital).
- Information system (IS): “An information system can be an organized combination of people, hardware, software, communication network, data resources and policies and procedures that stores, retrieves, transforms and disseminates information in an organization” (O'Brien & Marakas 2008). Information system creates framework and means to which the previously listed terms are used efficiently this is not to say that information system is technologically based and thus must be used with computer systems, an example is a log book or catalogue for employees in a workplace where manual records of work times and days are recorded by employee names, dates, clock in and clock out which can be easily accessed by supervisors.

## 2.5 Why Smart city?

Figure 5 shows the population of people living in urban locations around the world and a projected increase by 2030 (UN 2015).



Figure 5. World's population of urbanization by 2030 (UN 2015)

As depicted in Figure 5, the populations increase which shows an immediate need for management of resources.

Major cities and states have seen a massive increase in population in the past years and possibly will even get more populated in future times to come. An example is Lagos Nigeria which has seen a tremendous population growth, with an estimated twenty-one million (21 million) since as recent as 1970 which was then 1.4 million and its estimated to increase with a growth rate of 3.4% every 5 years (World population review 2018).

Another major example is London which saw a population growth from 6.8 million to 7.15 million by 1999 and continued to increase to 8.77 million people in 2017 and is estimated to reach about 10 million by 2041. London's gross value in the United Kingdom was seen an increase in numbers from the year 2000 to 2017, almost doubling in figures with over 421 billion British pounds in 2017 (Statista 2019). London is one of the top known smart cities, it has laid focus on its transportation system making its citizens utilize public transportation and decrease the consumption of fossil fuels. In this scenario smart transportation, smart people and smart economy solutions are being implementation not to talk about its

numerous smart city projects like smart underground parking services and its large free Wi-Fi network systems which are projected to be Europe's largest (Luciano 2017).

Major cities tend to be the centre of major business venture and opportunities. Thus, they are an ever-increasing population which means more consumption of resources, traffic congestion, increase in crimes, more housing demands and waste generation amongst many others. This has changed the ideology of smart cities frameworks from smart city 1.0 to smart city 3.0 as 3.0 tends to focus more on the current and future problems of its citizens instead of its previous version which were focused on a competitive edge (Cohen 2015), but this is not to say they don't automatically build a competitive edge in the process.

In 2009, one of the biggest known smart city campaigns was launched by the international business machines corporation (IBM) a year after an ongoing global economic crisis which led to the great recession (The balance 2019). The goal of this campaign was to come up with solutions and new ways to save and manage resources, thus saving money and improving citizens' quality of living as well as counter measuring future recessions with the help of the fast-growing interconnected information systems. Currently numerous smart city plans are underway in various countries such as India. India targets development of 100 cities across the country and aim on a sustainable and citizen friendly environment (IBM 2019).

## 3 FRAMEWORK

This chapter puts together several ideas and frameworks of smart city projects and guidelines, which act as a benchmark of establishing smart project ideas, identifying city challenges and calculating city relevance, identifying stakeholders involved and the possible role they play in such projects. In the next chapter a suggested smart solution is made based on details from this framework research. The following templates and framework are from the ASCIMER (Assessing smart city initiatives for the Mediterranean Region) project whose aim was to construct a comprehensive Smart city framework which will aid in smart city investment strategies as well as build skills for evaluation and prioritization of similar projects. Templates from the open university smart city course by Dr Lorraine Hudson and Professor Gerd Kortuem are also included in providing smart city project plans. This framework will be used to classify urban challenges which will be provided as a survey which will be directed to the citizen of Lagos to rank severity of those challenges, the results from citizens of Lagos will provide a personal view on the relevance of smart city challenges and suggested solutions. The solution suggestion will be provided in the next chapter case study.

### 3.1 Smart Cities Project ideas template

The smart project idea template is set up to give a structure on smart city projects. Smart city projects take a lot of time for planning because their structures are so complex an interchange in later stages.

Table 1 helps in noting down plans, discoveries, reflections and ideas which are drafted towards a project.

Table 1 smart project idea template (Hudson &amp; Kortuem 2017)

Design thinking stage	Questions	Ideas
Empathise	What challenges does the city face now?	<ul style="list-style-type: none"> <li>• Identification of smart city dimension in a city</li> <li>• Identification of current and past city issues which has not yet been solved</li> <li>• Breaking down challenges based on smart city dimensions</li> </ul>
	What challenges will they face in future years to come	<ul style="list-style-type: none"> <li>• Open data sources for predictions</li> <li>• Increase in urbanization and its effects</li> </ul>
define	Define the city problem	<ul style="list-style-type: none"> <li>• Asking the citizens</li> </ul>
	Who is impacted by this problem?	<ul style="list-style-type: none"> <li>• Stakeholders?</li> <li>• Citizens</li> </ul>
ideate	What ideas are to be place for a solution	<ul style="list-style-type: none"> <li>• Smart solution based on smart city relevance</li> <li>• Sorting out problems and therefore making solutions specific</li> <li>• Establishing solution structure for implementation</li> </ul>
	What are the parties involved for solution execution	<ul style="list-style-type: none"> <li>• Citizen involvement</li> <li>• Governmental involvement</li> <li>• Investors</li> </ul>

