

# Enhancing Public Housing Quality Using Machine To Machine Communication for SDG 11 In Ikeja GRA, Lagos

OLUNLOYO Olubukola Ainafnitp, OJOSIPE Tolulope

**Abstract**— The aim of this paper is to improve public housing quality and provide socio-economic sustainability through smart equipment and appliances in homes bridged by the Internet of Things (IoT) using Machine to Machine (M2M) communication network in Ikeja. This is achieved through collection of secondary data as a compliment of primary data. Questionnaire administration for primary data collection was achieved using simple random sampling technique. Oral interview was also conducted for officials in Ministry of Housing, for operational information and challenges. The sample frame is the total number of streets in Ikeja GRA which is 46 streets. The sample size from this is 25% of streets in the study area. Hence, 150 questionnaires were administered randomly to respondent household heads on 12 selected streets. Findings from the study reveal that despite Ikeja Government Reserved Area (GRA)'s economic relevance, the study area is faced with environmental defects caused by government negligence. These inadequacies are manifest as flooding, bad road, overstretched utility and buildings. These defects were confirmed by interviewed officials in the Ministry of Housing. Therefore, in order to ensure sustainable housing and environmental quality in the study area, recommendations would be the domestication of sustainable development goal 11 and inclusive rehabilitation of Ikeja GRA, Lagos.

**Index Terms**— Fourth Industrial Revolution (4IR), Housing Quality, Internet of things (IoT), Machine to Machine (M2M), Sustainable Development Goal 11(SDG 11).

## I. INTRODUCTION

This paper shows that technology is an evidence-based strategy for improving the quality of public housing in Ikeja GRA and Nigeria. For example, with smart analysis of demographic data, policymakers can gain a better understanding of the needs and preferences of the public housing population in terms of age, gender, income level, and family size. This can inform the design and management of public housing units, ensuring that they are well-suited to the needs of the residents. According to Resul and Gurkan (2015) [18], Machine to Machine (M2M) communication using the internet of things (IoT) protocol is a fast growing technology, it is used to gather data from smart devices and shared with other devices over a network. Therefore, within the town planning sector, information gathered can be analyzed to facilitate decision-making that would improve

the quality of life of residents within a community or indeed the world.

One of the policy goals of sustainable development is the delivery of adequate housing for countries in the global south. This is because in many countries of the global south housing delivered more through private mechanisms, consequently this poses challenges to adequate housing delivery for most countries of the global south and the Nigerian populace. Some of the challenges faced in providing decent and adequate housing for the people include problems of unskilled workmen, unachievable westernized building standards, housing finance, high level of urbanization, poor policy programmes, and contravention of building standards in addition to poor building materials (Ezeanah, 2021) [9]. Taking a sample case of housing in Ikeja GRA Lagos, smart information can be utilized to analyze the state of public housing development by gathering and analyzing relevant data from smart devices.

More so that, only about 30% of Nigerians have access to quality housing. Housing is the second most essential basic needs of humanity outside food and its impact on health, welfare and output of man is profound. The country's housing crisis is further exacerbated by low incomes, which make privately constructed houses too expensive for most people (Essen, 2022) [8]. In a bid to address housing dilemma, Lagos State Government has commissioned some housing estates in the state. Recently, it commissioned the Ikeja Millennium Housing Estate to cater for housing need of the people. The estate which is situated in Government Reserved Area (GRA) (Enisan, 2017) [7]. As a result, there is a need for government intervention to improve the quality and quantity of housing in Nigeria, particularly in the study area.

In addition to the above, M2M communication can be used to gather data on housing affordability and inform the development of targeted policies. By analyzing data on residents' incomes and housing costs, authorities can develop strategies to address affordability issues and ensure that public housing is accessible to those in need (Sina et al, 2022) [19]. One way M2M communication can enhance public housing quality is by providing real-time monitoring of housing conditions. Smart devices, such as temperature sensors and humidity meters, can be installed in homes to continuously monitor conditions and alert maintenance staff when issues arise (Fuzail et al, 2022) [10]. This can help prevent minor problems from becoming major repairs and ensure that residents are living in safe and comfortable conditions.

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In other words, M2M communication can be used to gather data on residents' satisfaction with their housing. Surveys and feedback forms can be distributed through smart devices, allowing residents to provide input on their living experience. This data can be used to identify areas for improvement and implement changes that increase overall satisfaction in the study area.

