Urbanization and Air Pollution: CO, CO_2 Concentrations in Kano Metropolis Nigeria

Hashim Abdullahi

(a) Department of Urban and Regional Planning, Faculty of Built Environment and Surveying, University Technology Malaysia UTM Skudai, 81310 Johor, Malaysia, (b) Department of Urban and Regional Planning, School of Environmental Science and Technology Federal Polytechnic Mubi, PMB, 35 Adamawa State Nigeria

hashimabdullahi46@yahoo.com

Gobi Krishna Sinniah

Department of Urban and Regional Planning, Faculty of Built Environment and Surveying, Universiti Technology Malaysia UTM Skudai, 81310 Johor, Malaysia

sgobi@utm.my

Ho Chin Siong

UTM Low carbon Asia Research Center, Universiti Teknologi Malaysia UTM Skudai, 81310 Johor, Malaysia

ho@utm.my

Abstract- The aim of the study is to unveil urbanization environmental pollution with references to CO, CO_2 emission concentration in Kano metropolis Nigeria. Carbon sensor and gas detector were employed for carbon emission concentration sensing and detecting. Geographical information system (GIS) was used for location map preparation. The results of the first six sampled local governments records depict that Fagge has the highest outdoor CO concentration of 12 Ppm, followed by Gwale with 11 Ppm and Kumbotso with exactly 10 Ppm. In contrary, the indoor records reveal that Gwale records the highest carbon concentration with 10 Ppm, followed by Fagge with 7 Ppm. In addition, the results of second four selected local governments with 12 selected stations indicates that CO_2 concentration is very high in station A across the stations (A, B, and C) used as sensing points. The results portray that outdoor carbon concentration is far greater than indoor concentration due the facts that more outdoor carbon emission related activities in the study area are discovered. Indoor carbon concentration is affected by population elements, household sizes, age group, gender, education level and income levels of the residents. While outdoor carbon concentration is influence by transportation activities, industrial activities, type of land use, densities, and income categories of the dwellers. It is strongly recommended for an in-depth and proactive control for the rapid urbanization environmental pollutions impacts to be enforced in the study area. Researches on the topic to be furthered conducted in the study area and an in-depth study on the related topic should be regularly conducted within the metropolis so as to achieve environmental air quality control and proactive mitigating measures could be fully implemented.

Keywords – Urbanization, Carbon Monoxides (CO), Carbon Dioxides (CO_2), Concentration, Kano Metropolis

I. INTRODUCTION

Traditionally, urbanization processes together with architectural buildings construction (housing) is the major converter of the agricultural land to land uses [1]. Urbanization is the prime cause of land-use changes in urban areas [2]. [3], revealed that the building sector is responsible for 40 % energy consumption globally and 30 % of world GHG gas emission. [4], stated that urban areas accommodate a large portion of the world population and is responsible for 75 % of world energy consumption. [5] studied that residential housing sector in Canada consumes 17 % of its energy and emits 14 of GHG. Housing demand with housing choice and urbanization are directly correlated with the level of income. Economic growth and land consumption could be intensively studied. Soil sealing, on the other hand, are majorly calculated by the help of cartographic and statistical data. Urbanization is speedily distorting environmental quality and its ecosystem globally. Before World War II, cities grew along routes, but development of car makes cities to expand towards rural area thereby fragmenting natural agricultural landscape. Forest and green belt that envelop and surrounded cities are vital parts of its ecosystem. Public green belt, therefore, improves the urban quality [1]. [6], comment that land use and climate intensity play an important role in spatial patterns of confrontation within the scope of biological elements together with socio-economic drivers. These result in very active gradients structuring European Ecosystem Services (ES) bundles. [7], environment and human health are facing great threats with regards to atmospheric pollution of Sulphur dioxides (SO_2). [8], comment that, the study solely focuses on the air quality in Belgaluru India. [9], comment that, study covers period 2005 to 2016 with special emphasis to air pollutants concentration. The scholarly research dwells on the concentrations and accumulations together with characterization of BTEX with the study area of Tehran. Ecosystem is environmentally and seriously being affected by particulates matters [10]. Ecosystem is receiving very great treats of mercury emission as one the major global pollutants [11]. [12] stated that land profiles, metrological conditions together with microclimate when sum up together are factors very in influential and influencing water dew. [13], respiratory chronic related diseases are the direct product of air pollution. The study uncovers around 4.2 million death across the globe and area because of the outdoor pollution [14]. China is significantly now and receiving, controlling, and mitigating predicaments and challenges of dramatic and rapid urbanization and socioeconomic development [15]. This study therefore aim is to unveil urbanization challenges with emphasis to environmental pollution directly connected to carbon monoxides and carbon dioxides emissions in Kano Metropolis Nigeria (KNMA).

