



**“USING DATA ANALYSIS TO SOLVE HOUSING PROBLEMS IN LAGOS,
NIGERIA”**

(PT): O uso da análise de dados para resolver problemas de habitação em Lagos, Nigéria

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Dissertation submitted as a partial requirement to obtain the degree of

Master of Science in Internet Studies (0242) [ESPP]

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September 2019

DECLARATION

I certify that I am the owner of this dissertation and that all materials, data and content used in this dissertation which is not my own work have been identified. And contains no material for which a degree has previously been conferred upon me.

ACKNOWLEDGEMENT

I will like to say thank you to my supervisor Tiago Lapa for his support, guidance and encouragement throughout this dissertation. His advice and insights helped me through the progress of my thesis.

His theoretical explanations played a big role in guiding me towards developing a better understanding of the Methodological approach in conducting academic research, data extraction, analysis overlaps and also the divergences among different research approaches. His support and patience are highly appreciated. I will also like to give gratitude to all my professors during my Masters in the World Internet Studies Program mostly professor Gustavo Alberto Guerreiro Seabra Leitão Cardoso who though his classes help me in understanding the association of internet with major social changes experienced in several sectors of our daily life today and also how the internet has shaped and impacted different social aspects like our government, business, and social science research etc...

This guided me to identify a specific domain of specification among different approaches and influenced my decision of a choice of career as a Data Analyst.

I will also like to acknowledge the individuals and different organizations whom I have contacted and interviewed during my preparation for this thesis both in France, Portugal and Lagos, Nigeria.

It is hardly possible to list the names of everyone who has taken part in one way or the other to make this thesis a success but I sincerely acknowledge the precious encouraging participation from everyone. Special thanks to all my colleagues who I have worked within different internships and job position. I owe my gratitude to a lot more people whose names I did not mention here. Above all, I am thankful to my family who has always supported and encouraged me.

ABSTRACT

The constant growth in population has made a significant impact on housing and accommodation in Lagos Nigeria and the shortage and the problem of distribution of housing for both homes and offices and urban planning, in general, has been a challenge in African cities in general. Housing a fast-developing city with a population in record speed increase like that constated in Lagos needs to be reviewed most especially with the fast rate of digital development and internet access. The United Nations (UN) has ranked Nigeria among the countries that will drive the growth of cities over the next four decades, posing challenging challenges in terms of job creation, energy consumption and infrastructure, as well as housing. This thesis aims to explore a maximum of data on housing, the development of the internet of things and how these perspectives envisaged by the government. One of the main sources of information of our century is big data, this element is extracted from the opinions of the inhabitants of Lagos on housing problems, their practice and information available in public services. The goal of using data is to improve practices, anticipate problems, etc. But to do this, it is necessary to digitally collect useful information to help public policies to the deployment of housing using these datasets.

The results of the thesis and the prospects for research or the deployment of applications, software or models could be useful to the Lagos government to manage the challenges of the future related to the expansion of the population, the disappearance of surfaces to urbanize and more global issues such as climate change and its effects on the population.

KEYWORDS : housing ; internet ; dataAnalysis ; Lagos ; big data ; data survey

KEYS NUMBERS :

- Lagos Island, where the density reaches 12,000 inhabitants per km²
- Lagos is the largest Nigerian city by population (8,048,430)
- 200 million people by 2050
- More than 500,000 people move every year in the city and in Nigeria
- The deficit of 17 million households

RESUMO

O crescimento constante da população cosou um impacto significativo nas moradias e acomodações em Lagos, na Nigéria, e a escases e o problema da distribuição de moradias para residências e escritórios, e o planetamento urbano, em general, tem sido um desafio nas cidades africanas em general. Viver dentro de uma cidade em rápido desenvolvimento, com uma população em aumento recorde de velocidade como a constatada em Lagos, precisa ser revisado principalmente com a rápida taxa de desenvolvimento digital e acesso o Internet. As Nações Unidas (ONU) classificaram a Nigéria entre os países que impulsionarão o crescimento das cidades nas próximas quatro décadas, apresentando desafios desafiadores em termos de criação de empregos, consumo de energia e infraestrutura, além de moradias. Esta tese visa explorar o máximo de dados sobre habitação, o desenvolvimento da Internet das coisas e como essas perspectivas são vistas pelo governo. Uma das principais fontes de informação do nosso século é o big data, esse elemento é extraído das opiniões dos habitantes de Lagos sobre problemas habitacionais, sua prática e informações disponíveis nos serviços públicos. O objetivo do uso dos dados é melhorar práticas, antecipar problemas etc. Mas, para isso, é necessário coletar digitalmente informações úteis para ajudar políticas públicas a implantação de moradias usando os conjuntos de dados.

Os resultados da tese e as perspectivas de pesquisa o implantação de aplicativos, software o modelos podem ser úteis ao governo de Lagos para gerenciar os desafios do futuro relacionados a expansão da população, ao desaparecimento de superfícies a serem urbanizadas e mais globais questões como as mudanças climáticas e seus efeitos sobre a população.

PALAVRAS CHAVES: habitação ; internet ; análise de dados; Lagos ; big data ; pesquisa de dados

NÚMEROS CHAVES:

- Ilha de Lagos, onde a densidade atinge 12.000 habitantes por km²
- Lagos é a maior cidade nigeriana por população (8.048.430)
- 200 milhões de pessoas até 2050
- Mais de 500.000 pessoas se mudam todos os anos na cidade e na Nigéria
- O déficit de 17 milhões de famílias

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CHAPTER ONE: INTRODUCTION

1. 1. Context

The constant growth in population has made a significant impact on housing in Lagos Nigeria.

This problem of shortage and distribution of housing is experienced not just in Lagos but has become a huge challenge in developing African cities. The issue of providing decent, safe and affordable housing for not only the rich but the poor and low wage income citizens.

The government of Nigeria has put in place several housing programs to provide a solution with this problem in Lagos, but most programs aim at making profit thereby focusing on the private sector real estate company for its distribution and allocation. These results to the prices of acquiring most of the housing units at a very exorbitant price and mostly unaffordable to the designated inhabitants.

Faced with these findings, we can then ask ourselves if it is possible to solve these problems by using the internet, data analysis and by developing digital tools, the subject of this thesis.

The city of Lagos

Lagos is the most populous city in Nigeria, which is itself the largest country in Africa. The metropolitan area, which covers about 300 km², is made up of a set of islands bordered by rivers and a lagoon connected to the ocean. Since 2013,

The former capital city, Lagos remains the most urbanized city despite the movement of the country's capital to Abuja. This may not be unconnected to the fact that Lagos remains the commercial capital for Nigeria.

Figure 1 : Map of Lagos



Source : Nigeria. © BIG

Just like "Big Apple", Lagos has direct access to the Atlantic Ocean. Its Apapa harbour is one of the largest in West Africa, its skyscrapers reflect the power of silver and the Third Mainland Bridge is the longest bridge in Africa (13 km) : it connects the continent to the islands. It is in this context that Lagos proudly displays its flagship neighborhoods such as Ikoyi, Victoria Island, Lekki, Banana Island, CMS Lagos, Badagry Beach, etc. Neighborhoods with more and more millionaires.

How not to attract a growing population by boasting this wealth? With this lush image, Lagos is considered, in Nigeria, the land of all opportunities: every day, thousands of people from other regions come to settle in search of a better future. Each year, the population grows by nearly 400,000 people. This complex city where chaos reigns is still very young since it was created just 50 years ago.

1. 2. Background to the study

One of the constantly recurring narratives that has accompanied the development process in Sub Saharan Africa and other developing countries of the world is the increase in the rate of urbanization coupled with the reality that urban areas are laden with challenges which stemmed from increased urbanization on the one hand and the paucity of structured efforts to counter these challenges on the other hand. As noted by Jones (1966), the urbanization of African countries has created cities which have size and population as their major urban qualification. Aluko (2010) contended that while these cities serve the functions of fostering the conditions that promote economic dynamism and consequently economic development, the situation in most sub Saharan cities is also one of unplanned urban sprawls, environmental pollution, deficiencies in basic infrastructure and facilities, deterioration and a remarkably high sometimes lack basic infrastructures such as electricity, pipe-borne water and good roads. As noted by – Alhaji A. Aliyu and Lawal Amadu - Urbanization the Challenges to Nigeria (Dec 2017)

The fact that most governments in these countries have characteristically expended little effort in managing the cities has served to aggravate the problems. The effects of these problems have provided justification for various interventions and have spawned several programs all of which are aimed at making urban life more conducive.

Some of these programs were put in place by Lagos local government bodies including the following.

Table 1 : Programs implemented by Lagos Local Government

Name and origin of the program	Date	Goal	Advantages	Disadvantages
<p>Lagos State Development and Property Corporation (LSDPC) <i>formed by the Lagos state government in 1972 as a result of the amalgamation between 3 already existing agencies: the Lagos Executive Development Board (LEDB), located in Lagos Island, the Ikeja Area Planning Authority (IAPA) located in Ikeja and the Epe Town Planning Authority (ETPA) located in Epe.</i></p>	1972	Give provision of movable and immovable property with the city of Lagos.	LSDPC: helped to enhance the lives of the urban population of Lagos state, from the rural habitation to modern a more habitation system. It also brought about economic development into the local habitats in the form of improvement in national trade and industry production which has, in turn, contributed to the gross domestic product (GDP)	Overpopulation of certain areas in Lagos as people keeps migrating in masses from the rural and poor areas to the urban centres where provisions were being made without a commensurate increase in the existing necessary social infrastructure.
<p>New Towns Development Authority (NTDA) <i>By the Lagos government in the north-west south-west lekki axis in order</i></p>	1981	Decongest the metropolitan centre and to ensure simultaneously and even development of Lagos State housing Loans were granted by a governmental participating bank.	Lead to the construction of accommodation mostly in the local and the urban areas with high population density with helped to provide accommodation for the people leaving in the overpopulated areas	Lead to the shortage of jobs for people due to long distance from their workplace, people who migrate to the urban centres in search of jobs to sustain their daily living without the government creating new job opportunities.
<p>Lagos Urban Renewal Agency (LASURA) : <i>established by the Lagos State government Urban Renewal.</i> Board of committees with an aim to The (LASURA) board was also renamed twice since after its existence in 2005 and 2010 it was called the Lagos State Urban Renewal Authority and in 2010, its name was changed to the Lagos Urban Renewal Agency (LASURA), respectively. (LMDGP) which were dissolved into LASURA.</p>	1991	Implement the slum improvement and upgrading programme of the 42 slum affected communities slum communities.	Provided housing for people living in defavorable conditions aaround slumly areas around lagos and also reduce the risk of epidimi from misquitoses and waterborn desecees in lagos.	This program has a major setback due to Inadequacy of resources and shortage of unconstructed land space because the density per km2 of each space keep increasing in value with subsequent overpopulation and crowding of the already existing resources. This results in shortage of land space resources.

Name and origin of the program	Date	Goal	Advantages	Disadvantages
<p>Lagos State Ministry of Housing (LSMH)</p>	<p>1999</p>	<p>Provide cheap and quality homes for the teeming population of Lagos State. Develop towards a vision of Lagos as a 'model city' high expected quality of living for its citizenry by providing adequate provision of homes and shelter as a basic human necessity.</p>	<p>LSMH : enabled the introduction and use of modern methods of construction, with cheaper and reusable equipment in some areas of living for the workers and also help them to accomplish their daily activities</p>	<p>Cost of acquiring a house in Lagos was relatively cheap but very difficult to acquire, the people had to possess their demand for accommodation through influenced real estate agents This lead to a high increase to the cost of real estate agents fees</p>
<p>Lagos metropolitan development and governance project (LMDGP): <i>One of the first internationally financed housing projects in Lagos state, it was a World Bank-financed project</i></p>	<p>2007</p>	<p>Take over the functions of the development and governance project of Lagos metropolis. Participate in the overall development of the city not only housing development projects, but also different economic and social development activities, infrastructure improvement (roads, education, sanitation and ecological disasters ...).</p>	<p>This programme encourages the establishment of not only housing and accommodation but educational institutions like schools, universities, polytechnics; places for worshipping. eg churches and mosques; and also restaurants and private hotels. these programme helps improve the socio-cultural education and exchange in communication and among the people of Lagos state .</p>	<p>This problem as a result of previous unsuccessful pollution. Air and water pollution may be caused mainly by either the release of greenhouse gases (GHG) and effluents from the industries into the environment or produced by exhaust emissions from vehicles used for transportation.or unsuccessful initiatives</p>
<p>Lagos Cooperative Home Ownership Incentive Scheme (Lagos-CHOIS) : <i>by the Lagos state government</i></p>	<p>2008</p>	<p>Encourage the acquisition of private property Create a collaboration between the government housing organisation and the private real estate development companies while the scheme was launched in 2010 it consisted of both offices in the local government and also offices in the private sector real estate professionals.</p>	<p>This program gave room for increase the private individuals and corporate bodies to invest in the real estate market. Giving more possibilities for creation of local shops and offices for rent And also small room apartments for students living around the university of lagos area</p>	<p>This clearly shows the scheme is unambiguous about its target and is clearly not aimed at providing the basic accommodation needs to all citizens of state including the rich as well as the poor. But is more favourable to the high-income groups in the city.</p>

Name and origin of the program	Date	Goal	Advantages	Disadvantages
<p>Lagos Home Ownership Mortgage Scheme (Lagos) : <i>by the Lagos State government it is being run principally by the Lagos Mortgage Board in conjunction with the Lagos State Building and Investment Company.</i></p>	2014	Enhance housing construction, renovations and delivery. Try and create an equality between the current demand for housing and its actual supply.	During this the programme was able to deliver 10,000 units of housing in 8 years and mobilising over 605 beneficiaries with the same year period	This system seems to serve more to the more privileged members of the society who have the capacity to take these loans, looking into the housing deficit estimated in excess of 2 million as at 2015 and had an estimated target of providing 20,000 housing units.

Source : Author's analyse

Even if with all these programs, according to Adebamowo (2011), housing in Lagos is grossly inadequate both quantitatively and qualitatively.

The income earned and payment matrix for one of the housing types, for example, with the lowest price tag and located in the less favorable or peri-urban area of the city-state is shown in the matrix below.

Figure 2 : Affordable metrics under for low-cost homes under Lagos HOMS



Source: Lagos Bureau of Statistics, 2013 and Lagos State Home Ownership Mortgage Scheme, 2014

With the emergence of big data, high performing telephone services 3G and 4G, wi-fi services, registrable sensors, big mining software and analytics present a large opportunity for developing cities like Lagos state to transform its old systems to a new phase of information and technological improvement. This will enable new modern ways to deliver products amenities and services to citizens at all levels.

The pressure on developed towards an efficient and economic city with the respect of the green and clean ecology management has led to various Smart City initiatives by both the government and the private sector businesses to invest more and more in ICT with an aim to find sustainable solutions to several problems including housing. The Internet of Things (IoT) has also been considered a solution to connect billions of sensors linking cities to the Internet and expects to use them to provide enough data for efficient and effective resource management in Smart Cities (T. Perera, C., Zaslavsky, A., Christen, P., & Georgakopoulos, D. 2014).