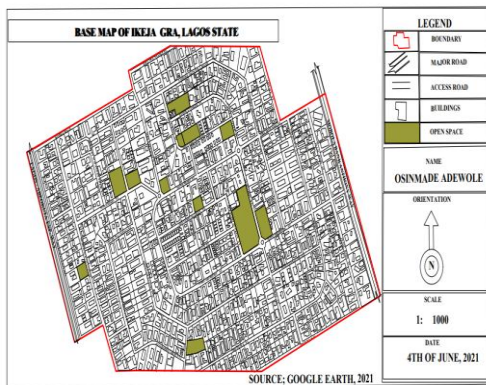
It is in the light of this that this study seeks, to fill the knowledge gap of public housing delivery and domestication of sustainable development goal (SDG) 11 in Nigeria, by introducing using machine to machine (M2M) communication using Internet of things (IoT) protocol to the holistic upgrade of GRA Ikeja in the 4<sup>th</sup> industrial revolution (4IR).

The aim of this paper is to improve public housing quality and provide socio-economic sustainability through smart equipment and appliances in homes bridged by the IoT using M2M communication network in Ikeja GRA.

In order to achieve this aim, the following objectives are relevant:

1. Assess socioeconomic characteristics of residents as stakeholders and SDG target group
2. Examine existing situation of the study area for housing and environmental deficit
3. Appraise residents' satisfaction of study area in the 4<sup>th</sup> industrial revolution
4. Assess residents' knowledge and ability to reside in a smart public housing
5. Examine inclusive improvement of GRA Ikeja for its sustainability.

## II. THE STUDY AREA



The study area is Ikeja G.R.A, located by coordinates on latitude DMS 6°34'49.84"N and longitude DMS 3° 21'5.35"E at an elevation of 36.93m (121.16 feet) (Distancesto.com, 2022) [5].

The reason behind choosing this study area is because it is a typical highbrow residential neighbourhood in Ikeja, the capital of Lagos state. According to Geographic.org (1995-2022), streets in Ikeja GRA are: Abeyiwa Amadasun, Adeunle Fajuyi way, Adeniji Adele, Adetunji Adeoba, Adeyemo Alakija, Airport road, Akinseye close, Alogba, Ayoola Coker, Ayo Rosiji crescent, Eso close, Esugbaye, Fajuyi way, Harold Sodipo crescent, Herbert Macaulay crescent, Ikeja Bridge, Ikeja general hospital road, Immigration barrack, Isaac John, Joel Ogunnaike, Ladoke Akintola road, Lagos-Abeokuta express, Lasucom road, Michael Ogun,

Mobolaji Bank Anthony way, Mohammed Yusuf, Muiz Banire, Oba Akinjobi way, Oba Ladejobi, Obasa, Oduduwa crescent, Oduduwa, Oduduwa way, Oladipo Bateye road, Old Works Yard road, Olutoye close, Remi Fani-Kayode avenue, Rev. Ogunbiyi, Sanni Tola Sonoiki close, Sasegbon, Sir Michael Otedola crescent, Sobo Arobiodu, Tayo Ayeni, Umaru Abass close, Works road, Works Ya road.

The pre-independent era marked the first effort towards housing delivery in Nigeria. Also, the beginning of the Government Residential Areas known as GRAs, where houses were built to provide adequate comfort for the residents as the "housing forms and spatial patterns of the GRA reflected the English nostalgia for the garden city." In the post-independence housing era, 1960-1972 housing units in the GRA formally occupied by the colonialist became the abode of the new Nigerian administrative and political elites without any form of objection by these elites (Ezeanah, 2021) [9]. Hence, history of government intervention in public housing especially in Ikeja GRA predates the present 21<sup>st</sup> century or 4<sup>th</sup> industrial revolution era. The pre-independence or colonial era occurred through 18<sup>th</sup> century, first industrial revolution or Baroque age to the 19<sup>th</sup> century machine age or second industrial revolution, while post-independent or post-colonial era, can be traced from the 1960s third industrial revolution.