II. URBANIZATION AND ITS ENVIRONMENTAL IMPLICATION

2.1 Environmental Pollution and Urbanization

The study assessed rapid urban growth in Kano metropolis with references to CO, NO_2, and SO_2 concentration and its impacts on the on-going global COVID-19 pandemic [16]. [17], comment that the study calculated and determined concentration of black carbon (BC) and $PM_{2.5}$ in a moderate city of southern Brazilian cities. [18], the study focused on the measurement at the major and busy streets in 2006 and in Stockholm with reference to concentration along Kernsides of NOx, black carbon (BC), and the sum total particles with 4nm diameter together with sizes distribution number ranging 28-410nm. [19], in the Southern Europe, the key and integral air pollutants is the ground level ozone(O_3). [20] comment that, the study shows in nearby rural areas in European Countries and USA poses upper ground -level ozone (O_3) than its corresponding urban areas. [21], the study employed Dynamic Land Ecosystem Model (DLEM) for the evaluation of the extend of urbanization in United States between 1945-2007. [22], comment that trees could have air pollution effects directly which could obviously observe within its life cycles of its physiological processes. [23], the study employed in its air pollution assessment survey of biomonitoring indicator of epiphytic lichens. [24], Lichens was employed for the evaluation of air pollution with the study landfill. [25], the study focused on the consequential effects of pollutants on the immune physiology of marine wildlife in relation to disease. [26], the study dwells on discovering related health effects on polar bears in relation to industrial pollutants transported over long period of time. [27] comment that Artic Council has a special working group named Artic monitoring and assessment program (AMAP) solely responsible for active and effective Artic ecosystem monitoring by evaluating contaminants. The study handled and evaluated environmental impacts of urban growth in Kano metropolis with emphasis to land use cover changes (LUCC) towards low carbon society development [28]

In addition, [29], the scholar elaborates that global weather system is directly being affected by Amazon and it regulates its regional climate specifically its precipitation in conjunction to its ecosystem. [30], in Artic, emission sources have significant effects on human health when its consistently and persistently expose to the organic pollutants. [31], the scholars employed black carbon indicator to assess fossil fuel combustion with the aid of on – bicycle air pollution concentration. [32], the work focused on the black carbon (BC) to the commuter directly collected from biodiesel and diesel buses within Curitiba city of Brazil. [33], the study uncovers that countries using old technologies and contaminated fuels, its urban commuter receives large proportion of air pollution. [34], the study employed ozone(O_3) concentration within the study period of 2015 to 2016 using 1497 selected station for the study in China. [35] the work takes its sources from experts and specialists within the trajectory of climate change, air pollution tremendous effects on the ecosystem from the 27th conference. [36], the study evaluated defoliation crown anticipated in 2050 within 3 climates with one nitrogen scenario as the primary aim of the study. [37], land use in China significantly affects its grassland between 1961-2000 and it was a very weak for carbon sink. This is the result of Dynamic Land Ecosystem Model (DLEM) simulation. [38], the scholars effectively connect and correlate climate change, environmental impacts of climate change on air quality and its consequential on vegetation of the case study employed for the study. [39], dynamic land ecosystem model (DLEM) was employed for the calculation and determinations of carbon storage with connection to assess its environmental changes within 1971 to 2001 in the study area Great Smoky Mountain National park.

2.2 Theoretical syntheses of carbon society models, policies, and principles

These forms the contents of Policies, Acts, and other related environmental challenges issues. These innovations have been in usage in the World and are used as mechanism of mitigating climate change issues. Waste to Energy (WtE) is an active technique that uses renewable energy (RE) to mitigate solid waste predicaments. Malaysian Acts of 2007 of MSW covers solid waste from households, commercials and public solid waste [41], the research conducted used the following dependent variables; oil price, coal price, gas price, temperature, availability, stock price, commodity, corporate risk premium, carbon price, carbon off set price and overall location. Passive House Planning Parkage (PHPP) is an energy software principally used to determined energy performance [42]. Over heating bench mark was used based on Passive house criteria. The work conceptualized and method integrated literature on innovation together with social inclusion and LCD [43]. Data was obtained through website and in-depth face- to -face interview conducted [44]. Data was collected through web-based survey and econometrics approach [45] and [46]. The work utilized socio-technical building performance in developing eco-housing in UK [47]. Data was collected through web-based survey. Codes for sustainable Homes is best technology chosen for housing developers in reaction to low carbon society and stated Nine areas essential as; energy/carbon, pollution , water, health and well- being, materials , management , surface water runs off, ecology and solid waste [45]. The work conceptualized and integrated literatures on innovation and social inclusion [53]. Four categories Energy efficient improvement, renewable energy development, sector structure adjustment and carbon sequestration. In China local governments plays vital functions in the constructions of low carbon city and model was formulated for anticipating the trend of carbon emission [48].