### 3.2 Identifying city challenges

Smart cities are built on the idea of providing growth and functionality for a city and its surroundings. This involves setting reachable goals and identifying current or possible futuristic challenges to this goal. A city must create a board which brings together stakeholders and governmental bodies as well as various classes of citizen to view this together (ASCIMER 2016). Based on the ASCIMER approach Urban challenges are obtained and subdivided and grouped based on the dimension of the smart city and the concept which is agreed to be used. Information from the various challenges are gathered from numerous sources such as international organizations, governmental organizations, environmental survey (field visits), citizen survey and researchers. For the purpose of this framework, general and common challenges as well as its relevance will be collected based on



research sources and results from questionnaires from the general public (residents of Lagos, Nigeria).

### 3.2.1 Mobility Challenges

As urban growth continues to rise in the west African region and all over the world, it is indeed important to point out mobility challenges which will be faced especially when considering smart solutions.

Table 2 suggests a list of challenges which are encountered in Lagos transportation system.

Table 2 Mobility challenges

Lack of transportation models	Fluidity of movement is must sort when it comes to urban transportation. Several transport systems which should be accessible and enable connectivity to all parts of the city and this requires implementation of new transportation modes, road networks and policies. (Badejo 2011)
Increase in private vehicle usage	An increase in privately owned vehicles is a result of poor public transportation systems and therefore brings a challenge. It increases the rate of traffic congestion and carbon emissions. (Taiwo 2013; Badejo 2011)
pollution	Air, water and land pollution due to mobility models and resource management models pose a serious threat to a city's surroundings (Taiwo 2013)
Infrastructure deficit	Systems are in awful upkeep conditions and don't offer the important ability to fulfill the requests of the Citizens. It is important to advance the reestablishment and improvement of the current systems for portability (street systems and rail frameworks), vitality circulation, ICT systems, water supply and treatment, and waste management organization (George 2012)

### 3.2.2 Governance Challenge

Governance challenges in developing countries are closely linked together. The unsteadiness of the establishments, their low limits and the current hole among them and the natives are issues that guarantee for a restoration in the administration models. The connection between the Government and the administered must be built to be stronger through instruments like support, yet additionally by the acknowledgment of the requirements of citizens furthermore, the inclusion that social administrations must give. The spatial circulation of

the governmental powers and the advancement of urban areas turns out to be additionally an essential issue that urban communities of the Region must accomplish (Meijer & Bolivar 2015). Table 3 suggests a list of challenges which are encountered in Lagos Governance system.

Table 3 Governance challenges

The gap between the government and the governed	The gap between the leadership and the citizens with respect to financial, political and social perspectives must be brought closer. City Residents tend to seek more inclusion in the way things are governed and tend to want to control their resources. a more inclusive network will greatly improve communication that lasts.
Inadequate urban institutional capacities	Frameworks of urban administration in the Region present shortcomings in formal foundations (and a general shortcoming in informal governance). They have a solid requirement for satisfactory frameworks of land use, movement authorizing, and lodging showcase the executives unhampered by administration. Enhancements in administration the executives are required, just as adaptability to react to mainstream requests with the fundamental speed and readiness.  Other related issues are the absence of precision in information accumulation. Centralization more often brings a few municipally based capabilities and services to the hands of the national governments.
Lack of institutional coordination	In numerous Developing nations the power conveyance between Federal Governments and Local governments is excessively unequal;  Local Governments don't have enough power and Authority locale to order self-governing activity on Smart City ventures. Absence of institutional coordination is additionally a test at a few scales, both among the distinctive Levels of government (Federal, State and local experts) and furthermore among city areas.
Instability in Governance	Cities have played a key role and can be directly affected by the new democratic spaces that have been opened."

### 3.2.3 People Challenge

The People challenge is the one that is increasingly identified with growing societies. Difficulties identified with this measurement include inequality issues, education and cultural differences. Reducing the distinctions and improving the quality in the access to information, education, innovation and the financial resources continues the difficulties urban communities in the locale must face (ASCIMER 2016).

Table 4 suggests a list of challenges which are encountered or predicted to be problematic in the future.

Table 4 People challenges

The threat of a loss of Cultural Identity	Landscape and architectural planning are what are commonly used to identify cities, there is a need to promote an environment that citizens can relate with. Traditional activities should be persevered and promoted.
Lack of digital skills and low educational levels	Continuous self-learning and skill acquisition needs an enabling environment. These are lacking in developing countries. All Levels of education needs to be increased in other to tap into the community's development potentials. Furthermore, the need for digital skills and capacity building is needed to encourage more inclusion
Poverty gap between Rural and Urban dwellings	High inequality exists in many developing nations. Fewer opportunities and lack of employment are on the rise this is evident in the increase in the poverty line. This has led to having a strong disparity in cities.
Societal flexibility	Societal communities are strictly characterized and are very rigid to change, this influencing the vision of things to come among youth and coming generations. This isn't just an issue of Current reality (inequality) however, with respect to the likelihood of progress influencing the vision of things to come among youth and coming generations.