## III. LITERATURE REVIEW

The survey of past effort in housing studies, relevant to this study provides secondary data. It reveals the link between machine to machine (M2M) communication using internet of things (IoT) protocol, 4<sup>th</sup> industrial revolution (4IR), housing quality, housing deficit, environmental defects, and SDGs especially target 11 as follows:

According to Resul and Gurkan, (2015) [18], gathering data on housing affordability using Machine to Machine (M2M) communication can be done through the use of smart devices, such as sensors and meters, that are installed in homes. These devices can gather data on various aspects of housing affordability, including:

- Income: Smart devices can be used to gather data on residents' incomes, either through self-reported data or through integration with income sources such as employment records or government benefits.
- Housing costs: Smart devices can be used to gather data on the costs associated with housing, including rent or mortgage payments, utility bills, and maintenance expenses.
- Affordability ratios: Data on incomes and housing costs can be used to calculate affordability ratios, such as the percentage of income spent on housing costs. This can provide a measure of the burden of housing costs on residents and inform policies to address affordability issues.
- Comparison with market rates: Data on housing costs can be compared with market rates for similar housing in the area to assess the relative affordability of public housing.

Similarly, Lavopa and Delera (2021) [14], defined the fourth industrial revolution (4IR) as a term coined in 2016 by Klaus Schwab, founder and chairman of the World Economic

Forum (WEF). It is characterized by the convergence and complementarity of emerging technology domains, including nanotechnology, biotechnology, new materials and advanced digital production (ADP) technologies. The latter includes 3D printing, human-machine interfaces (HMIs) and artificial intelligence, and is already transforming the global industrial landscape. Incorporating ADP technologies into industrial production processes has given rise to the Smart Factory – one that learns as it works, continuously adapting and optimizing its own processes accordingly.

Furthermore, from 3D printing to bio manufactured materials, new building technologies have been making the headlines as a quicker-and cheaper way to address the global housing deficit, which is expected to affect 1.6 billion people by 2025. These new technologies could also present outsized environmental benefits by cutting construction waste, while proving to be carbon neutral or even negative (Triveno and Nielsen, 2021) [23], Therefore Hayes (2022) [13], defined smart home as a convenient home set up where appliances and devices can be automatically controlled remotely from anywhere with an internet connection using a mobile or other networked device. Devices in a smart home are interconnected through the internet, allowing the user to control functions such as security access to the home, temperature, lighting, and a home theatre remotely.

Conversely, according to Ezeanah (2021) [9], housing is second most essential basic need of man outside food. Its impact on health and welfare and output of man is profound. Therefore, housing plays a vital role in a person’s standard of living and place in the society. Nnodim (2022) [17], in his report of the World Urban Forum stated that, housing is a key input in economic, social, and civic development. More so that, housing quality concerns simply the quality of the internal and external structure of a dwelling and aspects of the internal environment. It may include features of the neighbourhood and concepts such as environmental sustainability. It touches many facets of economic activity and development (Mbazor, 2018) [15]. Gov. UK (2011) [12] stated that, the housing quality indicator (HQI) system is a measurement and assessment tool to evaluate housing schemes on the basis of quality rather than just cost. These indicators are: location, site (visual impact, layout and landscaping), site (open space), site (routes and movement), unit (size), unit (layout), unit (noise, light, services and adaptability), unit (accessibility within the unit), unit (sustainability), and external environment. Streimikiene (2014) [21], discussed the measure of housing indicators related to quality of life to include: housing quality (space), housing environment (quality of dwelling and residential area) and housing expenditure burden (housing affordability).

However, with a growing urban population, increasing construction costs, and declining household income, access to affordable housing is becoming more difficult for millions of citizens. Emiedafe (2015) [6] stated that, Nigeria with a population of about 174 million people is currently facing a national housing deficit of about 17 million units. Ajakaiye (2022) [2], explained that, the origin of housing problem in Nigeria can be traced back as far back as the colonial period. The British colonial rulers wanted houses that met up to

living conditions of their own country and proceeded to develop special areas, hence the establishment of Government Residential; Areas (GRA) around the country. The houses in such areas were well planned and furnished with all necessary amenities. This approach only solved housing issues for a selected group. Over years, government has at various times tried different housing policies and programmes to treat the housing problems in the country. Some of these policies are reflected in: Land Use Act 1978, Mortgage Institutions Act 1989, Federal Housing Authority Act 1990, National Urban Development Policy 1997, Housing and Urban Development Policy 2002. Some of their interventions include: The Nigerian Army housing scheme, the Nigerian Police Force housing scheme, the Nigerian Port Authority housing scheme, Freehold housing scheme and Sites and service estates, Worker’s housing estate.