The evolution of the internet of things and Intelligent of sensor networking between appliances, streets, houses, highways and roads, and even cars will become more and more critical to the basic functioning of cities like we can already experience in other developed cities in the world.

According to Perera, today, infrastructure, platforms and software applications are offered as services using cloud technologies. Through their article, they study different models using big data et high technologies to create modern Smart City. Environnement, agriculture and Waste management treated to prove that the future of these technologies is an issue.

In this thesis, the aim is to highlight the opportunity of a game-changing measure by the use of data collection, storage, analysis and implementation to help provide a solution to the the long-time existing problem of housing in Lagos stated and also in most developing cities in Africa.

In the near future, most developed countries are expected to see smart cities with buildings that are with system or production of energy autonomy and renewable, optimized fluid and connected transportation system, electric cars produce zero Co2 emission and easy communication. Lagos, Nigeria is one of the noted cities in which the various problems associated with urbanization are manifested and have remained triggers for public concern over the years. The growth and increasing urbanization of Lagos are reflections of the high population growth rate of the country which has been averaged at 2.8% per annum in the past two decades and the quest for better economic opportunities among rural dwellers (Aluko, 2010; Adesoji, 2011). The current status of Lagos as the most populous and economically developed city in Nigeria is a result of cumulative advantages of having access to ports, consistently growing population and a concentration of indigenous and foreign commercial and industrial investments. Ademiluyi and Raji (2008) asserted that the present-day metropolitan Lagos developed from a narrow low-lying island situated on latitude 60 27' North and longitude 30 28' East along the West African coast. While

the population of Lagos has shown an upward surge culminating in a present population; Lagos has a population of over 17 million residents and a land area of 3,577km². This situation of a large population and relatively small land area provides the conditions of high population density, high population pressure on resources and the development of slums and shanties that have characterized Lagos.

A major effect of dynamics of rapid urbanization and inadequate planning in Lagos is the incessant housing problems in the city. Because Lagos, as a city is regarded as an engine of economic growth and development, it continually attracts new populations with the effect of making housing scarce and grossly inadequate. According to Ogungbemi and Abel (2016), Lagos has a shortfall of about 1 million houses if adequate housing conditions are to be ensured. Further, the housing situation in Lagos has the marked characteristics of the area - based differentiation. Lagos has 20 local government areas; however, the population is not evenly distributed thus creating some areas where overpopulation has led to enormous pressure on available facilities like roads, electricity, waste management and healthcare. Ogungbemi and Abel (2016) further noted that the overpopulation has brought about an increase in rents with the effect of aggravating the problems of poverty which is an endemic feature in the city. Tangential to the housing problems faced in Lagos and also a result of overpopulation is the inadequacy of infrastructure especially roads, electricity, healthcare and potable water. The resultant effects of these inadequacies include traffic gridlocks, epidemics, blackouts (which have crippled economic activities by increasing the costs of doing business) and private sourcing of water through artesian wells that have the potential of disrupting water- tables.

The situation of Lagos is not distinct. The expansion of cities all over the world have had attendant negative consequences and have called forth different coordinated responses. A trend that has deemed promising is the emergence of the concept of Big Data. According to Bettencourt (2014), there is a lot of possibilities attached to the collation and use of extensive sources of data to better understand and manage cities. The rise of big data is part of a much broader phenomenon. Evidence suggests that two important global trends- urbanization and increased use of ICT are at a level that is unprecedented in the history of the world in terms of their scope and magnitude (Wellman and Haythornthwaite, 2002; Ling, 2004). The implication of these trends is that there is a reasonable and feasible expectation that in the nearest future, a larger proportion of the world's population will live in cities and will have access to increasingly sophisticated information and communication devices- most especially smartphones and laptops. According to Batty (2013), the application of big data to solving the problems associated with urbanization is premised on a set of assumptions.

Most problems associated with urban planning and mitigating their consequences is a computational problem (Taewoo and Pardo, 2011; Papa, Garguilo & Galderisi, 2013). Essentially

this assumption is built on the realization that as cities are becoming increasingly smart (that is as the number of communication devices is increasing), the problems are urbanization become increasingly related to computing best options based on the available data. As noted by Batty (2013), the collection, storage and analysis of increasingly available data provides leverage that can be employed in understanding complex phenomena in computational terms.

The second assumption upon which the application of big data to solving the problems associated with urbanization is premised is the realization that while citizens are contained in and interact with other elements of the city, they are also active actors in the accumulation of data. The proliferation of smart devices among citizens provide a rich harvest of data that can be used for computational purposes (Bettencourt, 2014). The availability of such data can be traced to the fact that the new generation of smart devices embedded capabilities for computing information on weather, location, distance, available facilities, parking spaces and landmarks amongst others. These data and their aggregation from multiple devices in different locations provide valuable insight for such decision as traffic gridlock management, siting of facilities, waste management and public utility allocation.

The third assumption is the idea that aggregating information from a lot of devices will lead to the emergence of what is termed the *smart city* (Batty, 2013; Pan et al, 2016). The conceptualization of a smart city revolves around the idea that sophisticated algorithms can be used to collect information from smart devices and sensors which are embedded in various structures in the city- and then such information can be employed in increasing the adaptability of cities. The potential of smart cities remains one of the notable expectations of application of big data to urban planning. This is because smart cities offer a lot of potential such as the ability to compute accurate diagnostics about traffic, reduction of emissions through smart grids, utilization of Linky meters to measure consumption and usage of public facilities. A notable example is the London Underground which has systems that can- through the computation of data in embedded devices- can redirect users in cases when stations are closed (Batty, 2013).

These three assumptions set the context for the use of data analysis to solve housing problems in Lagos. While various solutions have been proffered to the endemic problems facing sub-Saharan cities in general and Lagos in particular, there has been little progress in ameliorating the dismal conditions under which city dwellers have to live. Such solutions ranged from town planning to public-private partnerships and development of satellite towns in a bid to reduce population pressure and the problems associated with it (Adesoji, 2011). The aforementioned solutions have failed essentially because they do not have the capacity to meet the current challenges. In fact, such problems as gridlocks and emissions cannot be solved within the context of conventional solutions. The emergence of big data coupled with the proliferation of smart devices in African cities like Lagos present massive opportunities to solve housing problems. This

thesis seeks to explore this route in solving the housing problems of Lagos and in the process proffer solutions based on the use of big data that is existent and just needs to be harvested.

1. 3. Statement of the problem

Access to housing is a significant and essential component of livelihood. According to Brockherhoff (2000), decent and affordable housing remains one of the basic needs of individuals, family and the community at large and as a prerequisite to the survival of man, housing ranks second only to food. Also, housing as a unit of the environment has a profound influence on the health, efficient, social behaviour, satisfaction and general welfare of the community at large. Associated with the problems of housing in a city are the other consequences of urbanization such as the strain on facilities, traffic gridlocks and environmental emissions. The magnitude of these problems is increased because it is not foreseeable that the trends of urbanization can be stemmed. According to the World Bank (2018), economic growth and urbanization are complementary and critical to poverty reduction in the developing countries of the world. The report estimated that between 2010 and 2040, the typical African city - like Lagos - would have doubled its population. This urbanization signifies tremendous opportunities for rapid development, it, however, comes with the cost of housing problems.

Table 2 : Largest built-up urban centers in Nigeria with a population of 500,000 and above

	Urban center	Population		Urban center	Population
1.	Lagos	13,910,000	14.	Ikorodu	825,000
2.	Onitsha	7,850,000	15.	Owerri	815,000
3.	Kano	3,875,000	16.	Maiduguri	795,000
4.	Ibadan	3,070,000	17.	Warri	770,000
5.	Abuja	2,605,000	18.	Enugu	755,000
6.	Uyo	2,230,000	19.	Zaria	750,000
7.	Port Harcourt	2,060,000	20.	Osogbo	715,000
8.	Nsukka	1,840,000	21.	Akure	630,000
9.	Benin City	1,445,000	22.	Sokoto	620,000
10.	Aba	1,290,000	23.	Lokoja	570,000

	Urban center	Population		Urban center	Population
11.	Kaduna	1,140,000	24.	Bauchi	560,000
12.	Ilorin	935,000	25.	Abeokuta	540,000
13.	Jos	830,000	26.	Ogbomosho	505,000

Source: adapted from Demographia world urban areas

The use of big data provides opportunities for solving these problems. It is, however, important to note that despite the tremendous potentials embedded in the use of big data in housing problems, its use is still limited in Lagos, Nigeria. This has important implications as the deleterious consequences of urbanization and the housing problems experienced in the city pose enormous human and systemic costs. The purpose of this study is, therefore, to take stock of the current housing situation of Lagos in terms of the state of housing and the ease of access by citizens. The study will also focus on the design of viable methods for the collection and organization of digital data that can be used to optimize the housing needs of Lagos and facilitate access of Lagos citizens to improved housing and urban conditions.

To this end, the study seeks to answer the following research questions

1. What are the current housing needs of Lagos?
2. What is the level of ease of access to housing in Lagos?
3. What are the current uses of big data in Lagos?
4. In what ways can big data be used in solving housing problems in Lagos?

1. 4. Obstacles and challenges of the use of Bigdata and ICTs in Lagos city urban planning

Lack of knowledge: the introduction of (ICT) could represent a huge change and could generate opportunities to introduce significant and lasting positive changes to the system of housing, urban planning and other sectors of the economy, in particular, the improvements in the lives of the people living in poor and rural areas and also in urban contexts.

Sustainability and scale: the lack of sustainability in the use of big data and ICT governmental and private organizations in developed programs had been relatively ad hoc.

Food distribution and Malnutrition: the problem of collaboration between the INGs and small private organisation and there integration to the use of ICT to ensure the even distribution and production of food by the Use Big Data and the

Application of machine learning and ICT detect early signs and agricultural potential crop optimization or failures, drastic climate change, speculated increase in food prices, and other different factors that could lead to food shortages. Over time, to Help Combat Malnutrition

Pace of change: the adaptation to Change is one major challenge faced by Lagos today, It is visible difficult to conceive the people to adapt to new ways of working with new technological infrastructures and also organizational constructs. this is fundamentally seen as different from the old traditional way of working. This challenge of the shift requires competence in terms of skill and organisational strategy.

Funding: financial funding could also be a huge challenge. Adequate financing and planning of the use of ICT and big data in developing programs could be quite expensive to run.

Therefor funding such ICT based projects could be a problem for interested organisation and partners both for the private and government sectors. It is often difficult for INGOs to provide adequate financial resources and also human investment in the development of ICT and data-driven projects or programs.

Changing roles and norms: with the emergence of the new international Data protection law has left some challenges in which some INGOs face in adapting to the fast-changing ICT.

The emergence of new ICT possibilities potentially presents some more fundamental and far-reaching questions, challenging or even undermining the assumptions on which INGOs came into being. When we reflect on why INGOs were originally founded, we can isolate a number of specific gaps between people and communities in poverty and those in more affluent, developed parts of the world. For example, if we think about gaps around understanding and information, traditionally INGOs helped us understand the dire need of communities in the poorest parts of the world. There are also gaps in terms of access, communication, and of course resources that INGOs have historically played an important role in addressing.

Discussion: The introduction of ICTs could represent a significant change and generate significant and lasting opportunities for positive change in the housing system, urban planning and other sectors of the economy, in particular, the improvement of people's lives.

But various obstacles have been identified and hinder this development.

As mentioned in the article (to quote), we must not reduce the lack of development of new technologies to one or two factors. Leading researchers in the information society Manuel Castells and Jan van Dijk, show that the structural inequality of society is the main cause of different types of the digital divide. It is a global hurdle made up of the gender divide, ethical divide, age, income difference, education and abilities.

While some developing countries face a lack of internal equipment that hinders the effectiveness of ICTs and their development, the major concern is the global divide.

For starters, there is a lack of knowledge. Most public and private companies simply do not have the capacity and expertise to ensure the effectiveness of ICT. As a result, most organizations still have this problem as a result of previous unsuccessful or unsuccessful initiatives.

The lack of sustainability in the use of big data and ICTs in developed programs is also a hindrance to their deployment.

But the question of money is also at the centre of the problem. In order to develop the use of big data and ICTs in a developing country like Nigeria, there is a need for adequate funding and planning. However, ICT and Big Data in program development are reputed to be quite expensive to manage. Financing such ICT-based projects could, therefore, be problematic for interested organizations and partners in both the private and government sectors. It is often difficult for INGOs to provide sufficient financial resources and human investment in the development of ICT- and data-based projects or programs.

The case study by Oyelaran-Oyeyinka and Nyaki Adeya (2004) on Internet access in Africa shows the example of the "finance" factor in the global digital divide. The costs of Internet use in Nigeria are extremely high: "In mid-2002, the average cost of using a local dial-up Internet account for 20 hours a month is about \$ 60 use and duration of local communication included, but not the rental of the telephone line).

These facts reveal the importance of this obstacle and explain why, while Africa represents 14.1% of the world's population, only 2.6% of all Internet users live in Africa.

Table 3 : Studies about African population and use internet

Part of Africa	Population (2006 Est.)	Internet users – December 2000	Internet users, latest data	% Population (penetration)	UN HDI rank (UNHDR, 2005)
Africa	915,210,928	4,514,400	23,649,000	2.6	
Nigeria	159,404,137	200,000	1,769,700	1.1	1.1 158

Source : Africa and the Digital Divide

For Christian Fuchs, Eva Horak Africa also has structural inequalities in society. The global digital divide then translates into inequities in terms of material, use, skills, benefits and institutional access to new information and communication technologies by different regions of the world. The global digital divide is an expression of the uneven geography of global capitalism, the effect of hundreds of years of colonial and post-colonial exploitation, exclusion and Third World dependency that have caused the same conditions as Africans. have to face today.

The emergence of new ICT opportunities potentially raises some more fundamental and far-reaching issues, challenging or even weakening the assumptions on which INGOs have emerged.

When we think about why INGOs were created, we can isolate a number of specific gaps between people and communities living in poverty and those living in the richest and most developed regions of the world. For example, if we think of gaps in understanding and information, INGOs have generally helped us understand the crying need of communities in the poorest regions of the world. There are also gaps in terms of access, communication and, of course, resources for which international NGOs have always played an important role.

The obstacles are therefore complex and difficult to untie. Few strategies have yet been developed to defeat Nigeria and other developing African countries from these fractures. Through her paper "Africa and the digital divide" Christian Fuchs, Eva Horak discuss the possible solutions of this digital divide with the first two examples:

1> Let it go and look: it is not possible, the gap between developed and developing countries is too great that it is highly unlikely that it will improve: because the difference in wealth between Western countries and third world countries is continuously developing and developing countries are systematically excluded from wealth and technological progress.