### 3.2.4 Living Challenges

Table 5 depicts the basic government requirement of living which tend to be lacking in key areas. A huge percentage of Lagos citizens work in private companies or set up self-owned business and the living wages are reported to be insufficient (Wagesindicator 2016).

Table 5 Living challenges

Lack of recreational facilities	Cities which have been built with citizens having less free time and leisure facilities have been known to have negative effects on social interaction among each other. This needs to be improved to develop a healthier lifestyle and improve a more social sustainability in general.
Access to information	There is a clear gap between access to information due to the lack of available media. There is also a gap in the way information is passed among various levels of government.
Lack of social services	To create better working and living conditions there is a need to improve the social services. Cultural changes and demographics in developing nations require an improvement in order to improve social sustainability. (Wagesindicator 2016)

Rising Urban Insecurity and Violence	The rising violence and insecurity in urbanized cities are factors that must be greatly considered. social insecurity may have negative impacts of the quality of life of its residents. Good social policies need to be applied to address such issues.
--------------------------------------	--

### 3.2.5 Environmental Challenges

Environmental changes are not to be neglected. Human population growth increases the need for environmental awareness and people induced problems like pollution and lack of maintenance of resources. Table 6 shows challenges which form a core for restricting and making plans for environmental preservation.

Table 6 Environment challenges

Lack of participation, engagement and awareness	Having lack of engagement and awareness among the population leads to insufficient involvement and participation. Communication, which is key to solve any challenges in the city, needs political assisted programs.
Climate Change	Globally rising temperature leads to water problems and desertification, urban development's plans need to consider the adverse effect of extreme weather, droughts and floods
Lack of recycling management	There is a need to improve the efficiency in the management of water, energy and water in cities. Cities need to adopt plans that optimized storage and supply of resources
Fast rising urbanization	Cities are being pushed above their limits in a very rapid process. This is in opposition to the natural process that older cities where built on. The migration from the rural to the urban area puts a lot of strain on the resources. This calls for a more delicate attention to the effects that such damaging effects have on the environment. Attending to such issues will also improve minimize the cultural values and economic inequalities.

### 3.2.6 Economic Challenges

The economic challenges deal with issues encountered from the city's economic resources, access to employment, balancing its economical revenue between its regions. Table 7 lists the economic challenges.

Table 7 Economy challenges

Increase in Informal economy	Informal economy which accounts to bigger majority of developing nations due to its wide presences plays a critical role. Furthermore, basic opportunities are opened to the less educated and poor people. Regardless of whether it shouldn't be totally controlled, it must be considered when drawing closer the economic challenges for urban communities in the Region.
Low competitiveness and Economical weakness	It is important to make a progressively open and focused business condition and a progressively equivalent access to financing and employment or business openings. The financial advancement of the locale must turn into increasingly self-propelled by further investigation of existing qualities, the executive's advancements and new innovations for raising residential efficiency and pay age. The casualness and privately-run companies ought to be included in this procedure.
Unstable geographical development	With most of economic activities taking place within the large cities along the coast, there is a need to push for more balanced geographic development by the provisions of secondary cities. This is help in sustainability and help create a resilience to exogenous shocks from the main cities
Lack of access to technology	There is clearly access to basic services such as electricity and piped water in urban cities in developing countries. However much of the population have lower access the communication technologies. access to the digital education and skills needs to be improved. this a major challenge when planning smart city projects

### 3.2.7 Relevance Dimension table

The relevance dimension table involves data collection and scoring based on survey results from various participants, in this case study we focused on citizens of Lagos state Nigeria to evaluate the importance of this various challenges listed. This helps in planning out the implementation structure on which area should be concentrated on.

Table 8 shows the list of challenges and an average score of relevance vote by the citizens of Lagos Nigeria. The survey was based a 1-5 grading with the average from the total number of grades score divided by the total number of votes.

Table 8 Relevance table

SMART CHALLENGES		AVG. VALUE	AVG PER DIV
<b>MOBILITY</b>	Lack of transportation models	4.8	4.0
	Increase in private vehicle usage	3.5	
	pollution	3.8	
	Infrastructure deficit	3.8	
<b>PEOPLE</b>	The threat of a loss of Cultural Identity	4.0	3.9
	Lack of digital skills and low educational levels	3.8	
	Poverty gap between Rural and Urban dwellings	4.5	
	Societal flexibility	3.3	
<b>GOVERN- ANCE</b>	The gap between the government and the governed	4.6	4.4
	Inadequate urban institutional capacities	4.3	
	Lack of institutional coordination	4.0	
	Instability in Governance	4.6	
<b>LIVING</b>	Inadequate recreational facilities	3.6	3.7
	Access to information	3.3	
	Lack of social services	3.8	
	Rising Urban Insecurity and Violence	4.1	
<b>ENVIRON- MENT</b>	Lack of participation, engagement and awareness	3.6	3.9
	Climate Change	3.6	
	Lack of recycling management	4.3	
	Fast rising urbanization	4.0	
<b>ECONOMY</b>	Increase in informal economy	3.8	3.7
	Low competitiveness and Economical weakness	3.8	
	Unstable geographical development	3.6	

	Lack of access to technology	3.6	
--	------------------------------	-----	--

### 3.3 Projects development Principles and Guidelines

To keep it simple, smart city development is complicated. This is because it requires several stages and substages as well as several parties to be involved in its development. Identifying a cities challenges gives a narrow plain on what is to be focused on, but development guidelines covers layout processes.