Nevertheless, growing housing deficit in Nigeria, particularly in urban areas, has resulted to various housing problems such as overcrowding, homelessness, slum and squatter developments. Despite the myriad of housing policies and programmes to solve the housing deficit, the desire goals have not been achieved (Adegoke and Agbola, 2020) [1]. Mboho (2021) [16], in his report stated that, solving the challenge of severe housing deficit will entail creating linkages between the provisions of land to property developers, through increased availability of housing finance, to a reduction in property transaction costs.

Concomitantly, Sustainable Development Goals (SDGs), also known as the Global goals were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity. The 17 SDGs are integrated –they recognize that action in others, and that development must balance social, economic and environmental sustainability. Sustainable Development Goal 11 make cities and human settlements inclusive, safe, resilient and sustainable (The Global Goals for Sustainable Development, 2022) [22]. According to United Nations (2019), as stated in Target 11.1 Safe and Affordable Housing: By 2030, ensure access to adequate, safe and affordable housing and basic services and upgrade slums.

Lesson from literature survey is that smart homes and new technologies are complimentary to quality housing and sustainable development. This is so because they mitigate climate change through reduction of waste and emission of harmful gases. However, these alone cannot solve the problem of housing deficit in the country, other variables which requires, meaningful spatial plan derivable on the basis of a series of data covering a wide range of gender, social and economic activities to reveal patterns of activities overlapping with other variables such as age, class or status in the family.

#### IV. METHODOLOGY

The methodology for this study involves collecting data from a sample of 12 streets (Oduduwa, Oduduwa way, Oduduwa crescent, Oba Dosunmu, Sobo Arobiudu, Oba Akinjobi, Ayo Rosiji, Remi Fani-Kayode, Ladoke Akintola, Eso, Isaac John, Harold Sodipo Streets) out of 48 streets in Ikeja GRA, representing 25% of the total number of streets in

the area. These streets were selected using a simple random sampling technique in order to provide a fair representation of the sample frame and to include known areas with environmental defects. A total of 150 questionnaires were administered to residents on these streets, and oral interview using structured questions were conducted with officials from the Lagos State Ministry of Housing to gather operational information and identify challenges.

The data collected were analysed using descriptive statistical methods such as percentages, charts, and tables. This will provide a comprehensive overview of the socioeconomic characteristics of residents, the existing housing and environmental conditions, residents' satisfaction with the 4th industrial revolution, and residents' knowledge

and ability to reside in a smart public housing environment. The results of this analysis will be used to identify potential strategies for improving the sustainability of the GRA Ikeja.

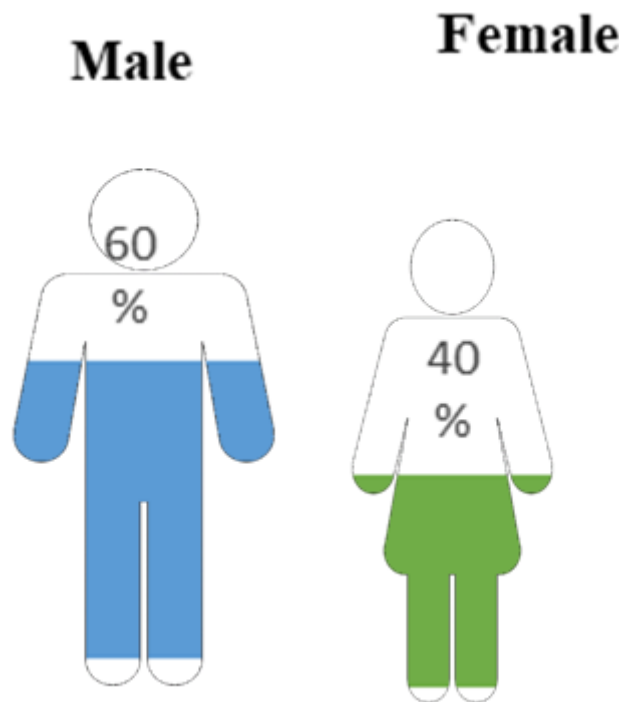
V. ANALYSIS

The below descriptive analysis reveals the derivative of inclusive improvement of Ikeja GRA for 4IR and sustainable development based on the data collected.