2> Making technology leaps: "In developed economies in other parts of the world, newer versions of technology are often used to upgrade earlier versions, but in developing economies where older versions of technology are often prevalent (if they exist), The possibility of switching over from successive technological generations to the most recent version is much greater. "It may, therefore, be possible to favour this development leap but without ever being sure that it will be deployed for the greatest number of people. Indeed, companies that could generate this type of technological boom, will certainly benefit a tiny part of the population.

The other strategies are based on more complicated discussions including the provision of foreign capital, the distribution of equipment to Third World countries and non-distribution. Each of these hypotheses has drawbacks and none finally answers the challenges of the digital divide ...

Issues that are discussed below.

Challenge 1: Enable all citizens to enjoy their rights

As mentioned in the article "Africa and the digital divide" (Christian Fuchs, Eva Horak) Information and communication are, like social security, a fundamental human right. Article 19 of the Universal Declaration of Human Rights explicitly mentions this right: "Everyone has the right to freedom of opinion and expression; this right includes the freedom to hold opinions without interference and to seek, receive and disseminate information and ideas by all means and at all borders. " In the information society's opinions are increasingly expressed and articulated using the Internet and other new media.

Therefore, access to new technologies in terms of material, use and skills is a contemporary expression of a fundamental principle.

It is unfair that Western citizens then have more human rights and economic, social, cultural and cultural rights than citizens of developing countries.

The development of ICT and the distribution of Big Data would then make it possible to meet this challenge n ° 1, which is often underestimated.

Challenge 2 - Food Distribution and Malnutrition:

The problem of collaboration between the ING and the small private organizations and integration of the use of ICT for as consistent food distribution and production through the Use Big Data and

The application of machine learning and information and communication technologies dictates early signs and potential crop optimization or failure, radical climate change, supposed rise in food prices, and other factors. factors that may lead to food shortages. Over time, to fight against malnutrition

Challenge 3 Rhythm of change

Adaptation to change is one of Lagos' main challenges today. It is difficult to conceive of people adapting to new ways of working with new technological infrastructures and also organizational structures. this is fundamentally perceived as different from the old traditional way of working. This challenge of change requires skills in terms of skills and organizational strategy.

There are more pilot initiatives and small-scale statuses than some large-scale programs based on data and ICT. To ensure the sustainable and successful development of the Internet and ICTs, development programs must be evidence-based and involve public and private investment in large-scale organizations. There must also be a collaboration between INGs and technology companies, universities and other international government agencies. As well as other traditional development entities.

1. 5. Significance of the study

The importance of housing in ensuring livelihood and its role in economic development cannot be overemphasized. The problems associated with inadequate housing in the long run bloom into conditions of degradation, economic retardation and pollution which are detrimental to livelihood. Because big data is becoming increasingly embedded in different aspects of urban life, it provides a means through which comprehensive and up- to- date information can be harnessed for planning and problem- solving purposes.

This study, by examining the utilization of data analysis in solving housing problems will potentially prove to be a valuable aid for policymakers in the housing and development sector.

1. 6. Research methodology

As will be further explained in chapter three, this research will utilize a mixed-method research design. The choice of this design is informed by the purpose of the study and the derived research objectives. The use of mixed research design would entail the use of qualitative and quantitative methods. The qualitative aspect involves the collection of secondary information on certain objectives while the quantitative methods involve the use of a multi-part questionnaire to elicit information the nexus of big data and housing in Lagos. In analyzing the data obtained from the survey, descriptive statistics will be used.

1. 7. Structure of the thesis

This study is thematically structured around six chapters. Chapter one covers the background to the study, a statement of the problem and the research objectives which set the overall direction for the study. Chapter two is a review of literature spanning, housing, housing problems, big data and the big-data-housing nexus. Chapter three covers the research methodology while chapter four discusses the results of findings as related to the objectives of the study. Chapter five proposes the framework for an API which applies the concept of big data to solve the housing problems in Lagos while chapter six spans the conclusions and policy recommendations of the study.

CHAPTER TWO: LITERATURE REVIEW

2. 1. Introduction

This section attempts a review of literature on the thematic aspects of this study. The concepts of urbanization and housing problems will be examined as well as that of big data and its applications. This section will also discuss the nexus of big data and housing problems as well as the constraints on this nexus. Lastly, a review of applicable theoretical frameworks as well as empirical literature relating to the topic will be discussed.

2. 2. The concepts of urbanization and housing problems

The concepts of urbanization and the housing problems that they spawn are interrelated. According to Brugman (2009), urbanization can be defined as the process through which a community takes on characteristics associated with increases in population, population density, functionality or social heterogeneity. The crux of this definition is the emphasis that urbanization is a function of the rating of a community along the continuum of certain indicators which are deemed to be the characteristics of urban centres. Menon et al (2019) defined urbanization as the physical growth of rural or natural land into urban areas as a result of immigration to an existing urban area. This definition emphasizes two aspects of population growth which qualifies an area to be called urban; the high influx of people and high organic growth rates.

Ayeyemi (2018) also expressed that urban areas are characterized by the availability of basic infrastructure and a high level of occupational differentiation which includes a significant proportion of secondary and tertiary occupations. The application of these conceptualizations to the purported urban centres of sub-Saharan Africa has, however, been shown to be laden with issues. Dickson (1965) and Caren (1992) asserted that the universal criteria of urbanization defined by most authors are not met by most African cities. Williams (2018) corroborated this point by remarking that some urban settlements in Nigeria are inhabited by people whose occupation revolves around primary and extractive industries and which sometimes lack access to such basic infrastructures as pipe-borne water, electricity and good roads. The level of social heterogeneity is also remarkably low in some urban centres in developing countries (Abiodun, 1997; Agboola, 2004).

Different authors have noted the relationship between the increasing rate of urbanization experienced in the developing countries of sub-Saharan Africa and the magnitude of housing problems that have emerged. Aluko (2010) and Das et al (2018) noted that while the process of

urbanization in the developing countries of the world was triggered by industrialization, in the developing countries is mainly a consequence of a push and pull dynamic between the rural and urban areas which revolve around migration into areas where poverty is less severe and the lure of the city. Consequently, urbanization in these countries featured a growing gap between 'employment opportunities and demand, and an ever-increasing shortage of urban services and facilities which are accessible to a diminishing share of urban population (Menon et al, 2019). The logical consequence of this was the aggravation of already severe housing problems. Tangential to the housing problems and related to the surge in urban growth are other problems such as rapid deterioration of living conditions, traffic gridlocks, urban blights, overcrowding, the emergence of slums and shanties, reduced economic opportunities and increased pressure on infrastructural facilities (Das et al, 2018). Reviewed evidence, therefore, suggests that housing problems can be linked with the process of urbanization and when coupled with inadequate planning on the part of government the deterioration of housing conditions is markedly faster and more severe.

2. 3. The concepts of big data and its applications

Big data in recent years has taken on the status of a ubiquitous concept with many applications and still many unknowns. According to Thakuria, Tilahun and Zellner (2016), big data is an umbrella term used to describe a broad and constantly expanding the spectrum of naturally occurring or observational data generated through transactional, operational, planning and social activities that are not specifically designed for research. De Mauro et al (2014), asserted that the conceptualizations of big data revolve around four main strands; the characteristics of big data, the technological needs behind the processing of large amounts of data, processing thresholds and the impact on the advancement of society. On the other hand, Davenport and Patil (2012) contended that big data is not just about data but with the curiosity and goal-driven approaches entailing data extraction and in a shift in the way data is being used to analyse, understand and organize society.

While big data was originally associated with sensor-generated data, the trend now is towards the Internet of Things (IoT) which is described by Ashton (1999) as a vision in which billions to trillions of everyday objects and the surrounding environment are connected and managed through a range of devices, communication networks, and cloud-based servers. The IoT essentially involves the embedding of intelligent devices into everyday objects for the purpose of harvesting information. Consolvo et al (2006) reported that big data has impacted many sectors including finance, insurance, manufacturing, aviation, sports and electronic commerce systems.

Batty (2013) also opined that while big data and its ancillary technology are based on the massive advances in computing and in information and communication technology, its functionality is enhanced by its characteristic of fostering the co-creation of information and User- Generated Content (UGC). As noted by Thakuria et al (2016), UGC can be generated through idea generation, feedback and problem solving thus providing a medium or platform through which citizens can contribute to the solving of societal problems. While the kind of problem-solving provided by big data is collaborative and contributory, it has been effective in situations where conventional problem- solving and decision- making have failed because of the non- linearity of problems plaguing societies in the modern world.

Another important point of application of big data is that it aids administrative decision- making. As noted by Consolvo et al (2006), the various manifestations of big data allow governments to harvest microdata on citizens and demographic groups as part of their everyday business. Such information covers taxes, revenues, registrations, employment and benefits and information on income, earnings and disability or retirement benefits. A major advantage of the use of big data for these purposes is that it helps in promoting efficiency in government operations, it is relatively cheap and according to Gowan et al (2015) 'potentially less intrusive and yet comprehensive'. Batty (2013), further asserted the benefits of big data include the fact that they naturally have relatively larger sample sizes, and are less subjected to the problems of attrition, measurement errors, subjective bias and non- response associated with traditional survey data sources.

2. 4. Sources of big data in urban areas

Various sources of big data exist in the urban area and each of these sources provides a particular type of information which when aggregated with data from other sources form the basis of the application of big data to urban planning and design. According to TMD studios (2017), "in the physical world, huge quantities of new data about physical space and the social behaviour of people in urban spaces is being generated through technologies" such as sensors, smart meters, social media, and mobile phones. Bettencourt (2014) reported that besides from smartphones, digitized cities have sensors which are embedded in various structures and urban furniture generating data on a continuous basis. In more specific terms, McKinsey Global Institute (2011) reported that as at 2015, the number of sensor nodes in retail, utilities, transportation, industrial and automotive sectors have reached around 30 million. In the UK, the Transport for London Company makes use of its Oyster Card payment system which covers 80% of public transport in London to collect data on passenger movements. In cities like New York and Chicago, location and building sensors are combined with information from public utilities to tackle perennial city challenges such as the detection of illegal buildings and the identification of food deserts (Li et al, 2005; Kitchin, 2014).

In other cities, sensors are embedded in public structures and selected buildings and are configured to collect and transmit data on the parameters needed for city planning. A notable instance is the Santander in Spain where the quest by city managers to measure air quality, light levels, service levels, traffic and the availability of parking spaces have led to the deployment and installation of about 12, 000 sensors in different parts of the city (NPR, 2013). Another identified important source of big data in cities is the social media space. The significant increase in the number of city dwellers who are active on social media combined with advances in the science of sentiment analysis have proved to be a treasure trove of data on the attitudes of people towards products, services and places (Mayer- Schonberger, 2013). Mayer- Schonberger (2013) asserted that the feedback from social media is valuable for urban design and planning purposes and is insightful in solving problems. Other sources of big data include the Internet-of-Things (IoT), monitoring cameras, participatory sensing systems, GPS, public administration data, storage card and business records, customer data and fleet management data (Bettencourt, 2014; Pan et al, 2016).

2. 5. The use of big data in solving housing problems

Housing problems in urban areas are embedded within the larger context of the myriad problems faced by people living in an urban environment. Such problems stemmed from the fact that there is usually a gap between the available resources in the city and the number of inhabitants. A review of existing literature revealed that the application of statistical data to solving housing problems in an urban area has a long history. Szanton (1972) and Bettencourt (2014) reported that quantitative data - the grail of the big data movement - was used as a basis for building statistical pictures of urban issues as early as 1892. Bettencourt (2014) further reported that the NYC - RAND Institute utilized statistics and models gleaned from urban data in computations for wartime and public facilities planning as early as the 1970s. The use of big data in solving housing and other urban problems is an extension of these earlier approaches.

According to Goldsmith and Crawford (2014), one of the uses of big data in solving housing problems is that the effective utilization of big data helps in creating efficiency in the use of available real estate which in turn frees up space for housing purposes. Most cities in developing countries have plans that do not account for the daily patterns in the concentration of people, as such people must commute long distances daily which contributes to traffic gridlocks and inefficient land use. As noted by Papa, Gargiulo & Galderisi (2013), advances in big data technology and the increased capabilities of smart devices can be employed in deciphering location patterns at different periods of the day and from such important data plan cities that consider these patterns. Such patterns can also be used in determining the potential demand for housing in the area and form the basis for converting areas with sparse activities into other uses.

The use of big data for planning purposes and its relevance to solving housing problems is also demonstrated.

The use of big data has also been demonstrated to improve accessibility, which is a key dimension of housing. Batty (2013) and Pan et al (2016) reported that the availability of data coupled with the development of various analytics software have aided the mining of different types of data for insights which are applied in city planning. Such insights have been shown to aid an understanding of how there are differences in how spaces and neighborhoods can be used at different times of the day by different people and in response to varying types of events. Taewoo and Pardo (2011) contended that this has tremendous implications regarding the use of utilities such as energy and water because by showing the feasibility and viability of using a certain facility for multiple purposes, there are options regarding power usage, emissions and the conservation of resources that would have been used for building new structures to accommodate needs.

As noted earlier, an important dimension of the housing problem in any urban environment is accessibility. Different studies have shown that big data has the potential of improving accessibility and as such improve the quality of life in a city (Batty et al, 2012; Kitchin, 2014; Thakuria et al, 2014). Thakuria et al (2014) expressed that the capability of big data to decipher the understandably complex relationships between variables such as traffic, public events and weather patterns is instrumental in forecasting future traffic and provides up- to- date information that can guide commuters and allow computation of best travel paths.

Another use of big data in solving housing problems is reflected in its capacity to serve as an updated information source for the different actors in the housing market. First, big data can help housing providers plan and justify future investments on a real-time basis. The World Bank (2018) asserted that the findings of big data in an urban environment and the insights garnered from such findings can help coordination between public investment in infrastructure, private investment in productive capital and household investment in housing. Kitchin (2014) also asserted that such findings also provide valuable information to policymakers and allow them to make decisions which promote affordable housing and business units, optimal transportation and spatial links between jobs and the creation of recreational, educational and health services areas. Tangential to this is the fact that big data serve as the basis of predictive analytics which can be tailored to analyse data obtained from the urban space and use such data to predict future needs (Pan et al, 2016).

Because the provision of housing or solving housing problems is embedded within the framework of the overall economic development (Brockherhoff, 2000), the importance of big data to solving housing problems cannot be discounted. Li et al (2014) and Lepri et al (2017) opined that big data provides critical real-time information that helps in driving sustainable urban development. Li et al (2014) reported that big data obtained from high- resolution satellites can be used for mapping

poverty. A number of techniques using this approach have been demonstrated and they are based on the use of structural indicators to highlight the level of poverty in the area and note feasible interventions. According to Taylor et al (2014), techniques are available that combine big data and advanced computation to identify such characteristics as built-up area, car densities, electricity or lighting and building concentrations. Other related techniques can be employed in calculating whether buildings are laid out in chaotic or rectangular angles (the former being an indicator of poverty). The insights made possible by the data obtained through these techniques help in focusing interventions in areas of high leverage and this has a tremendous impact on the quest for sustainable economic development and the attendant effects on solving housing problems.