Figure 6 illustrates a smart project development framework that shows the development stages and the importance of stakeholder's involvement in this process.

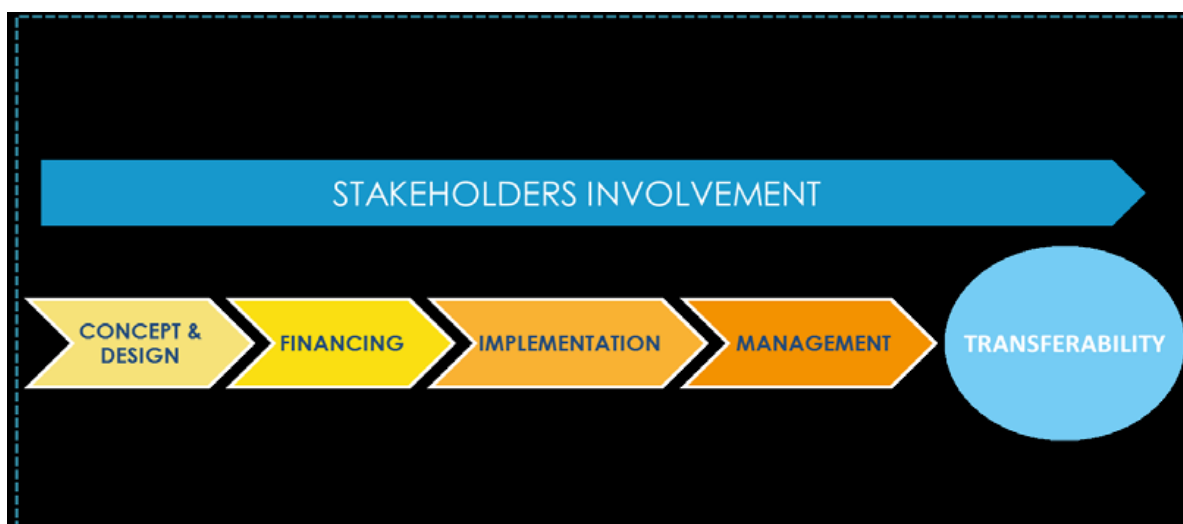


Figure 6 Stages of smart city project development (ASCIMER 2016)

In breaking down this step from ASCIMER (2016), the following key guides where established.

- Citizenship involvement:** Part of the idea of smart cities is to rise smart people along with it and make them the center focus of each project, this shows they are crucially involved in every division of smart city and their solution. Citizen at an early stage would favor their early participation in active projects and reduces risks of missing out on their benefits to this project (Granier & Kudo 2016).

- **Stakeholder involvement:** Stakeholders are the back bone of any project and its success is based on its stakeholder's management involvement in all stages of development to a certain project. Usually stakeholder have something to gain or lose from a project's life cycle, even citizens are stakeholders. In order to be on a similar footing stakeholder involved from the very beginning of a project. (Andrew & Samantha 2006)
- **Sustainability:** In all stages of smart city development, sustainability should be considered. Especially in terms of economic and environmental aspects. Smart projects must be developed to stand the test of time and other factors.
- **Innovation:** New ideas should always be considered and discussed on in every development phase. Introducing new concepts and tools along the way
- **Project monitoring and adaptive management:** massive projects such as this requires monitoring and documentations to track project development. This requires project management teams to be established and have monitoring guides in each phase
- **Knowledge transferability:** stakeholder ability to be flexible in terms of sharing and handling new information amongst themselves is a good sign of cooperation between several groups which probably see view differently.



Table 9 illustrates suggested stakeholders' involvement in smart city project development to further show their importance.

Table 9 Stakeholder involvement in project development (ASCIMER 2016).

	Concept and design	Financing	Implementation	management
<b>Citizenship involvement</b>	- social needs initiative driven - participation	-Transparency	-Citizen workforce	-citizen feedback -awareness
<b>Political institutions and Municipal government (Stakeholder involvement)</b>	-shared vision -leadership -new knowledge	-Support from institutions -governmental funding	-leadership -procurement	-framework coordination -establishing management department
<b>Financial Institutes Sustainability</b>	-profitability	-Financial stability	-Fair competition in fostering local development	-linking project stages together
<b>Research institutes Innovation</b>	-Private interest driven	-New mode and models of project financing	-Tools for implementation transparency and awareness	-procurement -continues update -adaptive management
<b>Project monitoring and adaptive management</b>	-Clear objectives -iterative design -Addressing challenges	-risk management	-monitoring implementation -risk management and contingency plans	- adaptive management -Monitoring
<b>Networking and social organizations Knowledge transferability</b>	-previous experience	-Continuous search for funding	-knowledge sharing in implementation phase	-capacity building in management phase.