AIM endues AIM, Energy snap shot, Exss, Bilan and MARKAL but ExSS and MARKAL [49], carbon sequestering in forest [50], carbon prediction [51], Climate change and carbon Models calculations [52], European Union in its consideration developed a Cap-Trade Scheme in reaction to the general obligation of Kyoto Protocols [39]. European Union Carbon Emission Trading Scheme (EUETS) is the most functionally largest across the Globe. It allows and permits industries to acquire trade permits (permission) on market financial bases. Industries that go beyond its permissible level must purchase and acquire new additional permission in the design market. While, those that under-utilized their desirable and allowable permits level can sale its excess and this is governed by statistical modelling [39]. Carbon emission and contribution globally of African continent is not known , this is because researches conducted are but very few. The continent experiencing dramatic raise in population growth, land degradation and deforestation [53]. Literature studied so far revealed tremendous effort is being made towards low carbon society across the World as a whole. However, the study also depicts less effort is made in the subject matter in African Nations towards the development of carbon society particularly in Nigerian Housing Sector. This may be because of weak interest of the government together with lack of experts in the field. Low level of technology may have significant role in this issue together with lack of public awareness. Carbon emission and contribution globally of African continent is not known , this is because researches conducted in African are not enough. The continent is experiencing dramatic raise in population growth, land degradation and deforestation [53].

2.3 Building Environment Carbon Emission

This shows an overview of the housing sector's contribution towards low carbon society development. Housing sector across the globe consume high energy with relatively high emission. This is because housing accommodate greater percentage of sociological and psychological activities in all ramifications. For examples, sleeping, cooking, indoors recreational, trading (petty trading) and some houses are used as workspaces and offices as well. All these required high energy supply and utilization (carbon emission). Yet, housing as revealed by scholars can effectively be used as a tool for implementing low carbon society plans. On the other hand, scholars unveiled the potentialities of housing sector in mitigating carbon emission. Correlation between environment , energy consumption and emission call for radical policy making. Households sizes is declining but research showed per capita energy consumption is at increase side also [54]. This is because actual demand of comforts related spaces in terms of additional kitchens, bedrooms , outdoor and indoor recreational leisure spaces are at the increase sides. Housing sector has inactive energy consumption and its related regulation [54]. Low emission Land use planning (LEC) expertise covers dramatic change of the building industry structure together with Vocational Education Training [55].

Housing industry can play a vital role in mitigating Carbon emission through transformation and development [44], Zero Carbon Building (ZCB) [56], Sustainable homes with low carbon [43] and [57], low carbon neighbourhoods, development [58], Low Carbon Infrastructure provision [59] and systematic and market shaping approaches [60]. Although , 25% relatively being the contribution of household's emission, emphasis is to the housing sector in achieving low carbon society or sustainability, Passive House Standard as defined by a new climate specific cover, Bias towards conservation, maximize energy per capita, Specified air tightness in relation to climate and Cost effective. UK codes as linked with building laws covers; Energy carbon emission (b) Water (c) Materials (d) Surface water runs off (e) Waste (f) Pollution (g) Health and wellbeing (h) Management (i) Ecology [61]. There are inequalities in energy consumption [62]. It studied carbon within 2015-2050 [63].It uncovers analysis of residential energies related [64]. [65], utilized ages, sizes, gender, level of education together with quintile as variables affecting household energy saving and carbon emission. [66], stated that future sustainbility of energy sytem of building sectors is generally accepted as integral requirement for energy improvements as well as its efficacy. [67], the resaerch dwells basically on how electricity markets could favourably influence , green gas , renewble heating together with liquids fuel markets in the future and how smoothly the later could positively influence the former. [68], comment that computer's operating system (COS) is employed by energy planners it their energy plans in the basic processes of the tool for commding and executions

2.4 Urbanization and Environment in Developing Nations

[69], comment that trends of urban growth in developing nations within the span of the last two decades has witnessed significant growths. This is because of technological transformation of population growth with economics and political changes. Relatively half (3 billion) of the world population dwells in the urban settlements. Urban communities could be defined in many perspectives which include consideration of: Population density and sizes, political and administrative extent, economic functions and mix of the 3 issues above. [70], urban growth usually causes great challenges in the urban areas in the form of congestions and overcrowding, pollutions of all kinds, squatters and squalor settlements, biodiversity damages and poor environmental sanitation. The above is the product of rapid socio-economic and cultural growth together with environmental predicaments. These developed very numerous environmental challenges to Nigerian Cities. Challenges of urban growth in Nigeria and urbanization in Nigeria brought about; loose of biodiversity, green housing warming, desertification, salinization of agricultural land, air and water pollution, environmental decay, slums, insanitation, overcrowding, housing congestions and crime and violence [70]. Impacts of housing construction as supported by [2], housing construction is the major cause of soil sealing and air pollution.