Lepri et al (2017) and Taylor et al (2014) have also highlighted the potential application of big data to the construction of relatively less expensive and sustainable housing. This application and the benefits associated are based on the assumption that a smart approach- based on big data- to the architectural and urban design could help in achieving economies of scale and collaboration, creating designs that would respond to dynamic change and helping the construction industry realize resilient and low carbon development that have the dual benefits of being flexible enough to accommodate economic growth and climate change (Batty et al, 2012; Bettencourt, 2014; Kowald and Axhausen, 2015). The interface of big data and housing problems consists of four main dimensions; utilization of data in meeting building needs, experimentation and modelling, analysing data in order to improve housing-related policy making at all levels of government and utilizing data to improve transparency and speed up development processes.

2. 6. Constraints on using big data to solve housing problems

While the potentials of utilizing big data as an important tool for solving housing and other problems in the cities have been recognized and demonstrated with significant benefits, it is important to point out that instituting the processes that aid this utilization is subjected to a number of constraints. According to Barkham, Bokhari and Saiz (2018), the constraints revolve around the use and usability of open data, privacy concerns, and technology and human capital constraints. According to Wellman and Haythornthwaite (2002), open data usability and privacy concerns remain key issues limiting the utilization of data embedded in smart devices.

A number of challenges are related to the use of open data. While the open data movement is based on the cardinal principles of collaboration, participation and transparency, access to government data has always been a cumbersome process and the data collection projects in many cities have stalled due to funding limitations- this has also led to situations where open data is being treated like a commodity (Batty et al, 2012; Mayer- Schonberger & Cukier, 2013). Another

challenge related to the use of data is the fact that many open data websites have limited use. Barkham et al (2018) expressed that, because many open data websites were created during hackathons and data dives, they are largely unstructured, and the lack of post-event follow-up, maintenance and development limit their usability.

Another assumption that has limited the use of open data is that everyone has the potential to access and use it. In real life, this is not always the case. 'Not all citizens have either the skills to process and interpret open datasets nor the ability to voice their opinions about them' (Barkham et al, 2018). In instances, where several users cannot make adequate use of open data, there are cases of exploitation (Hilbert and Lopez, 2011).

Another identified constraint on the use of big data revolves around privacy concerns. An established trend in the developed countries and one that is gaining increasing acceptance in the developing countries is the consideration that privacy is a basic human right and must be protected by law. Kitchin et al (2014) noted that at the intersection of data use and privacy concerns lay limitations on what type of data can be collected and how such data can be used. Barkham et al (2018) noted that the issue of privacy is complicated because on the one hand the data and behavioural patterns of people are constantly captured through transaction records, credit cards, GPS, the Internet- of- Things and social media (Facebook, LinkedIn, Instagram) and on the other hand there are regulations preventing the free use of such information.

In cities where digitization and big data are taken seriously, serious thought has gone into the design of guidelines around the issue of privacy (Bettencourt, 2014). Hilbert and Lopez (2011) also mentioned the current trend is in the direction of cities developing guidelines and visual aids informing people on the presence of sensors and the type of data such sensors are capturing. From another perspective, Taylor et al (2014) noted that the issues that have been created around privacy concerns have necessitated the design and implementation of explicit guidelines about rights and privacy in the public data space, social contracts guiding the use of data and what citizens should expect in return for the capturing and use of their data.

The third major constraint on the use of big data to solve housing problems related to technological and human resource limitations. This third type of constraints-more than the previous two- have important implications for the use of big data in the developing countries of the world. According to Thakuria et al (2015), the application of big data to urban informatics and other processes characterized by complexity entails building a large and meaningful data portal that will be useful and machine-readable. This is a very technical process that relies on ample funding and developed capabilities (Barkham et al, 2018). Evidence in the literature suggests that the failure of big data projects can sometimes be traced to the misalignment between the scope and requirements of the project and the available technical capabilities. A notable example is the experience of cities that have attempted to build citywide wireless networks. Such projects have

characteristically failed because due to several technical limitations cannot be adapted for large scale outdoor networks (Lepri et al, 2017). The technological and human capital constraints pose more threats in the emerging cities of sub-Saharan Africa where the level of technology is still low.

Other constraints on the use of big data include the high cost of investments in infrastructure, urban furniture, mining technology and support systems that big data requires (Papa et al, 2013). Goldsmith and Crawford (2014) expressed that while big data will save enormous costs in the long run, in the short run the initial investment is beyond the reach of most cities. The alternative of public-private partnerships (PPPs) girded by the need for legal frameworks specifying the rights and obligations of partners has gained acceptance in the developed countries but is still an emerging phenomenon in the developing countries.

While the use of data in solving housing and urban problems have a long history, it is important to point out that big data and big data analytics are relatively new technologies. Technology Readiness and Technology Acceptance are two frameworks that have aided an understanding of the adoption of new technologies. Technology Readiness (TR) can be expressed as a measure of a person's general beliefs and thoughts towards a particular technology. Parasuraman (2000) defined Technology Readiness as people's propensity to embrace and use new technologies for accomplishing goals in home, life and at work. The importance of Technology Readiness and Technology Acceptance and their relevance to this study lay in the fact that the success of big data in solving housing problems is premised on the willingness of individuals to give or input data on their smartphones using various APIs. The underlying assumption of the two models is the belief that an individual's tendency to adopt a particular technology which is new to the individual is dependent on the personal individual's perception of the technology, the demonstrated or perceived the value of the technology and the ease of its use. Technology Readiness (TR) is expressed as the 'propensity to embrace and use new technologies for accomplishing goals in home, life and at work' (Parasuraman, 2000). TR is expressed as an index known as the Technology Readiness Index (TRI), which according to Parr and Shanks (2000) is a measure used in differentiating users based on their beliefs- negative or positive- to new technology. Parasuraman (2000) further noted that optimism, innovativeness, discomfort and insecurity are the yardsticks that constitute the components of Technology Readiness. The author stated that the key contribution of this index, which seeks to identify a consumer's propensity to adopt and use new technologies, is in the finding that a consumer's level of readiness to adopt is positively affected by both the consumer's level of optimism regarding the product's ability to provide substantial benefits and his/her level of innovativeness with reference to the tendency to pioneer new ideas.

2. 7. Gaps in literature

The importance attached to the subject of big data and its nexus with housing in particular and urban development has informed a lot of research. However, there are gaps which research opportunities for this study and future ones. Pan et al (2016) discussed the importance of urban big data and its relation to the development of city intelligence. The study, focused on China, defined urban big data in relation to Chinese city's intelligence and also examined the role of urban big data in developing city intelligence and proffering solutions to the myriad needs of urban living. Barkham et al (2018) examined the application of urban big data in city management and real estate markets. The study examined current trends in the application of big data and the impact of these trends on real estate markets in terms of the quality of life and productivity. The study leaned toward the assertion that big data and smart city technologies will be the key determinants of urban primacy in the nearest future. Lepri et al (2017) examined how big data can be utilized in the design of smart, safe and sustainable cities. The study took the position that while the trend towards the use of big data will continue in cities in the developed countries of the world, what is more, likely to work in the developing countries are smaller-scale interventions. Such interventions are expected to work in improving the conditions of blighted neighborhoods. Other studies (Neirotti et al, 2014; Thakuriah et al, 2014; Paroutis et al, 2014; Thakuriah et al 2015) have shown different dimensions of the application of big data to solving housing and other problems in urban areas.

A particularity of a larger proportion of literature on big data application to housing and urban development is their focus on cities in the developed countries of the world. It is understandable that the advanced level of technology and computing in such countries present them as ideal hubs for experimentation and innovation in big data analytics and urban informatics. However, the rapidly increasing rate of population growth and urbanization in the developing countries of the world necessitates research into the use of big data to solve housing problems. According to the World Bank (2018), around 450 million people will be added to the urban population between 2010 and 2040.

This statistic portends that there will be an exponential increase in the complexity of problems such as housing gaps, infrastructure strains and pollution. As Bettencourt (2014) asserted, big data are particularly suited to solving complex problems because such problems are computational in nature. From the above, there are existing gaps in research into the application of big data in developing countries. Such gaps include the viable and feasible modes of big data adoption, the regulations that can work within the concept of the often ineffective legal systems of most developing countries, the introduction of APIs, how sensors in urban furniture can be financed and maintained and how issues such as privacy concerns will be addressed. This study will be filling a research gap by exploring how big data can be used in solving housing problems in Lagos, Nigeria.

CHAPTER THREE: RESEARCH METHODOLOGY

3. 1. Introduction

This chapter focused on the methodology adopted in this study for the collection and analysis of data based on the aim and objectives of the study. The research design was discussed as well as the underlying philosophy. This chapter also explained the processes of sampling, the sample size, and the data collection instrument used in the study. The validity and reliability of the data collected were also discussed.

3. 2. Research was design

The success of a study is to a large extent dependent on the selection of appropriate research designs. The selected design must be appropriate to the aim and objectives of the study. Newman and Benz (1998), defined research design can be conceptualized as the plans and procedures used in research which is premised on the research assumptions and influences the methods of sampling, data collection and data analysis. This study will adopt a mixed or pragmatic design which is a combination of positivism and interpretive methods. While the positivist method uses data to test a theory, the interpretive mode builds a theory based on the available data (Bhattacharjee, 2012). The importance of a mixed-method is that it is more suitable for generating insights into complex social problems (Kumar, 2005).

A study of the use of data analysis to solve housing problems in Lagos is a complex problem with many dimensions. A dimension relates to the availability of housing in the first place, while another important dimension relates to the ease of access to housing in Lagos. Underlying this and deriving from the aim of this study is the use of big data to solve housing problems. The many facets of this problem necessitates the use of a mixed-method design. While the identified objectives of the study will be achieved by interpreting secondary data while a quantitative survey will be used in eliciting data that will form the basis of the framework for an API which applies the concept of big data to solve the housing problems in Lagos.

3. 3. Focus of study

The focus of this study is Lagos City. According to reports from the Nigeria Bureau of Statistics (NBS, 2016), Lagos is the commercial centre of Nigeria and contain 50% and 60% of industrial capacity and foreign investment respectively. The population of Lagos has been ranged from 13 million- 22 million (NBS, 2016; Ogungbemi & Abel, 2016). Lagos is also the city with the highest population density in Nigeria. According to Boonke and Helke (2017), Lagos is Nigeria's most populous urban centre and the large population coupled with a small land area provides a fatal combination that has led to problems of inadequate housing over the years. The demand for commercial and residential housing in Lagos is driven by the fact that the concentration of commercial institutions offering various business services such as banking, marketing, financing and insurance makes it an ideal location for locating businesses and this attracts people from other parts of the country who are in search of work opportunities and greener pastures. The high population density (2,500- 3,000 persons/km²) coupled with the relatively higher GDP per capita (\$4, 333) are growth factors drawing companies looking for markets. All of these have created a city faced with congestion, infrastructural strain and gridlocks.

The choice of Lagos for this research is informed by a number of reasons. First, while the city has a high concentration of homes of 3- 5 rooms or more (homes which can contain a larger number of people and reduce the capital costs of housing), such houses are mostly located in areas characterized by haphazard planning, slums and inaccessibility, as such they are considered inaccessible for the classes whose proportion are increasing every year and who form the core of the quest to using big data to solve housing problems in Lagos. Inaccessibility and housing constraints also exert a toll on human capital in Lagos. Bajinatu (2019) noted that the average Lagosian loses around 600 hours yearly in traffic congestions with This signifies the tremendous loss of productivity. Because of its huge population, its perennial housing problems, high level of smartphone and internet accessibility and rapidly increasing income (Boonke and Helke, 2017), Lagos provides an ideal focal point for studying the nexus of big data and housing problems.

3. 4. Population, Sampling procedure and sample size

In providing background data that would inform the framework for a proposed API aimed at using data to solve the housing problems in Lagos, a socio-demographic survey was conducted. The respondent population for the survey includes inhabitants of Lagos who must meet the criteria of living in Lagos and being able to use the internet. However, the presence of time and resource constraints necessitated the selection of a sample which would provide responses to the questions in the survey. Tuckman (1972) defined sampling as the process of identifying and selecting a subset of the population being studied for the purpose of research.

The study aimed at a sample size of 60 respondents. In choosing the respondents who formed the sample of the study, convenience sampling was utilized. The rationale for convenience sampling was that the choice of this sample was informed by the large population of the study (13 million- 22 million). The selection criteria used were adopted because the internet usability for answering surveys connotes internet use for other purposes such as searching for information which is related to this study. Each of the respondents received a note accompanying the survey which specifies what the survey is about and the contact email address of the researcher. The respondents were sent the survey via email.

3. 5. Data collection and Data analysis

In order to achieve the objectives of the survey (which are, examining the current housing needs of Lagos, evaluating the level of ease of access to housing in Lagos, identifying the current uses of big data in Lagos and identifying the ways in which big data can be used in solving housing problems in Lagos), secondary data was interpreted. In order to provide data that would inform the framework for a proposed API aimed at using data to solve the housing problems in Lagos, a sociodemographic survey was conducted. The survey research method involves the use of instruments such as structured questionnaires and interview schedules for collecting information from selected respondents (Bhattacharjee, 2012). Survey method is considered suitable in situations where the number of respondents is too large to observe directly, where the costs of direct interaction with a large number of respondents is expensive and where respondents place a premium on responding to questions at their own convenience.

The sociodemographic survey made use of a structured self-administered email questionnaire as the instrument of data collection. The use of a self- administered survey is rationalized on the grounds that such survey can be sent to a few of respondents at the same time, is unobtrusive and not expensive. A drawback of the use of self- administered questionnaires is the low response rates associated with such questionnaires (Tuckman, 1972). Respondents ignoring questionnaires and long delays in returning the questionnaires were reasons for low response rate. In a bid to ensure maximum response rates, the questions were designed to be clear, unambiguous and brief. Selected respondents were sent the questionnaires through Google forms® portal and responses were received and collated through the same portal. the portal also collates answers which allow for easy analysis. The questionnaire was divided into seven sections and had a total of 26 questions. The table below shows the category of questions covered in each section.

Table 4 : Type of questions

Section	Category of Questions
1	Socio-demographic information about respondents
2	Landlord Choice
3	Annual Income level/ Education and Employment
4	Length of occupation and rent of the current apartment
5	Source of information on accommodation
6	Frequency of- and constraints posed by traffic
7	Interaction with the Internet

Source: Author's schematization

Data from the socio-economic survey was analyzed using descriptive statistics (frequency counts and percentages).

3. 6. Limitations and Ethical compliance

The socio-economic survey has a number of limitations. The first limitation was the possibility of sampling bias in the study. Because of a number of constraints, the study was limited to a sample which was conveniently selected. This limited the number of respondents and also marked the possibility of sampling bias. The second limitation related to the low response rate of the survey, of the 60 questionnaires sent out to respondents, only 32 were returned which gives a response rate of 53.5%. The last limitation related to the possibility of respondents providing misleading responses; this will essentially jeopardize the validity of these responses. The last limitation is related to the fact that the results of the socio-economic survey are not representative of the entire Lagos population as the sampling technique precluded some populations, as such caution should be taken in generalizing these results with an exploratory character and hopefully expanded in future studies like this.