### 3.4 Stakeholders Involvement

Governance plays a major role in a successful smart city development. One of the key governance steps is identifying stakeholders and their role to play in smart city development. Stakeholders are people or a body of people with interest or concern in a project, business or development. Without stakeholders a project will not exist. According to the ASIMER project, stakeholders are divided into two groups:

- Internal stakeholders: internal stakeholders are usually active within the city and would not function without the city's functionality. This consist of citizens, public servants, local economic, social and research department agencies. Citizens have been represented to be the core of smart city (Fernandez-Guell, 2016)
- External stakeholders: external stakeholders usual operate outside or have branches established, with a main aim for investment several service, such as re-search data, new knowledge, finance, technology innovation.

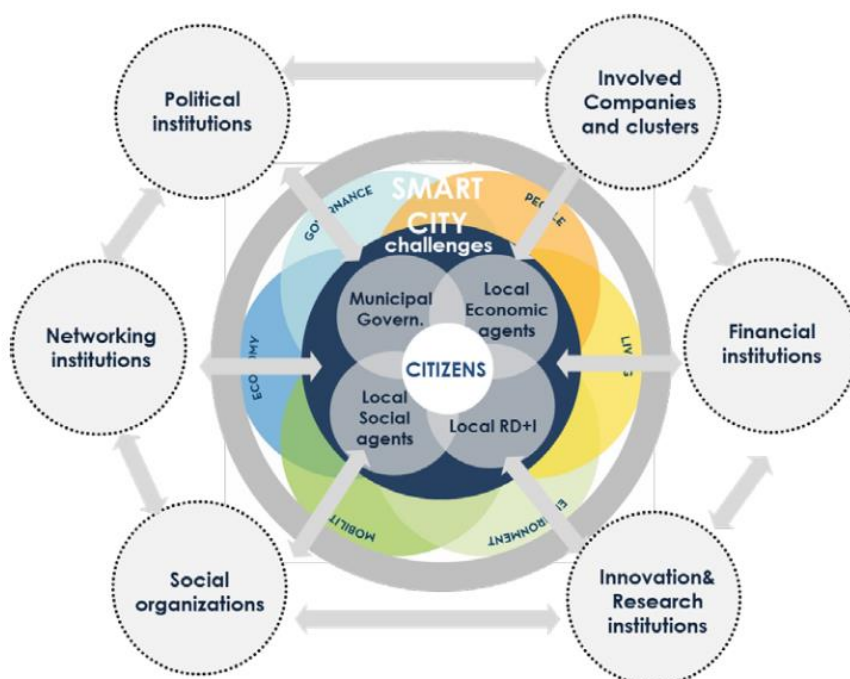


Figure 7. Internal and External stakeholders' representation (ASCIMER)

Figure 7 shows the representation of internal and external stakeholders in identifying smart city challenges and participating in its development process.

## 4 CASE STUDY: LAGOS, NIGERIA

Lagos is a port city and one of the most populous state in Nigeria. Being one the nation's largest industrial and commercial centres, it accounts for 65 percent of industrial and commercial activities (the world bank 2018). This attracts a large growth in its population which is estimated to increase by 5% every 5 years (world population review 2018). This comes with its numerous challenges which it faces, which makes living a struggle and sustainability a major complication presently and when smart solution is put in place. Lagos is one of the worlds fastest growing mage cities, third largest in the world but with fewer infrastructures than cities of its counterparts and an estimated half of Lagos population resides in the slum regions due to cheaper living expenditure amongst other factors.

Figure 8 shows a demographical statistic of Lagos population, economy and government.