A. Gender Analysis

Chart I gives an insight on the distribution of the gender in the sample. It reveals that 40% of the respondents are female while the remaining 60% are male. Therefore, respondents in the study area are mostly of the male gender. This implies that challenges or discrimination in property acquisition in the study area is affects the male gender mostly.

Chart I: Respondents' Gender



Source: (Authors' field work, 2023)

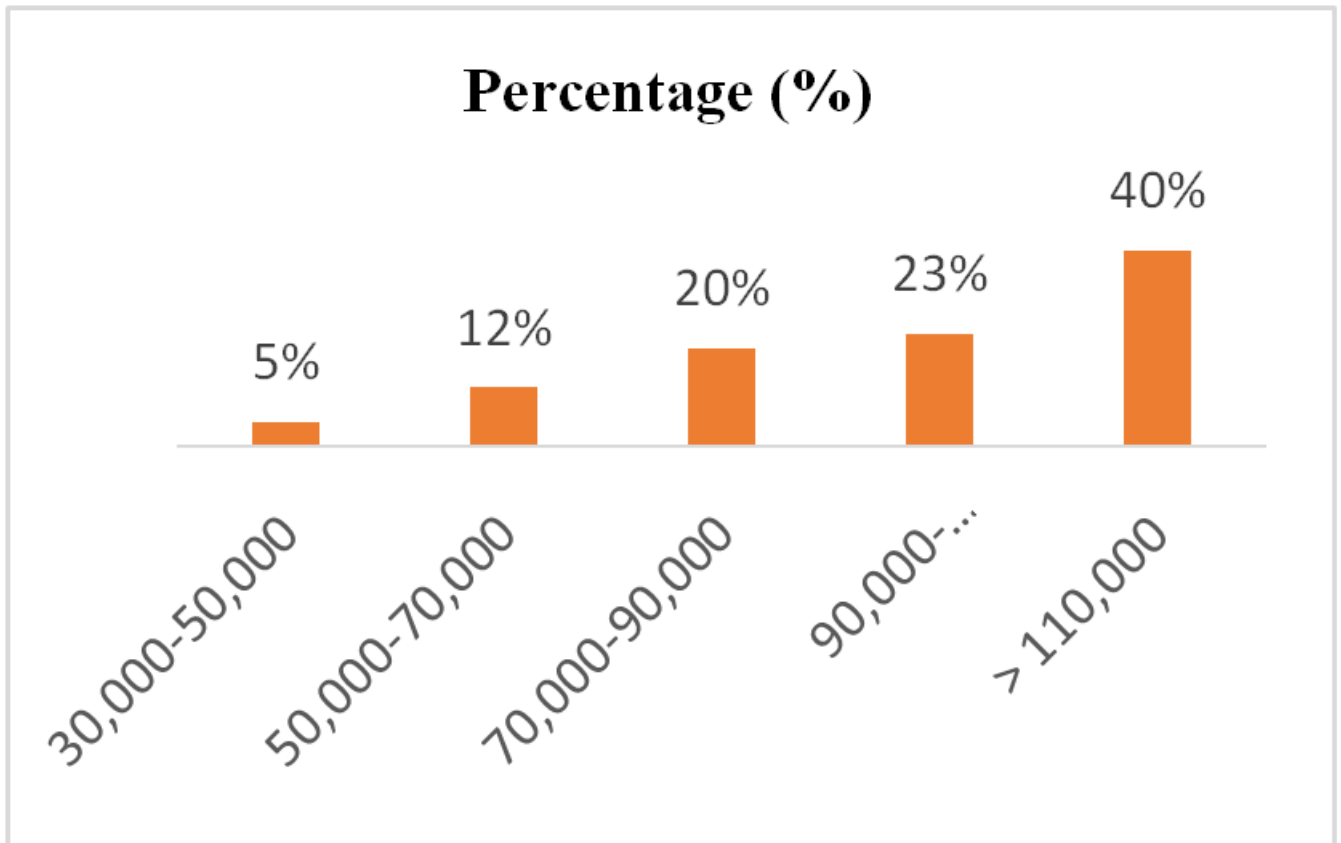
B. Income Analysis

This gives an insight into the income range (in Naira) of the total 150 respondents in the survey. Chart II reveals the frequency and percentage of each income-range such that 5% of the respondents earn between N30,000 – N50,000 on a

monthly basis, 12% earned between N50,000-N70,000, 20% earn between N70,000-N90,000, while 23% earn N90,000-N110,000 and 40% earn above N110,000. Therefore, majority of respondents earn above N110, 000 monthly. This confirms that majority of the residents are high income earners, living above the United Nations' poverty line of one dollar per day.