CHAPTER FOUR: DISCUSSION OF RESULTS

4. 1. Introduction

This section discusses the data for each of the identified objectives. Secondary data was discussed for the four objectives (examining the current housing needs of Lagos, evaluating the level of ease of access to housing in Lagos, identifying the current uses of big data in Lagos and identifying the ways in which big data can be used in solving housing problems in Lagos) while the last section discussed the analysis of the socio-demographic survey.

4. 2. Objective 1: The current housing needs of Lagos

Lagos is perennially plagued with several housing needs. Adedire and Adebamowo (2018) asserted that housing problems in Lagos have both quantity and quality dimension. The quantity dimension relates to the inadequate number of houses in the city. They witnessed an upward trajectory in the past decades. Lagos State Governor, Mr Akinwunmi Ambode and several studies (<http://www.obsmigration.org>) emphasized that 85 new immigrants arrive to live in Lagos every hour.

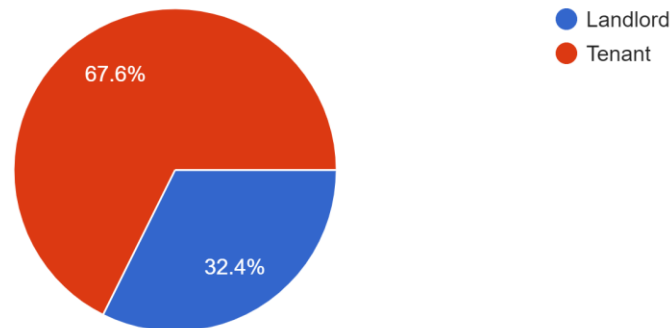
This combined with the already existing housing shortage. The Commissioner of Housing in Lagos State in 2016 reported that the state has a deficit of 2.5 million houses (Udodiong I, 2016). Ministry of Lands, Housing and Urban Development (Lagos) and NBS (2016) corroborated this view by noting that out of the country's 17 million housing deficit, Lagos alone accounts for 14.7%. In another study, Oshodi (2010) asserted that Lagos alone has a housing deficit of 5 million which accounts for 31% of the national housing deficit and has resulted in acute shortages of quality housing in the city.

Available evidence extracted from the result of the survey done shows that 65% of people who replied to my survey are the landlord and 32.4% are tenants (figure 3).

Figure 3 : Extract of the questionnaire

Q (5) Are you a Landlord or Tenant?

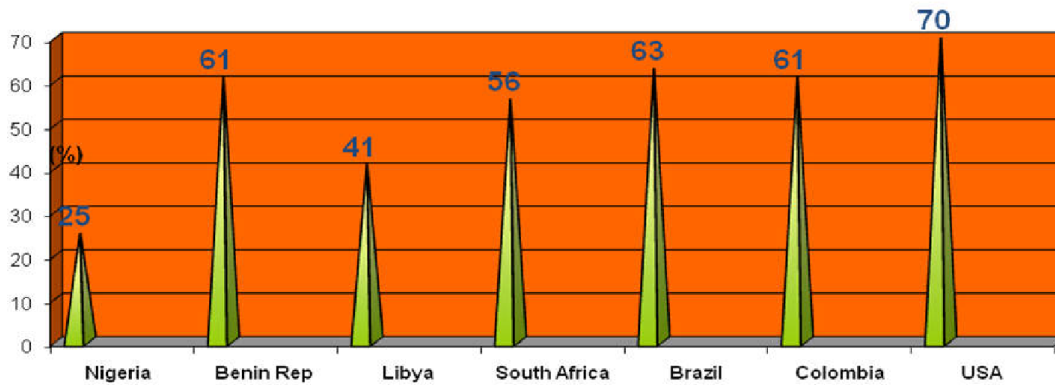
34 responses



Source: Author's Schematization

This how a huge gap in the ownership of properties in the private sector of housing in Lagos state Although there had been several housing schemes put together by the Lagos State Ministry of Housing and the Lagos Property Development Corporation (LSPDC)-the two major large scale housing providers in Lagos- provide houses has not been in tandem with the population increase of Lagos. Enisan and Ogundiran (2013) and Olurode et al (2018) reported that in the 17 years from 1955 to 1972, the Lagos State Government was able to deliver 4,502 units of housing even as the population increased from less than 1 million to 3.5 million. Between 1972 and 1999, the government was able to deliver 20, 120 units while the population rose from 3.5 million to 11 million. The accumulation of these gaps is reflected in the current housing shortages in Lagos which stands at over 2.5 million and the low housing ownership rate when compared to cities in other countries as indicated in figure 4, next page.

Figure 4 : Rate of home ownership comparison (for Lagos in Nigeria and cities in selected countries)

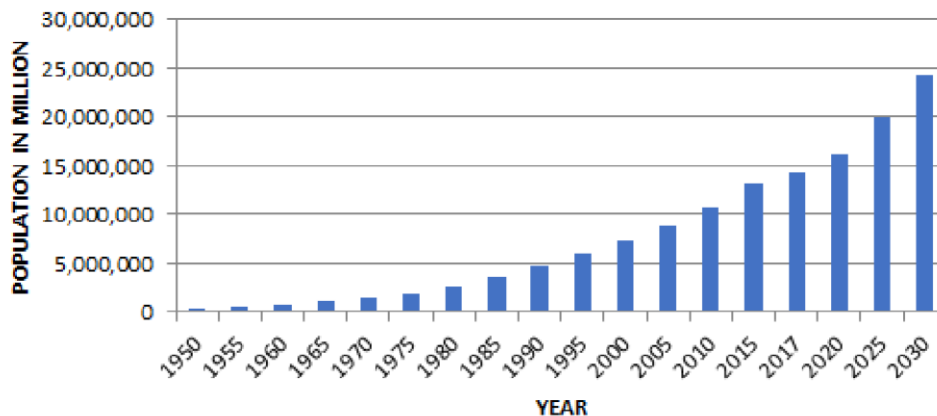


▼ **Low homeownership rate of 25% compared to 70% in the USA, 63% in Brazil, 61% in Benin and 56% in South Africa**

Source: Ajanlekoko (2011)

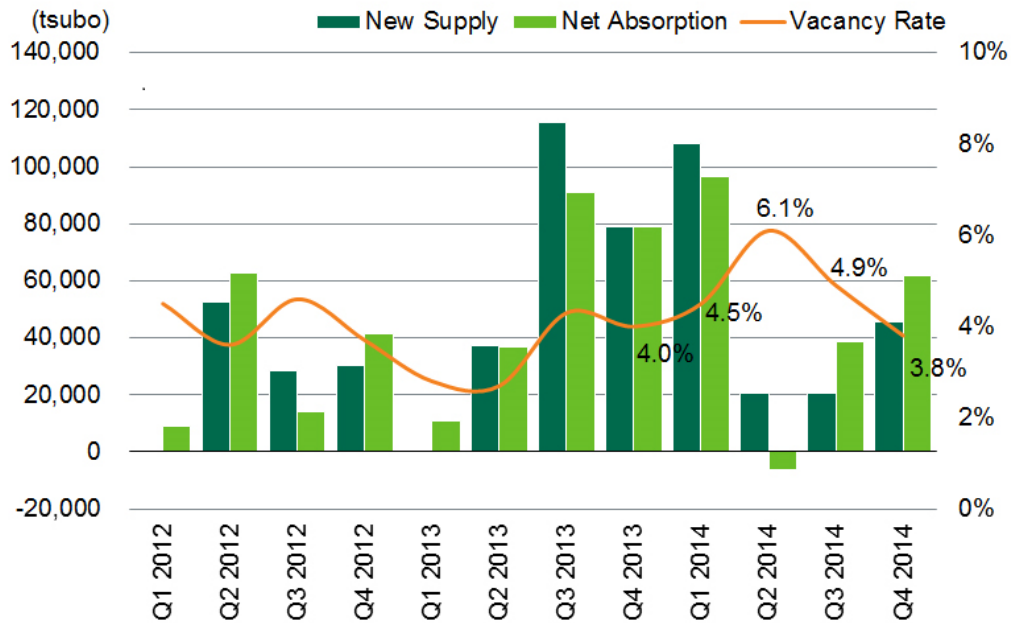
Figures 5 and 6 below (sourced from Olurode et al (2018) and CRBE (2014)) described the underlying realities of housing problems in Lagos. From the figures, it is evident that while the growth of the population in the metropolitan Lagos has assumed a geometrical proportion, the provision of urban infrastructure and housing to meet this demand is, not at commensurate level. The inadequacies are far-reaching and the deficit is both quantitative and qualitative; even those households with shelter are often subjected to inhabiting woefully deficient structures as demonstrated in the multiplication of slums from 42 in 1985 to over 100 as at January 2010. Aluko (2010) further explained that around 60% of Lagos residents are tenants who often have to pay as high as 50%- 70% of monthly income as salaries.

Figure 5 : Population increase of Lagos: 1950- 2030



Source: Olurode et al (2018)

Figure 6 :Rate of supply and demand for new houses in Lagos (2012- 2014)



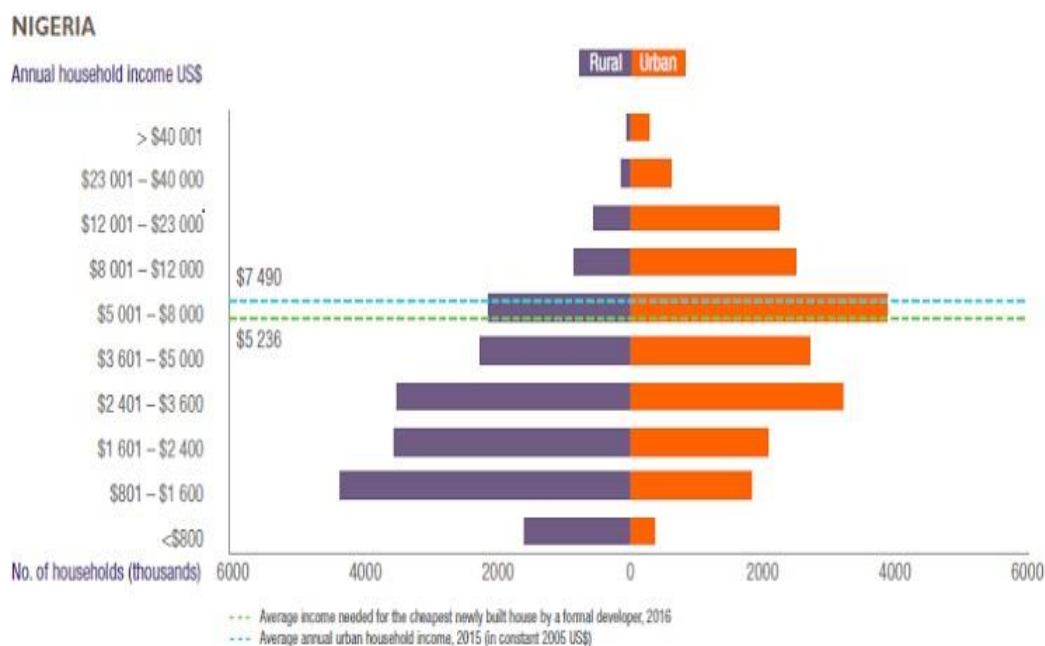
Source: CBRE, Q4 2014

Source: CRBE, Q4 (2014)

4. 3. Objective 2: Ease of access to housing in Lagos

Accessibility relates mainly to the ability of an individual or household to access affordable housing (Clapham and Kintrea, 1992). In Nigeria, Obi and Ubani (2014) expressed that affordable housing as ratio of income to housing costs has become elusive to most Nigerians. Accessibility is also defined in terms of access to houses with improved water, sanitation, sufficient living space and security of tenure. The situation is magnified in a city like Lagos. The Lagos Bureau of Statistics (2014) reported that 70% of the state’s population of 22 million people do not have access to adequate housing. Azzez and Mogaji- Allison (2017) contended that the cost of homes compared with the annual income of households (as illustrated in the table below) portend a situation in which a larger percentage of households cannot afford available housing and instead have to live in slums and sub- standard structures.

Figure 7 : Household Incomes and Access to Housing (Nigeria)



Source: Azzez and Mogaji- Allison (2017), Olurode et al (2018)

This situation is mostly common in most developing cities like witnessed in the city of Lagos. 70% of the state’s population of 22 million people without access to adequate housing.

A problem that contributes to the inaccessibility of housing in Lagos is the inadequate transport infrastructure. Above all “Lagos is the commercial capital of Nigeria and spatially the smallest state in the country an area approximately 3,577 sq. km, out of which 39% are wetlands.” (CB Insights, 2016).

Oshodi et al (2018) asserted that while differentials in housing can be mitigated by adequate transport facilities, Lagos has low levels of such infrastructure compared to other big cities as highlighted in table 2 below, most of the developed cities in other parts of the world have a more developed infrastructure system like the railways system and highways.

Table 5 : Comparative analysis of rail network between Lagos State and other large cities (2016)

S/N	City	Population	System Length (Km)	Density (persons/km ²)	No of Stations	No of Lines	Daily Ridership
1	Lagos	20 million	30	776, 867	11	7	132, 000
2	Seoul	26 million	940	27, 447		19	6,898,630
3	Shanghai	24 million	468	51, 606	303	12	6,235,616
4	Beijing	21 million	456	48, 877	270	17	6,739,726
5	London	9 million	402	21, 430	270	11	8,205,479

S/N	City	Population	System Length (Km)	Density (persons/km²)	No of Stations	No of Lines	Daily Ridership
6	New York	20 million	368	53,658	468	24	4,561,643
7	Moscow	12 million	318	38,418	190	12	6,545,206
8	Tokyo	13 million	310	42,632	290	18	8,498,630
9	Madrid	7 million	317	22,184	300	18	1,720,547
10	Paris	2 million	218	10,320	300	16	4,175,642

Source: World Population Review (2016) and Oshodi et al (2018)

From the table, while Lagos has the highest population density, it has the lowest number of railway stations and the shortest system length. The problem associated with this is that individuals who cannot find accommodation in the city will also find the option of living in the suburbs, satellite towns and nearby cities problematic because of the dearth of adequate transport facilities and this has a detrimental effect on accessibility. Aluko (2010) also reported that the problems associated with accessibility have over the years led to stratification of housing according to income levels, as such there are low-income/high density, medium income/medium density and high income/low density neighborhoods.

4. 4. Objective 3: Current uses of big data in Lagos

The uses of big data in Lagos mainly presently revolves around applications and portals which aggregate information from users in order to design new solutions for the society. A survey of online apps and portals based on the use of big data in Lagos revealed that such apps and portals provide services and functions such as getting traffic updates, locating stores, businesses and emergency services, getting emergency help, transport services, lodging a complaint with the government and finding accommodation. The table presents the apps and portals reliant on big data and the type of functions they serve, or the services rendered.