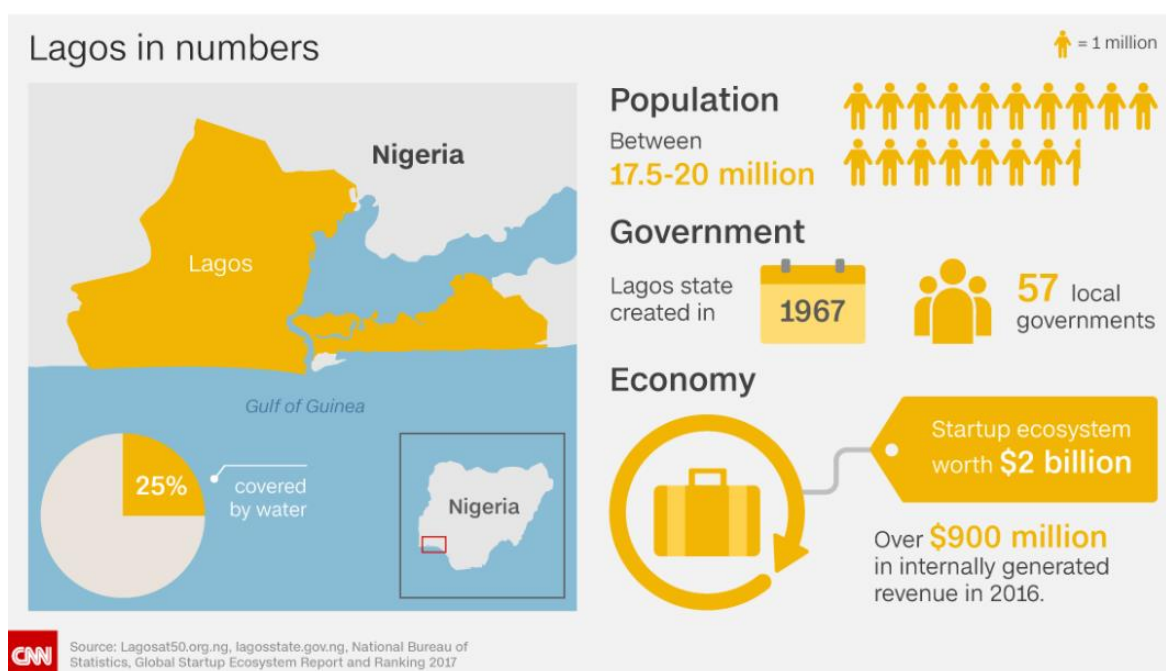


Figure 8. Lagos demographic (CNN 2017)

### 4.1 Lagos Transportation

Mobility has usually been identified as one of the most important determinants of how smart a city is, because it connects to most other smart subdivision and plays a role in a city's productivity and service distribution level. Lagos annual population growth puts its

transportation structure to a stretch this leaves gaps for unstructured solutions such as private transportation vehicles, minibus, motorcycles and three wheelers to meet demands and make profit in the process. Car ownership has seen a massive increase due to inefficient public transit and over reliance on road mode which reflects on the policies and planning of the cities mobility system (Badejo, 2011).

Lagos transportation consist of four modes:

- Road
- Rail
- Water
- Air

## 4.2 Mobility Solution

Table 10 shows Mobile challenges. Based on the smart mobility challenges, smart solutions could be derived, this suggested smart solutions are expected to tackle each challenge listed.

MOBILITY challenges	Lack of transportation models
	Increase in private vehicle usage
	pollution
	Infrastructure deficit

Table 10 Mobility challenges

### 4.2.1 Introducing electric transportation

Going electric has always been a talking point by companies and countries seeking to make mobility solutions it has been adopted by leading nations such as the United Kingdom

(London) and the United States (New York) among a list of several others in their public transportation. Electric vehicles have been in existence for a while now with top vehicle producers on board since its popularity in the 1890's and Toyota first mass produced Hybrids in 2000 (energy gov 2019).

With the new setup's being made in Lagos Nigeria and its BRT systems (Bus Rapid Transit) by the Lagos Metropolitan Area Transport Authority (LAMATA) a major advancement will be to introduce hybrid buses (both electrical and fuel powered) or fully electrically powered buses. According to the Lagos air quality monitoring study from 2007-2009, vehicles contribute approximately 43% of the total level of air pollution in Lagos and an increase in vehicle registration records indicates vehicle ownership by 5% annually (Taiwo 2016, Lagos motor vehicles statistics 2010). Electrically power vehicles can make an official introduction to the public via public transportation, in this way stressing its important in handling the problem of carbon dioxide emission

The advantages of electric or hybrid vehicles for smart mobility are as follows:

- Cleaner energy, thus emitting less pollution
- Reduced fuel dependences

#### 4.2.2 Utilising data and IoT in transportation networks

Transport network systems are a necessary project for development and frequent evaluation. Transportation planning and research on all modes of transportation should be carried out starting from its backbone mode which in this case is its road transportation vehicles. The city must adopt standard transportation companies, one for a region if possible and this companies operations and network routes should be overseen by the Ministry of transportation and the Lagos metropolitan area transportation authority (LAMATA). This sets the transport networks for the following:

- Routes Connections:
- Citizen Accessibility
- Research data
- Good Service delivery
- Easy Approachability of stops and stations



Figure 9. BRT proposed transport network for Lagos, Nigeria (Taiwo, 2016)

Figure 9 shows a projected transportation network for its major transport mode in Lagos by the Lagos metropolitan area transportation authority (LAMATA).

As stated in earlier chapters data specifically open data and IoT are important smart city components, they complement themselves in terms of delivering information in various forms and through various mediums and devices. Open data is being used to create solution to city problems and prevent future problems, several major cities provide free access to specific data for private use or company use therefore encouraging solutions such as a journey planner application for navigating within streets, cities and counties via various means of transportation, private vehicle, buses, trains etc. Lagos consist of a few journey planners such as the BRT planner application but due to lack of real time data update on delays coupled with a poor transportation network, it tends not to be reliable and hardly used. The google map navigator service is only available for private vehicle movements and walking and not buses or rails this is due to the poor transport network and data which should be generated from such networks.

The advantages of Open data and IoT to Lagos Nigeria transportation are as follows:

- Open data gives private sectors a competitive chance to invest on applications and solutions to improve navigation and trip planning within the city.