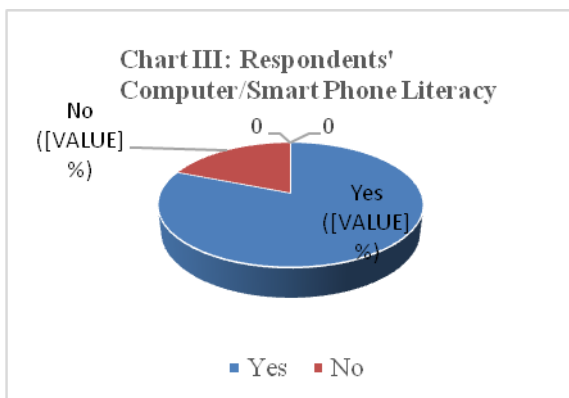
Chart II: Monthly Income Percentage



Source: (Authors' field work, 2023)

**A. Computer-Literacy Analysis**

The data collected is analyzed to show respondents' Computer or smart phone literacy. As seen in Chart 3, 81% of the respondents are computer or smart phone literate, while 19% are not computer or smart phone literate. Therefore, majority of respondents in the study area are computer or smart phone literate. This implies that respondents as stakeholders will understand and support digital upgrade of the study area, which will be a good development.



Source: (Authors' field work, 2023)

**B. Environmental Analysis**

TheTable Ishows an inventory of Ikeja GRA sample areas'environmental characteristicsby authors' perception as follows: Sample areashave internet facilities either on their phones or in their buildings; other available facilities such as: Schools, Police post, recreational facilities, clinics, and air space. The manifestation of environmental defect shows that, sample areas have shanty development around their buildings, and only utilized as corner shops. No smart public utilities to provide the citizens, electricity usage monitoring, security, safety, transportation and other public services; smart lighting to control the lighting in their homes remotely and help save energy by turning lights off when they are not needed; smart appliances, such as smart refrigerators and washing machines, can be controlled remotely and may have features that help save energy and water; smart security systems use sensors, cameras, and other devices to monitor homes for security purposes and can be controlled remotely; smart health devices such as wearable fitness trackers and smart scales, can track users' health data and provide insights and recommendations.

Also, no landscape, no trees except a few in Oduduwa street, Oduduwa way and Oduduwa crescent; they are floodable areas, no traffic light, no ICT cameras, no street light, bad or no drainage, no sidewalks, with parking problems, no fire

service stations and insufficient setbacks. This environmental defects in the study area confirms noncompliance to the 4<sup>th</sup> industrial revolution (4IR) standard and need for inclusive improvement or upgrade.