Table 6 : Uses of Big Data in Lagos (Apps and Portals)

Functions	Applications/Portals
Getting traffic updates	GidiTraffic, JonnyWaka360, TrafficLite, TrafficTalk, Traffikator, TrafficButter, RoadPeer
Locating commercial/service centers	Google Locator, Addide Locator etc.
Emergency Help	EmroApp, EppMe
Transport Services	Uber, Bolt, GoKada, Max.ng
Complaints Management	CitizensGate
Paying Bills	Remita, LASG-EBS- RCM
Finding an accommodation	Jiji, AirBnb, RentALodge, Fibre, Nigeria Property Centre
Hotel Bookings	Wakanow

Source: Author's schematization

According to Ndem (2016), these apps based on the interaction of people with their smart devices are already revolutionizing life in Lagos. GidiTraffic, TrafficTalk and RoadPeer rely on traffic reports generated by other road users. These reports which are then processed using advanced algorithms form the basis of traffic news uploaded to the devices of other users trying to get information on traffic. TrafficLite is a community-based application which provides real time traffic updates to subscribers. Traffikator on the other hand delivers instantly updated traffic information that is based on geolocation and crowdsourced traffic updates. TrafficChief is another app like TrafficLite and it is also an online- community-based traffic visualization and notification app. These apps which signify the advantages that can be gained from the use of big data in improving urban living conditions are available for urban dwellers using various smartphone platforms. In Lagos, the public ratings and reviews of shared transport services such as Uber, Bolt and Max.ng increase the amount of communal information available to other residents. The process of locating commercial addresses in the city and getting information based on the reviews of people who have interacted with such commercial concerns has being made easier by the use of apps such as Google Locator while interaction with the government is now being aided by a smartphone app called Citizens Gate.

4. 5. Objective 4: Proposed uses of big data in solving housing problems in Lagos

The ongoing trend in Lagos is the design of interactive platforms through which residents of Lagos can interact with the government. Examples of such platforms include Remita, LASG- EBS- RCM. Apps such as Jiji, Rent A Lodge and Nigeria Property Centre also provide platforms through which prospective landlords and tenants and can be brought together in the same space. Kuo (2017) noted that Lagos as part of its smart city initiative has plans to install smart parking systems in the city. This would allow for more optimal use of land and free up land that can be used for other purposes. Jiaji (2019) revealed that big-time players in the data sector like IBM and Cisco are partnering with the government and private sector to use big data in improving the living conditions in such upscale areas like Lekki and Eko Atlantic City. This is to be aided through the installation of urban furniture, sensors and apps through which dwellers can leverage the bigdata generated from the activities of others.

The vision of a Lagos Smart City

The smart city of tomorrow, in its super connected version, or "Smart City", will be smart almost ideal and safer. Its major goal is to collect information in the form of data which identifies the needs of its citizens and to better the life its inhabitants this is possible with the increased adaptability and use of the internet. like observed in the London Underground through big data

collection, London city metro stations are able to redirect users trapped or in case of closure of stations. To collect an ever larger and more precise amount of data, there are new waves of new urban furniture in these cities. They are connected to different sensors and are managed and centralized to provide data consumption, emissions storage in form of Big Data, leading to accurate diagnostics of the city, and now know for example traffic Gps devices with faster routes propositions.

Big data can also capture the pressure on the highway roads using measuring tools and sensors installed on underground track, also identify urban areas lacking trade

Major challenge for cities in the future is the reduction of emissions, they will depend on the development of "smart grids" or Smart Grid that aim to adjust the supply and demand of energy supply in real time. Thus, thanks to sensors installed in houses and apartments, like digital meters, an exact knowledge of energy consumption of the people is possible. Not limited only limited to buildings, giving a knowledge of how many people live in buildings and help connect landlords with tenants without the Agent coming in as middleman.

Home appliances of the city that can also be connected, streetlights to billboards etc. these city's facilities are connected to this Smart Grid and this allows for centralized and coordinated management.

Data is therefore a new powerful tool with a huge possibilities or solution to the everlasting problem of accommodation. Thanks to these sensors integrated into buildings and the diversification of renewable energy production means, all infrastructures are connected and interact via this intelligent network in order to better manage the production and consumption urban arrangement and housing availability.

4. 6. Analysis of Lagos Housing survey

The socio-demographic survey was conducted using a structured questionnaire mailed to 60 respondents using The Google Forms survey 39 questionnaires were filled and returned, giving a response rate of 53.3%. The Google Forms survey analysis will be presented in the appendix.

The findings of the survey provide several insights. The data presented in table 1 aligns with previous studies like Aluko (2010) and Olurode et al (2018) who reported that most of the residents of Lagos are tenants and Ajanlekoko (2011) who reported that the rate of home ownership is low in Nigeria. The survey also noted that only 22% of respondents used the internet as the main source of information when purchasing their house and 50% of respondents will use the same medium if they want to sell their house. The implications of this is that the internet is considered to confer significant sellers' advantages. The survey also pointed to the fact that a

significant portion of tenants do not move frequently as 50% and 30% have used between one to five years and more than five years respectively in their current house.

It was also evident from the survey that the traditional modes of acquiring information such as newspapers and radio are less frequently used by respondents with the implication that proliferation of smart devices provide opportunities for leveraging on the internet and big data in solving urban problems. As found by the survey, an overwhelming majority of respondents noted that they encounter traffic gridlocks on their way to work which makes traffic congestion a key urban problem in Lagos. Half of the respondents also reported facing challenges in finding accommodation which partially explains the long tenancy tenures (the high costs of finding an apartment deter relocation even in the face of other constraints such as traffic). According to the respondents the causes of the difficulty in finding accommodation relates to the high costs of housing, high costs of real estate agents, inadequate housing and lack of information.

CHAPTER FIVE: FRAMEWORK FOR PROPOSED API

5. 1. Introduction

One of the major purposes of this study is to provide background information that can be used in the design of an API towards solving housing problems in Lagos, Nigeria. This section discusses the informational input that would form the basis of the design of an API that can help in solving the housing and other urban problems of Lagos. The API is based on identified gaps based on the socio-economic survey and other relevant information.

5. 2. The utilization of API in solving housing problems

The importance of API (Application Programming Interface) in solving the myriad of business and non- business problems faced in the world today cannot be overemphasized. The shift in paradigm towards viewing these problems as computational in nature, the increasingly pervasive need to make data- driven decisions and the potentials offered by Big Data has increased the relevance attached to APIs. According to Bettilyon (2018), APIs are programs which serve as mediums to increase data accessibility, especially by third party users. Young (2018) noted that APIs are the invisible infrastructure connecting people together. Essentially, APIs enable the harnessing of entire ecosystems of data in order to inform, optimize and communicate daily operations. APIs have been demonstrated in a wide range of functions including ordering food, finding an apartment, hailing a cab and studying the traffic pattern along a route.

As noted by Smith (2018), APIs have been used in coordinating urban transportation, bookings, airline management and online services management. As such, used effectively, APIs potentially proffer viable and feasible solutions to the various problems plaguing an urban area including housing. A major limitation of APIs relates to the problem of integrating data from different databases and presenting such data in a form that can be used. APIs form the basis of many applications which seek to solve urban problems. Young (2018) reported that such applications can also be used in coordinating emergency responses and urban services.

According to Desouza and Bhagatwar (2012) and Young (2018), a key problem in the design and implementation of APIs for urban solutions, the data generated by these APIs often end up in silos rather than becoming integrated into a shared data ecosystem that can provide solutions for a large population. Essentially, data harvested from smartphones are piped to discrete dashboards and as such cannot be integrated and viewed in combination with other public

information neither can it be accessed by a large population thus limiting the range of insights and actions that such data can foster.

In a city like Lagos where the need to solve urban problems especially housing takes on urgent proportions, there is a need to realize that tackling such complex urban problems is reliant on an examination and leverage of diverse information sources. The challenge for an API designed to solve housing problems in Lagos is integrating the diverse sources of data already available into a single application which can be accessed by individuals and constantly updated with data. Lagos City already captures large amounts of real-time data on public utilities consumption, transportation and traffic patterns, weather events, available lands, and the use of government services by citizens. The corporate sector generate data on services, news updates, and locations of services among others. Citizens, on the other hand, generate data on preferences, utilities consumption, housing availability, housing demands, complaints, traffic updates and other constraints. The API proposed will be based on integrating these sources of information together and creating a single exchange or interface where individuals can access information about solutions to their problems. While, there are no APIs with an integration of public and private data-approach towards solving housing or urban problems, Desouza and Bhagatwar (2012) reported such apps as One Bus Away, TriMet Trip Planner, Roadify, Rate Your Route Ottawa and Parking Founder as typifying this approach.

5. 3. Identification of constraints and associated informational gaps

It is important to identify the constraints and informational gaps as expressed in the socio-economic survey. Such information will form the basis of the API to be developed. The table below highlights the constraints and gaps identified in the survey.

Table 7 : Constraints and Informational Gaps

S/N	Constraints	Informational Gap
1.	Inadequate housing	<i>No portal linking directly landlord and tenant</i>
2.	High costs of agents	<i>No transparency in agency fees</i>
3.	Traffic congestion	<i>No integrated real time and route- based traffic monitoring portal</i>
4.	Complaints	<i>No centralized portal for making all government complaints</i>
5.	Government charges	<i>No centralized portal for paying all government-related charges</i>
6.	Rent Comparison	<i>No portal for side- by- side and criteria- specified comparison</i>
7.	Utilities	<i>No centralized portal linked to other functions that can be used in paying for utilities</i>

S/N	Constraints	Informational Gap
8.	Land availability	<i>No centralized portal specifying land availability, ownership and documentation</i>
9.	Structural Durability of Buildings	<i>No portal for checking the structural records, safety and ratings of buildings</i>
10.	Parking	<i>No portal providing information the availability of parking spaces in the business districts</i>

Source: Author's Schematization

5. 4. Opportunities for Big Data and Potential Sources of Data

Table 8 : Constraints, Opportunities and Potential Sources of Data

S/N	Constraints	Big Data Opportunity	Potential Sources of Data
1.	Inadequate housing	<i>Portal providing real-time data on vacant apartments</i>	<i>Landlords, Realtors</i>
2.	High costs of agents	<i>Interface for landlords and tenants to interact directly</i>	<i>Landlords, Tenants</i>
3.	Traffic congestion	<i>Real-time 3D traffic map of the city</i>	<i>Drivers, Sensors, Traffic Cameras, Traffic Forums</i>
4.	Complaints	<i>A single portal for all government complaints</i>	<i>Government</i>
5.	Government charges	<i>A single payment portal with options</i>	<i>Government</i>
6.	Rent Comparison	<i>Real time rent comparison based on citizens' data</i>	<i>Landlords, Tenants, Realtors</i>
7.	Utilities	<i>A single payment portal with options</i>	<i>Government, Utility providers, online payment processors</i>
8.	Land availability	<i>Single portal listing available land and details</i>	<i>Government, Google Maps</i>
9.	Structural Durability of Buildings	<i>Single portal providing structural reports based on unique structure ID</i>	<i>Government</i>
10.	Parking	<i>Portal listing available parking by area using data generated by park operators and users</i>	<i>Government, Car Park operators, Drivers, GPs</i>

Source: Author's Schematization

5. 5. Design for API

The design for the proposed API is based on the identified constraints and informational gaps noted in table 1 and the big data opportunities and proposed sources of data identified in table 2. Below is the schematic for the functions of the API.

Figure 8 : Apply schematization



Source: Author's schematization

From the figure above, the API will hopefully revolve around four main functions; apartments, traffic and parking, utilities and government services. Each of these functions have a number of sub- functions which target each of the constraints mentioned in table 7 and makes use of the potential sources of data mentioned in table 8. The apartments function is basically targeted at landlords and tenants and aims to mitigate the constraints associated with housing in Lagos. From the survey, such constraints include lack of information and the high costs of real estate agency. Essentially, the apartments function will allow landlords and tenants to interact directly and thus reduce the costs associated with the agency. The apartment function has the functions of rent comparison, lease an apartment and rent an apartment which would rely on big data to make tailored suggestions based on preferences and budget. The apartment function when fully functional will also provide information on the rate of provision of new apartments and rate of absorption (supply and demand of apartments, which is an indicator of accessibility that can be used for planning purposes).

The second function is the traffic and parking function and it is aimed at providing a real-time 3D map which would allow users to navigate traffic hold-ups and suggest alternative routes. The traffic and parking function also have the sub-function of finding a parking space. This will be based on the data uploaded by park attendants, tweets of other commuters and information from databases of car parks. The third function relates to utilities and here users can make comparisons on payments for utilities based on the data uploaded by other users. They can also make payment for electricity, water, waste disposal and toll permits. This function will, in turn, serve as a feedback mechanism for utility service providers. Such feedback is essential for service improvement and valuable for future planning purposes. The utilities function also enable users to lodge complaints on the service level of utilities. The generate details sub-function provide data to other users on changing demand for utilities, and vacancies.

The last function is the government services. One of the major users of big data is the government and this API provides a means through which data can be gathered for insight by the government. Through this function, users can make payments and lodge complaints. This function will save time as all government payments are consolidated in this function. Crucial to the purpose of solving housing problems in Lagos are two critical sub-functions that can be accessed through this function. These are the processes of checking land availability and structural durability of buildings. One of the bottlenecks leading to an increase in housing deficit gaps in Lagos is the issue of illegalities that revolve around the acquisition of land. The ability to check the genuine availability of land including past history of transfers will play an immense role in mitigating this constraint.

5. 6. Implementation and Management of API

Implementing the design and promotion of the API will be a public-private initiative (between the Lagos State Government and a private company) while maintenance will be by a private company set up for this purpose. The importance of involving the government lay in the fact that this would guarantee access to such sensitive data as land availability. The API would also operate on a pay-as-you-use basis except for free sub-function such as lodging complaints, traffic reports, parking space, rent comparison and structural reports for buildings in the city.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6. 1. Introduction

This section discusses the summary, conclusions and recommendations derived from these conclusions.

6. 2. Summary

This study explored the use of big data in solving the housing problems in Lagos, Nigeria. Informed by the fact that Lagos, as a city and the largest urban concentration in Nigeria and one of the biggest in the world is perennially afflicted with such urban problems such as housing deficits, slums, infrastructural strain, pollution and traffic congestion, this study noted the ineffectiveness of solutions such as the establishment of satellite towns. Based on the emergence of big data and its demonstrated use in improving urban problems all over the world, this study tried to explore the use of big data in Lagos. To this end, secondary data were used to achieve the four identified objectives of the study (examining the current housing needs of Lagos, evaluating the level of ease of access to housing in Lagos, identifying the current uses of big data in Lagos and identifying the ways in which big data can be used in solving housing problems in Lagos). The study also conducted a socio-economic survey which provided baseline data that can be used in the design of an API which can potentially solve the housing problems of Lagos, Nigeria. Major constraints identified by respondents are lack of information, inadequate number of houses, the high costs of real estate agents and traffic congestion. The respondents also demonstrated a low-level utilization of internet for accessing information on urban problems.