- IoT could help in real-time bus tracking, and traffic control which could make bus trips faster and therefore more reliable and dependable.
- Reduces the rate of private vehicles and personal mass transportation and eases traffic congestion and pollution.

## 5 CONCLUSIONS

Smart cities are not just technologically developed cities, basic city restructuring and policies which are set up to make things better and sustainable for its citizens also count as a smart city move but surely modern technology helps a great deal.

Smart city projects will surely take a long time to set up. But it is very vital that the planning phase is well set up. This planning phases involves identifying challenges the city is facing and setting up a team for solution development. This team are otherwise known as stakeholders, which should consist of experts in several fields, research institutions, financial institutions, government bodies and citizens organization. Each decision and survey should be carried out by this body of stakeholders.

This thesis attempts to explore the potential of smart solution and not indicate how important planning is before that. Citizens of Lagos Nigeria were the only main part of the survey, but it was useful in seeing challenges in their perspective as they are the core part to a smart city project.

Based on this study it is evident that transportation network must be established with governing policies as a first solution before smart solutions and project can be set up. The citizens will not trust a transportation system that is disorganised and unreliable and there will be more private solutions which is not really an organised solution. A resolve in the mobility division is a gateway to more infrastructural development in such a rich city as Lagos.



## LIST OF REFERENCES

- Ascimer. 2016. Governance and implementation of smart city projects in the Mediterranean Region. [accessed 25 January 2019]. Available at: [https://institute.eib.org/wp-content/uploads/2017/02/2017\\_0131-ASCIMER-DELIVERABLE-3-GOVERNANCE-AND-IMPLEMENTATION-OF-SMART-CITY-PROJECTS-IN-THE-MEDITERRANEAN-REGION.pdf](https://institute.eib.org/wp-content/uploads/2017/02/2017_0131-ASCIMER-DELIVERABLE-3-GOVERNANCE-AND-IMPLEMENTATION-OF-SMART-CITY-PROJECTS-IN-THE-MEDITERRANEAN-REGION.pdf)
- Andrew, L. & Miles, S. 2006. Who are stakeholders? Stakeholders: Theory and Practice. OSO: Oxford University Press USA, pp. 14-16 [accessed 10 April 2019]
- Badejo, B. 2011. Transportation removing the clogs to Nigeria's development. Lagos, Nigeria: Anchorage Press & Publishers. [accessed 26 April 2019]
- BSI 2014. Guide to establishing strategies for smart cities and communities, PAS 181:2014 [accessed 9 February 2019]. Available at: <https://shop.bsigroup.com/ProductDetail/?pid=000000000030277667>
- Centreforcities 2014. Smart Cities.[accessed 9 February 2019] Available at: <https://www.centreforcities.org/reader/smart-cities/what-is-a-smart-city/1-smart-cities-definitions/#fn-68>
- Cohen, B. 2015. The 3 generations of smart cities. 8th October 2015. Fast company compass. [accessed 4 February 2019]. Available at: <https://www.fastcompany.com/3047795/the-3-generations-of-smart-cities>
- Cosgrove, M., Hartoorn, W., Hogan, J., Jabbar, R., Kehoe, M., & Meegan, J. 2011. Smarter cities series: Introducing the IBM city operations and management solution. IBM corporation. [accessed 9 February 2019]. Available at: <https://www.redbooks.ibm.com/redpapers/pdfs.redp4734.pdf>
- Deleawe, S. 2010. Predicting Air Quality in Smart Environments, Journal of ambient intelligence and smart environments. 145-152
- Fast company 2015. The three generations of smart cities. [accessed 17 February 2019]. Available at: <https://www.fastcompany.com/3047795/the-3-generations-of-smart-cities>.
- Fernández-Güell, J., Collado-Lara, M., Guzmán-Araña, S., & Fernández-Añez, V. 2016. Incorporating a Systemic and Foresight Approach into Smart City Initiatives: The Case of Spanish Cities. Journal of Urban Technology, 1–25. [accessed 1 May 2019]. Available at: <https://www.tandfonline.com/doi/full/10.1080/10630732.2016.1164441> .
- Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., & Meijers, E. 2007. *Smart cities Ranking of European medium-sized cities*. Vienna. [accessed 21 January 2019]. Available from: [http://www.smart-cities.eu/download/smart\\_cities\\_final\\_report.pdf](http://www.smart-cities.eu/download/smart_cities_final_report.pdf)
- Granier, B & Kudo, H. 2016. How are citizens involved in smart cities? Analysing citizen participation in Japanese "Smart Communities". Information Polity. 1(21), 61-76.

Hudson, L., Kortuem, G. 2017. Smart cities project business ideas template. [accessed 25 March 2019]. Available at: <https://www.open.edu/openlearn/ocw/mod/oucontent/olink.php?id=67877&targetdoc=Smart+Cities+Project+Ideas+Template+PDF>

Ismail, N. 2018. Smart city technology: it's all about the Internet of Things. 14 March 2018. Information age. [accessed 4 February 2019]. Available from: <https://www.information-age.com/smart-city-technology-123473905/>

Kortuem, G. Kawsar, F. Fitton, D. & Sundramoorthy, V. 2010. Smart Objects as Building Blocks for the Internet of things, IEEE Internet Computing. Vol. 14, No.1, 44

World population review. 2019. [accessed 1 May 2019]. Available at: <http://worldpopulationreview.com/world-cities/lagos/>.