**Table I: Inventory by perception of Ikeja GRA Sample Areas’ Environmental Characteristics**

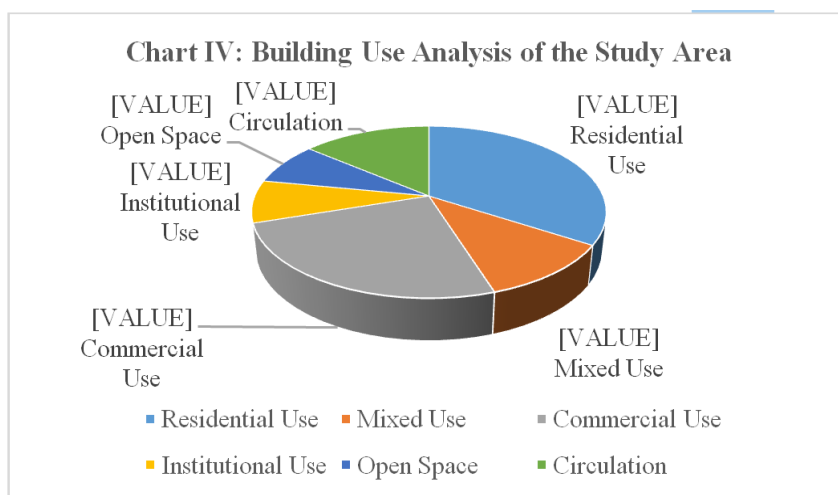
Sample Areas	No internet facility	No Landscaped	No Trees	Floodable Areas	No traffic light	No Banks	No ICT camera	No Street light	Bad / No Drainage	No Electricity	Uncontrolled Waste	No Public Toilets	Bad Roads	No Sidewalks	Parking Problems	Insufficient Schools	No Clinics	No Police Post	Facilities	Setback	Setback	No Smart utilities	
Avo Rosiji		x	x	x	x		x	x	x		x	x	x	x	x			x				x	x
Eso		x	x	x	x		x	x	x		x	x	x	x	x			x				x	x
Harold Sodipo		x	x	x	x		x	x	x		x	x	x	x	x			x				x	x
Isaac John		x	x	x	x		x	x	x		x	x	x	x	x			x				x	x
Ladoke Akintola		x	x	x	x		x	x	x		x	x	x	x	x			x				x	x
Oba Akinjobi		x	x	x	x		x	x	x			x	x	x	x			x				x	x
Oduduwa		x	x				x	x	x		x	x	x	x	x			x				x	x
Oduduwa Way		x	x				x	x	x		x	x	x	x	x			x				x	x
Oduduwa crescent			x				x	x	x		x	x	x	x	x			x				x	x
Oba Dosunmu		x	x	x			x	x	x		x	x	x	x	x			x				x	x
Remi			x	x	x		x	x	x		x	x	x	x	x			x				x	x
Sobo Arobiodu		x	x	x	x		x	x	x			x	x	x	x			x				x	x

Source: (Author’s field work, 2023)

**C. Building-Use Analysis**

This gives an insight into what the existing buildings in the study area are being used for. Chart 4 analyses this in different categories of usages such as; Residential use makes 34%, while commercial use stands at 25%, whereas mixed use (Commercial and Residential) remains at 8%, while

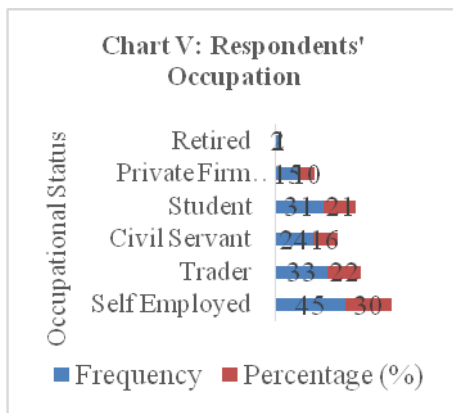
institutional use makes 11%, open space stand at 8% and circulation stands at 14%. Therefore, residential use is predominant building use in the study area. This indicates that the study area is residential and expected to have residential facilities and infrastructure that enhances good living.



Source: (Authors’ Field Work, 2023)

**D. Occupation Analysis**

The occupational analysis of residents of the sample study area is analysed using their frequencies and percentages to draw conclusions. In Chart 5 below 30% are self-employed and 22% of respondents are traders. Whereas, civil servants stand at 16%, while 21% are Students, and private firm workers in for example estate agent and architectural firm make 10%, however 1% of respondents are retired. Therefore, majority of respondents are self-employed mostly owning outlets for distribution of goods or services. This confirms that the unemployment rate in the study area is zero, which insinuates that majority of residents earn above the UN’s poverty line of one dollar per day.



Source: (Author’s Field Work, 2023)

**VII. RECOMMENDATIONS**

Having established that the study area requires inclusive improvement or upgrade for its sustainable development, the following recommendations are suggested as follows:

**A. Improvement and Upgrade to 4IR**

Enlightenment for re-orientation of residents on 4IR should be made a priority for sustainable development. There should also be a general sensitization through mass media, seminars, and symposium of professional in the building industry, property owners and residents in the study area on importance of 4IR for sustainable development of a smart metropolitan Lagos. This will ensure smart citizen’s inclusion as essential to sustainable upgrade of Ikeja GRA. Therefore, all stakeholders especially women who make a lower percentage of the study area, should be mobilized for this reason. Inclusion of stakeholders in the improvement of Ikeja GRA is a priority because they are the target group in the sustainable

development goals (SDGs) especially target 11. Hence, Lagos state government and Ministry of housing, should also adopt the SDGs guide.