Based on this information, an API was proposed which includes four apartments, government services, utilities and traffic and parking. Utilized effectively, these functions provide opportunities for solving housing problems in Lagos in a number of dimensions. First, the API provides valuable data on the supply and demand of housing in Lagos. This statistic is an important input in any policy aimed at improving housing. Secondly, the API provides a direct link between landlords and tenants and thus cut out the middleman (real estate agents) who often charge high fees for their services. Thirdly, ancillary information provided by API such as rent comparison, distance between points and structural reports helps tenants in making decisions such as the value of rent.

Also, the structural reports function which includes reports on the availability of amenities will play a critical role in valuing the rent that should accrue to a building. This will serve the dual role of preventing extortion of tenants and provide an incentive for landlords to improve their properties. Lastly, the API by providing relevant information based on user-generated data reduce the overall costs of renting an apartment and improves accessibility to quality housing.

6. 3. Conclusions

From the findings of the study, a several conclusions can be reached. As shown in Chapter four, there is a wide gap between housing demand and supply in Lagos. This has created housing problems and the associated consequences of congestion and strain on public infrastructure. This study concludes that the housing problems faced by Lagos are computational in nature and can be solved by ensuring the accessibility of information to users who need such information in making decisions. Another conclusion reached by the study is that the proliferation of smart devices over the years has led to an exponential increase in the amount of user-generated data. Also, the shift towards digitization of commercial and government activities coupled with the availability of such tools as Google Maps and Locators have contributed to the increase in data available. From the above, there is a need for a medium such as an API that can integrate data from different sources and provide such data in usable forms to individuals who need them to make decisions. By taking this route, the stand of this study is that the housing problems of Lagos can be managed.

6. 4. Recommendations

A number of policy recommendations are informed by the findings of this study;

- I. The development of an API that aims to use big data in solving the housing problems in Lagos is dependent on close interaction between the public and private sector. Such synergy should be promoted as it is necessary for the formulation of policies that would aid such development.
- II. The synergy between the public and private sector should encompass the establishment of prizes and hackathons for the development of protocols for APIs that can feasibly and viably solve the housing problems of Lagos. Such prizes and hackathons have been demonstrated to work in other developed countries because they provide incentives to software developers ([Richterich A. \(2017\)](#)).
- III. Related to the above is the need for government and the private sector to foster an enabling environment and provide support for startups tailoring their operations towards the development of APIs at the nexus of housing and urban problems and big data? This is done

to ensure the development of this important sub-sector. Examples of such support include tax-breaks for companies exploring the use of API in solving housing problems.

- IV. It is also important that the government provide a supportive regulatory framework for the use of big data in the city. While it is necessary to recognize the importance of privacy, especially as it relates to personal data, it is important to realize that straight-laced policies in this area will stiffen innovation. The government should, therefore, design and promulgate policies that guide the use of big data and simultaneously ensure that privacy is not encroached on.

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Africa Internet usage statistics extract from "Africa and the digital divide" Christian Fuchs, *, Eva Horak b.

ANNEXES

- 1) Questionnaire
- 2) Questionnaire's analysis

Sociodemographic

Websurvey - ISCTE MSc (world internet studies) MBA GRADUATE DISSERTATION
A quantitative analysis survey

This web survey is conducted in accordance with the requirements of the University for the students in the MBA GRADUATE DISSERTATION in world internet studies of ISCTE university of Lisbon ; (note this survey is confidential). The survey should only take less than 5 minutes, and your responses are completely anonymous.

You can only take the survey once, but you can edit your responses until the survey is closed on July 1st, 2019. Questions marked with an asterisk (*) are required.

If you have any questions about the survey, please email : ibeh90@gmail.com

I really appreciate your input to help me with my quantitative data collection and analysis .

* Required

1. Email address *

2. Mark only one oval.

Option 1

I - About you

3. Q. (1) What is your Gender ? *

Mark only one oval.

Male

Female

4. Q. (2) What is your age ?

Example: December 15, 2012

5. Q (3) What is your current marital status?

Mark only one oval.

Single

Married

Living with a partner (boyfriend/girlfriend)

Divorced

Widow/ Widower

Prefer not to answer

6. Q (4) Which Local government area do you currently reside? *

Mark only one oval.

- Alimosho
- Ajeromi-Ifelodun
- Kosofe
- Mushin, Lagos
- Oshodi-Isolo
- Ojo
- Ikorodu
- Surulere
- Agege
- Ifako-Ijaiye
- Somolu
- Amuwo-Odofin
- Lagos Mainland
- Ikeja
- Eti-Osa
- Badagry
- Apapa
- Lagos Island
- Epe
- Ibeju-Lekki
- I prefer not to Answer
- Other: _____

7. Q (5) Are you a Landlord or Tenant? *

Mark only one oval.

- Landlord
- Tenant *Skip to question 10.*

II Landlord choice

8. Q (6) Which of the following did you use to find information when purchasing your house

Mark only one oval.

- Internet
- Social media
- News paper
- housing agents
- Lagos state housing office
- My house was a Family inheritance
- Offer from my job
- I prefer not to answer
- Other: _____

9. **Q (7) If tomorrow you had to sell your house / apartment, what means would you use?**

Check all that apply.

- Housing agent
- TV AND RADIO
- NEWS PAPER
- INTERNET
- LOCAL GOVERNMENT AGENCIES
- Other: _____

10. **Q (8) In the context of the sale of a house / apartment, which (s) are, in your opinion, the main advantages that can bring you a real estate agency?**

Mark only one oval.

- the assurance of selling my property
- time saving
- the assurance of selling it at the right price
- profit from each traction
- Other: _____

III Level in the society

11. **Q (9) Which category best describes the total gross annual income of your household? (Please add all your household incomes)**

Check all that apply.

- Less than ₦100,000
- ₦100,000 to ₦500,000
- ₦500,000 to ₦1million
- ₦1million to ₦5million
- ₦5million and above

Untitled Title

12. **Q (10) What is the highest level of education you have completed?**

Mark only one oval.

- Elementary School (or lower)
- High school
- Vocational/ Professional Course
- BA
- Master's degree
- Doctoral degree
- Prefer not to answer

13. Q (12) What is your current employment status?

Mark only one oval.

- Full-time job (30 hours or more per week)
- Part-time job (less than 30 hours per week)
- Unemployed
- Student
- Pensioner
- Prefer not to answer
- Other: _____

14. Which kind of job contract are you under?

(RECORD ONE ANSWER. IF THERE IS MORE THAN ONE JOB, FOCUS ON YOUR MAIN JOB)

Mark only one oval.

- PERMANENT CONTRACT
- I AM UNEMPLOYED
- DEPENDENT WORK WITHOUT EMPLOYMENT CONTRACT
- SELF-EMPLOYED (ENTREPRENEUR, LIBERAL PROFESSIONAL, FREELANCER OR INDEPENDENT WORKER)
- PREFER NOT TO ANSWER

IV. Your house / Apartment

15. Q (13) How long have you lived at your current residence?

Mark only one oval.

- Less than 6 months
- between 6 months and 1 year
- between 1 and 5 years
- more than 5 years

16. Q (14) How much is the Annual rent ?

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
¥100,000	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	¥3MILION

17. Q (14) How did you find this apartment / house?

(SELECT ONLY ONE OPTION)

Mark only one oval.

- Through a real estate agency
- I reside with my family
- relationship with owner
- Company accomodation
- Other: _____

18. Q (15) Did you have difficulty finding this accommodation?

Mark only one oval.

- YES
- NO
- I DONT REMEMBER
- PREFER NOT TO ANSWER

19. Q (16) If YES, what are the main causes according to you?

Mark only one oval.

- Lack of housing
- no information
- lack of real estate agencies
- high cost of real estate agent
- High cost of housing
- Other: _____

V. source of information

20. Q (17) Have you ever used the internet for the following option?

Mark only one oval per row.

	YES	NO	DO NOT KNOW	PREFER NOT TO ANSWER
Search for accommodation offers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Search for information about my local govement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Search for a housing agent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Search for traffic information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

21. Q (18) Do you use any newspaper to find Accommodation?

Mark only one oval.

- YES
- NO
- DO NOT KNOW/ PREFER NOT TO ANSWER

22. Q (19) Do you receive information about Lagos state government housing projects?

Mark only one oval.

- YES
- NO
- DO NOT KNOW/ PREFER NOT TO ANSWER

23. Q (20) Do you usually listen to the radio stations to look for available accommodation ?

Mark only one oval.

- YES
- NO
- DO NOT KNOW/ PREFER NOT TO ANSWER

VI. Daily

24. Q. (21) How often do you encounter Traffic on your way to work ?

(SELECT ONLY ONE OPTION)

Mark only one oval.

- Everyday
- 3 or 4 times per week
- 1 or 2 times per week
- At least once a month
- Less than once a month
- Do not know/ Prefer not to answer

25. Q (22) If so do you think this traffic congestion problem can be resolved ?

Mark only one oval.

- YES
- NO
- DO NOT KNOW
- PREFER NOT TO ANSWER

26. Q (23) What would you be willing to change for an improvement?

Mark only one oval per row.

	YES	NO	DO NOT KNOW	It's not possible
Moving to live close to work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leave my job to find one close to my house	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Change city	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I prefer not to change anything	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

27. Q (24) Do you use the internet for the following?

Mark only one oval per row.

	YES	NO	DO NOT KNOW	PREFER NOT TO ANSWER
1. FIND INFORMATION ABOUT YOUR TOWN	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. SEARCH FOR JOBS	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. READ BLOGS	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. USE TWITTER	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. SEARCH INFORMATION ON PUBLIC SERVICES	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. FIND INFORMATION ABOUT AVAILABLE ACCOMODATION	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. SEARCH FOR HOUSING AGENTS	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

VII .Interaction with the internet

28. Q.(25) Taking into account all the channels through which you can access and share local information and news online, please indicate if you have ever done the following:

Mark only one oval per row.

	YES	NO	Don't Know; Prefer not to answer
A. Contribute to an online discussion or message board about your local community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B. Send a link by e-mail about a local news article or video to someone you know	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C. Tag or categorize contents of local news online	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D. Contribute with your own article, text, photo or video about your local community for an online news website	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E. Publish news or information about your local community in social media	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
F. Reply to a survey	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
G. Contact a housing agent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
H. Visit the Lagos state housing website	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

29. Q.(26) Over the last year, how often did you use social network sites (e.g., Facebook, etc.) for the following purposes:

Read and record one answer per line
 Mark only one oval per row.

	Several times per day	Daily	weekly	monthly	rarely	never	Don't know/ Prefer not to answer
A. Comment positively or negatively on government policies?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B. Comment positively or negatively about a particular public figure?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C. Criticize economic practices or companies/banks decisions?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D. Post or click "like" to support the performance of companies or banks?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E. Support a national cause by clicking "like" or making a comment?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
F. Support an international cause by clicking "like" or making a comment?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
G. Suggest support for a political party by clicking "like" or making a comment?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
H. Call for participation in demonstrations?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I. Call for participation in a cultural event?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
J. Create a support group of a social, civic or environmental cause?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
K. Click "like" or comment positively or negatively on political measures?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
L. search for available housing accommodation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

VIII. Internet trust

30. Q (27) How well do you trust information on the internet ?

Check all that apply.

- Don't trust at all
- Trust only if my family and friends trust
- Trust based on public reviews
- I Trust partially
- Completely trust
- N.A. (Ex.: Don't watch, don't listen to, don't read or don't use)
- Prefer not to answer

iiX PERSONAL PREFERENCES

31. **Q.(27) Would you rather (or would you have preferred to) own your own house and your own landlord, even if you earn (or earned) less?**

Mark only one oval.

- YES
- NO
- DON'T KNOW/ PREFER NOT TO ANSWER

32. **Q.(28) Would you rather (or would you have preferred to) be self-employed and your own boss, even if you had (had) less job security?**

Mark only one oval.

- YES
- NO
- DON'T KNOW/ PREFER NOT TO ANSWER
- Option 4

33. **Q.(29) What do you consider as the most important aspect to consider before choosing a house :**

Mark only one oval.

- proximity to school
- Cost of acquisition or rent
- Don't know/ Prefer not to answer.
- Less traffic congested area
- proximity to work place

34. **Q.(30) To what extent do you agree with the following sentence: "THE USE OF INTERNET AND DATA CAN HELP SOLVE HOUSING PROBLEM IN LAGOS STATE? ***

Mark only one oval.

- Totally agree
- Agree
- Neither agree or disagree
- Disagree
- Totally disagree
- Don't know/ Prefer not to answer

A copy of your responses will be emailed to the address you provided

Questionnaire analysis

Section I- Respondents Information

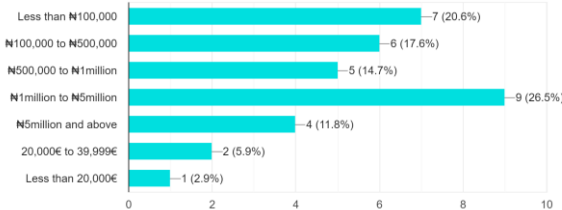
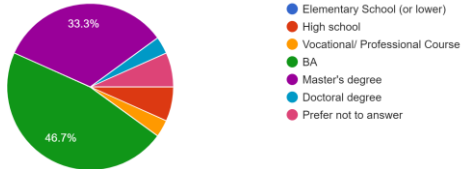
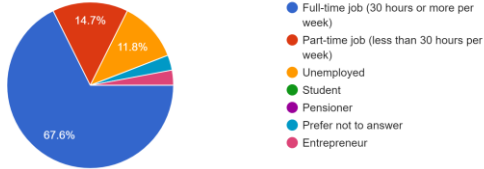
S/N	Question	Options & Data
Q(5)	<p>Are you a landlord or tenant?</p> <p>Q (5) Are you a Landlord or Tenant? 34 responses</p> <p>A pie chart with two segments. The larger segment, colored red, represents 'Tenant' at 67.6%. The smaller segment, colored blue, represents 'Landlord' at 32.4%. A legend to the right of the chart shows a blue dot for 'Landlord' and a red dot for 'Tenant'.</p>	<p><i>Landlord (33.3%)</i> <i>Tenant (66.7%)</i></p>