Luciano, M. 2017. ECN. [accessed 2 April 2019]. Available from: <https://www.ecnmag.com/blog/2017/11/top-10-smartest-cities-world>

Manyika, J. 2013. McKinsey Digital. [accessed 12 April 2019]. Available from: <https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/open-data-unlocking-innovation-and-performance-with-liquid-information>

Meijer, A., & Bolivar, 2015. Governing the smart city: a review of the literature on smart urban governance. *International Review of Administrative Sciences*. [accessed 22 February 2016] Available from: <http://ras.sagepub.com/content/early/2015/04/29/0020852314564308.abstract>

Meola, A. 2016. What is the Internet of Things (IoT)? [accessed 27 January 2019] Available at: <http://www.businessinsider.com/what-is-the-internet-of-things-definition-2016-8>

MMDA 2014. Manchester digital development agency [accessed 9 February 2019]. Available at: <http://www.manchesterdda.com/smartcity/>

O'Brien, J. & Marakas, G. 2008. *Introduction to information systems*. 14th ed. Boston: McGraw-Hill/Irwin, 4-9.

Rode, P. 2017. LSE. [accessed 26 January 2019]. Available at: [http://www.lse.ac.uk/lse-cities/People/philipp-rode/Philipp-Rode?from\\_serp=1](http://www.lse.ac.uk/lse-cities/People/philipp-rode/Philipp-Rode?from_serp=1)

Rouse, M. 2006. IoT agenda. [accessed 9 March 2019]. Available from: <https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT>

Saleem, Z & Sukaina, A. 2019. Regional development getting smarter with ICT. [accessed 9 February 2019]. Available at: <https://www.igi-global.com/dictionary/smart-interactive-game-based-system-for-preschools-in-tanzania/38186>

Scholl, H. J., & AlAwadhi, S. 2016. Creating Smart Governance: The key to radical ICT overhaul at the City of Munich. *Information Polity*, 21(1), 21-42. [accessed 15 March 2019]. Available at: <https://doi.org/10.3233/IP-150369>.

*Smart governance in the context of smart cities: A literature review*. [accessed Mar 10, 2019]. Available from: [https://www.researchgate.net/publication/325304603\\_Smart\\_governance\\_in\\_the\\_context\\_of\\_smart\\_cities\\_A\\_literature\\_review](https://www.researchgate.net/publication/325304603_Smart_governance_in_the_context_of_smart_cities_A_literature_review)

Somayya, M & Ramaswamy, R. 2014. Smart city- six dimensions. *Institute of Research Engineers and Doctors*. 38-41. [ accessed 30 January 2019]. Available from: [https://www.researchgate.net/publication/289868190\\_Smart\\_Cities\\_-\\_Six\\_Dimensions\\_A\\_Scholarstical\\_Articles\\_Review](https://www.researchgate.net/publication/289868190_Smart_Cities_-_Six_Dimensions_A_Scholarstical_Articles_Review)

Statista. 2019. Statista. [accessed 2 April 2019]. Available from: <https://www.statista.com/statistics/910658/population-of-london/>

Taiwo, O. 2013. Benefit of LAMATA establishment in Lagos. [accessed 25 April 2019]. Available from: [http://gefsustran.sutp.org/images/documents/8\\_LAMATA\\_Lagos](http://gefsustran.sutp.org/images/documents/8_LAMATA_Lagos).

The open university 2018. Smart cities. [accessed 27 March 2019]. Available at: <https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=67887&section=1.2>

United nations 2015. Population Division world urbanization prospect [accessed 25 February 2019]. Available at: <https://population.un.org/wup/>

## APPENDICES

## APPENDIX 1

## SURVEY FORM

	- Relevance +				
	1	2	3	4	5
<b>Lack of transportation models</b>					
<b>Increase in private vehicle usage</b>					
<b>pollution</b>					
<b>Infrastructure deficit</b>					
<b>The threat of a loss of Cultural Identity</b>					
<b>Lack of digital skills and low educational levels</b>					
<b>Poverty gap between Rural and Urban dwellings</b>					
<b>Societal flexibility</b>					
<b>The gap between the government and the governed</b>					
<b>Inadequate urban institutional capacities</b>					
<b>Lack of institutional coordination</b>					
<b>Instability in Governance</b>					
<b>Inadequate recreational facilities</b>					
<b>Access to information</b>					
<b>Lack of social services</b>					
<b>Rising Urban Insecurity and Violence</b>					
<b>Lack of participation, engagement and awareness</b>					
<b>Lack of recycling management</b>					
<b>Fast rising urbanization</b>					

<b>Increase in informal economy</b>					
<b>Low competitiveness and Economical weakness</b>					
<b>Unstable geographical development</b>					
<b>Lack of access to technology</b>					