**B. Housing Deficit Solution**

Emiedafe (2015) proposed 9 solutions to Nigeria’s 17 million housing deficits, to include:

- Review and totally implement the National housing Policy
- Establishing a viable mortgage system
- Easy registration
- Public Housing projects
- Private sector participation
- Locally manufactured building materials
- Provision of rental housing (subsidized housing or incorporating social housing)
- Provision of infrastructures
- Policy research

**C. Implementation of Smart Development Plans**

To ensure M2M using IoT protocols, findings show that a larger percentage of the residents in the sample area are computer literates, therefore, smart development plans which could be viewed on any device with internet, should be prepared and implemented to fast track urban development and monitoring. Also, to be implemented are environmental models to solve environmental defects, such as non-compliance with public open space standard and other elements of urban design contained in a development plan.

**D. 4IR Monitoring of Smart homes and Cities**

This is essential to ensure sustainability of improved Ikeja GRA. Optical devices/cameras for digital city surveillance, ICT (internet-based technologies) and e-government services should be encouraged for improved quality of life in smart homes and cities. Therefore, upgrade and improvement of sampled area for effective treatment of environmental defects and non-compliance to 4IR standards is imperative. There is need for Lagos State government to facilitate effective smart monitoring and social inclusion of smart citizens; allocation of sufficient funds to concerned agencies such as Lagos state

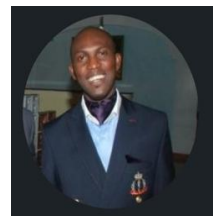
parks and gardens, LASPARK and Lagos state urban renewal agency, LASURA for efficiency and sustainable services.

## VII. CONCLUSION

This study concludes the use of M2M communication has the potential to bring significant benefits to Nigerian cities, including improved public services, enhanced urban planning, increased efficiency, and economic development. It also shows that adoption of the SDGs is essential to the upgrade of Ikeja GRA to 4IR standard. Area of further studies could be derived from 4IR for sustainable development of cities in Nigeria. Analysis from the collected data reveals that environmental defect confirmed during inventory of the study area, is manifest as the following: Floodable areas, no traffic light, no ICT cameras, no street light, bad or no drainage, no sidewalks, with parking problems, no fire service stations and insufficient setbacks. These environmental defects which varies only in degree in the study area confirms noncompliance to the 4<sup>th</sup> industrial revolution (4IR) standard and need for its upgrade. Therefore, in the upgrade and improvement of sampled area, there is need for the government to facilitate effective social inclusion through general sensitization using; mass media, seminars, and symposium of professionals in the building industry, property owners and residents in the study area. Also, optical devices/cameras for digital city surveillance, ICT (internet-based technologies) and e-government services should be encouraged to ensure sustainability of quality of life in Ikeja GRA. This will ensure sustainable development of a smart Ikeja GRA and metropolitan Lagos.

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### Educational and Professional Qualifications

<b>2023</b>	International Institute of Business Analyst IIBA professional member
<b>2023</b>	Certified Business Analysis professional (CBAP)
<b>2022</b>	Member Honors Society
<b>2022</b>	Professional Scrum Master (PSM I)
<b>2021</b>	Oracle Business Intelligence Explorer



2021	OCI Foundations Associate
2018	EU General Data Protection Regulation (GDPR) Foundation
2018	AWS – Solution Architect
2008	Microsoft Business Intelligence Specialist (MCPS)
2005	Microsoft Certified Business Intelligence
2022	Masters Business Administration in Information Management - Wester Governors University
2017	Bachelor of Science. Computer Science - ESPAM University
2015	Diploma in Strategic Project management – Westford College



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- 2019 Fellow, Lagos Studies Association
- 2018 Fellow, Nigerian Institute of Town Planners (FNITP/364)
- 2015 Masters of Science (Hons) Geography &

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*(Regional Planning & Development, First Class Division) University of Lagos, Nigeria*

2005 Master of Science (Hons) Urban & Regional Planning

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