Section II- Landlord Choice

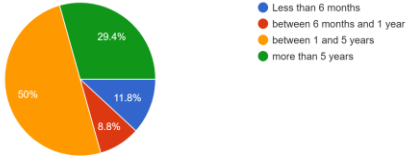
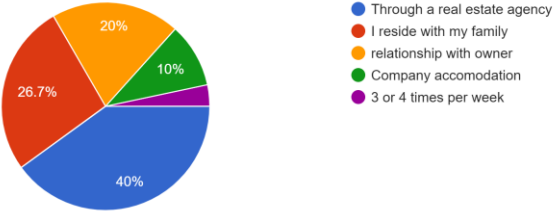
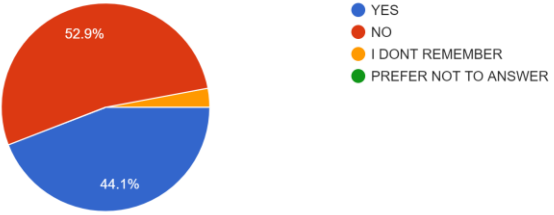
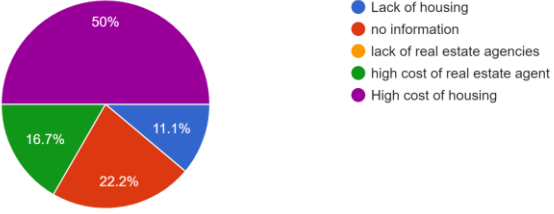
S/N	Question	Options & Data
Q(6)	<p>Which of the following did you use as a source of information when purchasing your house</p>	<p><i>Family inheritance (55.6%)</i> <i>Offer from my job (11.1%)</i> <i>Internet (22.2%)</i> <i>Housing Agents (11.1%)</i></p>
Q(7)	<p>If tomorrow you had to sell your house/ apartment, what means would you use?</p> <p>Q (7) If tomorrow you had to sell your house / apartment, what means would you use? 11 responses</p> <p>A horizontal bar chart with cyan bars. The x-axis represents the number of responses from 0 to 8. The y-axis lists the means used. The bars are: Housing agent (8, 72.7%), TV AND RADIO (0, 0%), NEWS PAPER (1, 9.1%), INTERNET (5, 45.5%), LOCAL GOVERNMENT AGENCIES (0, 0%), and Le bon coin (1, 9.1%).</p>	<p><i>Housing Agent (70%)</i> <i>Newspaper (10%)</i> <i>Internet (50%)</i></p>
Q(8)	<p>In the context of the sale of a house, what are the main advantages that a real estate agency has to offer?</p>	<p><i>The assurance of selling my property (40%)</i> <i>The assurance of selling at the right price (50%)</i> <i>Time saving (10%)</i></p>

	<p>Q (8) In the context of the sale of a house / apartment, which (s) are, in your opinion, the main advantages that can bring you a real estate agency? 11 responses</p>  <ul style="list-style-type: none"> ● the assurance of selling my property ● time saving ● the assurance of selling it at the right price ● profit from each traction 	
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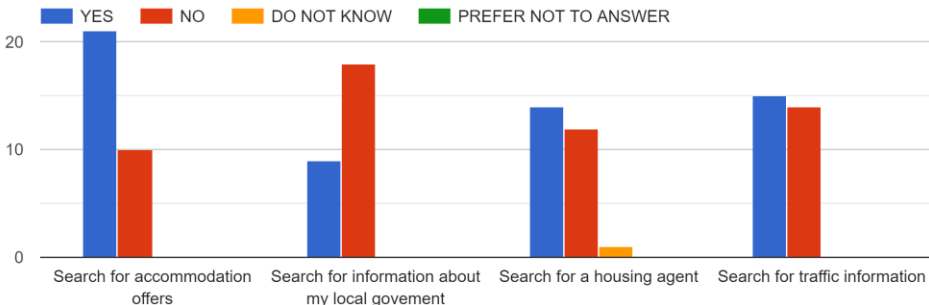
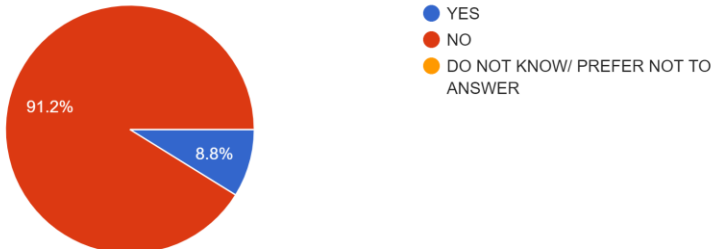
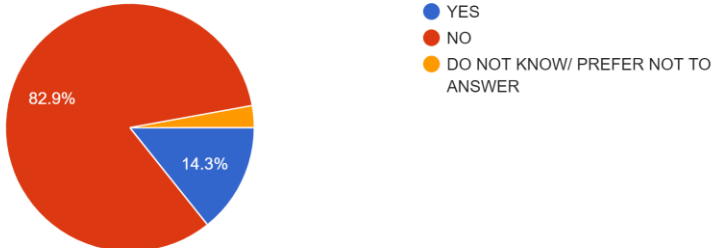
Section III- Level in the society

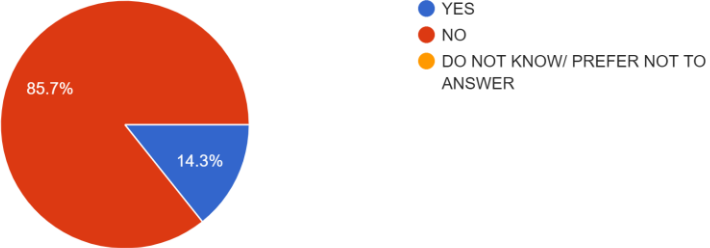
S/N	Question	Options & Data
Q(9)	<p>Which category best describes the total gross annual income of your household?</p> <p>Q (9) Which category best describes the total gross annual income of your household?(Please add all your household incomes) 34 responses</p> 	<p><i>Less than N100, 000 (20%)</i> <i>N100, 000- N500, 000 (16.7%)</i> <i>N500, 000- N1 million (13.3%)</i> <i>N1 million- N5 million (26.7%)</i> <i>N5 million and above (13.3%)</i></p>
Q(10)	<p>What is the highest level of education you have completed?</p> <p>Q (10) What is the highest level of education you have completed? 30 responses</p>  <ul style="list-style-type: none"> ● Elementary School (or lower) ● High school ● Vocational/ Professional Course ● BA ● Master's degree ● Doctoral degree ● Prefer not to answer 	<p><i>BA (50%)</i> <i>Masters' Degree (34.6%)</i> <i>High School (7.7%)</i></p>
Q(12)	<p>What is your current employment status?</p> <p>Q (12) What is your current employment status? 34 responses</p>  <ul style="list-style-type: none"> ● Full-time job (30 hours or more per week) ● Part-time job (less than 30 hours per week) ● Unemployed ● Student ● Pensioner ● Prefer not to answer ● Entrepreneur 	<p><i>Full- time Job (70%)</i> <i>Part- time Job (13.3%)</i> <i>Unemployed (10%)</i></p>

Section IV- Length of occupation and rent of current apartment

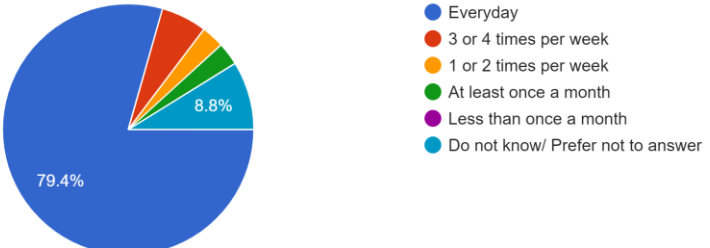
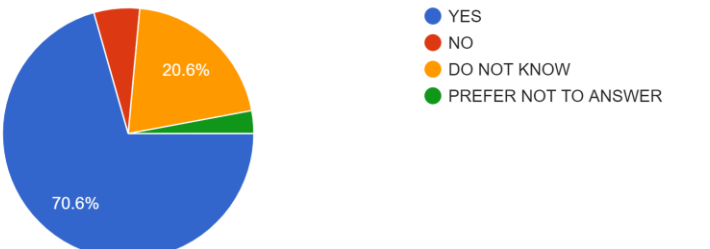
S/N	Question	Options & Data
Q(13)	<p>How long have you lived at your current residence</p> <p>Q (13) How long have you lived at your current residence? 34 responses</p>  <ul style="list-style-type: none"> ● Less than 6 months ● between 6 months and 1 year ● between 1 and 5 years ● more than 5 years 	<p><i>Less than six months (13.3%)</i></p> <p><i>Between six months and 1 year (6.7%)</i></p> <p><i>Between 1 years and 5 years (50%)</i></p> <p><i>More than 5 years (30%)</i></p>
Q(14)	<p>How did you find this apartment/ house?</p> <p>Q (14) How did you find this apartment / house? 30 responses</p>  <ul style="list-style-type: none"> ● Through a real estate agency ● I reside with my family ● relationship with owner ● Company accommodation ● 3 or 4 times per week 	<p><i>Through a real estate agency (42.3%)</i></p> <p><i>I reside with my family (26.9%)</i></p> <p><i>Relationship with owner (15.4%)</i></p> <p><i>Company accommodation (11.5%)</i></p>
Q(15)	<p>Did you have difficulty finding this accommodation?</p> <p>Q (15) Did you have difficulty finding this accommodation? 34 responses</p>  <ul style="list-style-type: none"> ● YES ● NO ● I DONT REMEMBER ● PREFER NOT TO ANSWER 	<p><i>Yes (50%)</i></p> <p><i>No (50%)</i></p>
Q(16)	<p>If YES, what are the main causes according to you?</p> <p>Q (16) If YES, what are the main causes according to you? 18 responses</p>  <ul style="list-style-type: none"> ● Lack of housing ● no information ● lack of real estate agencies ● high cost of real estate agent ● High cost of housing 	<p><i>High costs of housing (52.9%)</i></p> <p><i>High cost of real estate agent (17.6%)</i></p> <p><i>No information (17.6%)</i></p> <p><i>Lack of housing (11.8%)</i></p>

Section V- Sources of information

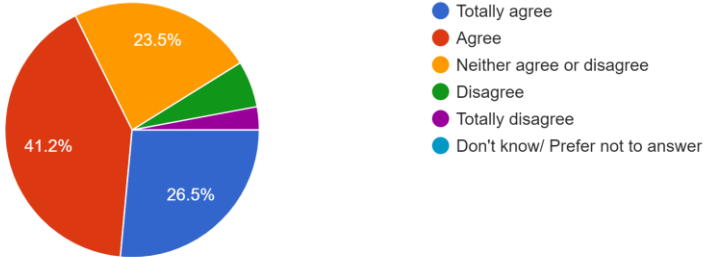
S/N	Question	Options & Data																									
Q(17)	<p>Have you ever used the internet for the following option</p> <p>Q (17) Have you ever used the internet for the following option?</p>  <table border="1" data-bbox="343 604 1276 907"> <caption>Data for Q(17) Bar Chart</caption> <thead> <tr> <th>Search Option</th> <th>YES</th> <th>NO</th> <th>DO NOT KNOW</th> <th>PREFER NOT TO ANSWER</th> </tr> </thead> <tbody> <tr> <td>Search for accommodation offers</td> <td>21</td> <td>10</td> <td>0</td> <td>0</td> </tr> <tr> <td>Search for information about my local government</td> <td>9</td> <td>18</td> <td>0</td> <td>0</td> </tr> <tr> <td>Search for a housing agent</td> <td>14</td> <td>12</td> <td>1</td> <td>0</td> </tr> <tr> <td>Search for traffic information</td> <td>15</td> <td>14</td> <td>0</td> <td>0</td> </tr> </tbody> </table>	Search Option	YES	NO	DO NOT KNOW	PREFER NOT TO ANSWER	Search for accommodation offers	21	10	0	0	Search for information about my local government	9	18	0	0	Search for a housing agent	14	12	1	0	Search for traffic information	15	14	0	0	
Search Option	YES	NO	DO NOT KNOW	PREFER NOT TO ANSWER																							
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Search for a housing agent	14	12	1	0																							
Search for traffic information	15	14	0	0																							
Q(18)	<p>Do you use any newspaper to find accommodation?</p> <p>Q (18) Do you use any newspaper to find Accommodation? 34 responses</p>  <table border="1" data-bbox="502 1153 1220 1400"> <caption>Data for Q(18) Pie Chart</caption> <thead> <tr> <th>Response</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>YES</td> <td>8.8%</td> </tr> <tr> <td>NO</td> <td>91.2%</td> </tr> <tr> <td>DO NOT KNOW/ PREFER NOT TO ANSWER</td> <td>0%</td> </tr> </tbody> </table>	Response	Percentage	YES	8.8%	NO	91.2%	DO NOT KNOW/ PREFER NOT TO ANSWER	0%	<p>Yes (10%) No (90%)</p>																	
Response	Percentage																										
YES	8.8%																										
NO	91.2%																										
DO NOT KNOW/ PREFER NOT TO ANSWER	0%																										
Q(19)	<p>Do you receive information about Lagos State Government housing projects</p> <p>Q (19) Do you receive information about Lagos state government housing projects? 35 responses</p>  <table border="1" data-bbox="502 1724 1220 1971"> <caption>Data for Q(19) Pie Chart</caption> <thead> <tr> <th>Response</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>YES</td> <td>14.3%</td> </tr> <tr> <td>NO</td> <td>82.9%</td> </tr> <tr> <td>DO NOT KNOW/ PREFER NOT TO ANSWER</td> <td>2.8%</td> </tr> </tbody> </table>	Response	Percentage	YES	14.3%	NO	82.9%	DO NOT KNOW/ PREFER NOT TO ANSWER	2.8%	<p>Yes (16.1%) No (83.9%)</p>																	
Response	Percentage																										
YES	14.3%																										
NO	82.9%																										
DO NOT KNOW/ PREFER NOT TO ANSWER	2.8%																										

Q(20)	<p>Do you usually listen to the radio stations to look for available accommodation?</p> <p>Q (20) Do you usually listen to the radio stations to look for available accommodation ?</p> <p>35 responses</p>  <p>Legend: ● YES ● NO ● DO NOT KNOW/ PREFER NOT TO ANSWER</p>	<p>Yes (16.1%) No (83.9%)</p>
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Section VI- Frequency of and constraints posed by traffic

S/N	Question	Options & Data
Q(21)	<p>How often do you encounter traffic on your way to work?</p> <p>Q. (21) How often do you encounter Traffic on your way to work ?</p> <p>34 responses</p>  <p>Legend: ● Everyday ● 3 or 4 times per week ● 1 or 2 times per week ● At least once a month ● Less than once a month ● Do not know/ Prefer not to answer</p>	<p>Every day (83.3%)</p>
Q(22)	<p>If so, do you think this traffic congestion problem can be resolved?</p> <p>Q (22) If so do you think this traffic congestion problem can be resolved ?</p> <p>34 responses</p>  <p>Legend: ● YES ● NO ● DO NOT KNOW ● PREFER NOT TO ANSWER</p>	<p>Yes (73.3%) Do not know (20%) No (6.7%)</p>

Section VII- Interaction with Internet

S/N	Question	Options & Data
Q(30)	<p>To what extent do you agree that the use of the internet and data can help solve housing problem in Lagos State?</p> <p>Q.(30) To what extent do you agree with the following sentence: "THE USE OF INTERNET AND DATA CAN HELP SOLVE HOUSING PROBLEM IN LAGOS STATE?"</p> <p>34 responses</p> 	<p><i>Totally Agree (26.7%)</i></p> <p><i>Agree (36.7%)</i></p> <p><i>Neither Agree nor Disagree (26.7%)</i></p>