2.5 Urbanization and Environmental Challenges in Africa

[71], stated that Sub-Sahara Africa is rapidly growing with a very high rate of population growth. However, the growth is horizontally rather than vertical. This causes a lot of site clearance for the city's expansion rather than skyscrapers development. This also generates high population densities, concentrations, and significant land-use changes. It is predicted and projected that, by 2050, Sub-Sahara African land use will dramatically increase by 12 times its initial sizes of the year 2000. Urban Sprawl is highly significant because of insufficient transportation mobility for poor urban dwellers to build in disaster-prone areas like areas liable to floods, rugged hilly areas, mangroves, flood plain and under the high-tension national grid power lines [71]. Also, in Africa, spatial expansion and its nature, population densities of cities, informal economies, and the nature of settlements together with governance structure have vital roles in risk reductions [71]. [72], urbanization has significantly risen in Africa from 18 % of 1950 to 40 % by 2000 with high anticipation of reaching 50 % in the year 2020 by 2050 %. Urbanization in Africa is therefore closely like developing nations. Three key players responsible for urbanization in Africa are Natural population growth, Rural-Urban Migration, and Development of rural settlement into urban.

[73], major challenges of sub-Sahara Africa are; rapid urban and high population growths but without well-organized governance that could meet the spontaneous growth needs generalization of sub-Sahara Africa include; 2/3 of its urban centers dwellers stay and live in poor housing, majorly used non environmentally friendly energy sources, inadequate potable water for large populace, poor households solid waste system, high health problems closely to parasites and infectious related diseases, high rate and frequent road accidents, urban location closely located to communicable diseases, physical hazards closely to informal settlements, and air pollutions above United Nations standards in some cities. Common risks in Sub-Sahara Africa: flooding, earthquake, drought/food insecurity, traffic accidents, politically related violence, gender sexually related issues, drowning in rivers and related, frequently animal attacked, pollution (poor air and water quality) and diseases and illness [73].

2.6 Urban Growth in Nigeria and Environmental Challenges of Housing Sectors

[74], housing provides physical and social enclave and it also provides spaces for socialization. Decent and affordable housing is the most essential infrastructure in urban areas. There is going to approximately experience 17 million housing deficits in Nigeria by the year 2012. Housing predicaments in Nigeria is so huge that governments only could not easily provide an effective solution or solve the challenges. This, therefore, is paving ways for public-private partnership (PPP) Qualitative and quantitative housing predicaments is a global issue. Residential housing in Nigeria has a great contribution to the climate change within the environmental impacts through its construction process together with its useful life cycle. Agricultural activities land-use changes, forestry, and fugitive emission are the major contributors to carbon emission. The rapid rate of urbanization, 17 million of housing deficits and Inadequate infrastructure. Satisfaction surveys to evaluate housing performance. Nigeria is blessed with much abundant renewable and non - renewable energy sources. However, its energy sector remains inactive. this affects speedy economic growth in the country: Nigeria is the 6th oil reserved country of the world 5,000 billion cubic meters of natural gas and14,000 KW hydropower and Solar Radiation [74]. Bombai industrial zone of Kano metropolis has air pollution-related to its high industrial activities. [75], assessed the environmental impacts of PET bottles generations in Kano metropolis in Kano metropolis. The results indicate PET bottle waste generation was relatively very much within the metropolis. Additionally, PET disposal within the metropolis makes the environmental accosting (PET Polyethylene terephthalate). An average of 200 million PET bottles in a day is produced in Nigeria. PET bottles and related considered, bottled table water, soft drink in PET bottles, canned drinks, sachet pure water, bottled milk drinks, plastic bottle juice, soft drinks in glass bottles. [76] stated that residential 3 case study in Kano metropolis as Nassarawo, Sabon Gari and City. The Results demonstrates that the pattern of distribution and the gas skewed closely

to the high frequency with recorded and deviation of 4.93 +- 3.08Ug/m^3. The study indicates built up area triples its initial status within the period of the study 1984 to 2019 in Kano metropolis Nigeria [77]. Rapid building growth is one of the key environmental challenges in developing countries major urban areas like Kano metropolis, Kano state Nigeria. This calls for proactive policies that could help in achieving sustainable development [78].

2.7 Environmental Challenges Scholars Way Forwards Point of Views

[79], comment that CLUE-S model is used to simulate deforestation, Land degradation, urbanization, land abandonment, integrated assessment of land cover changes. The Model contains two (2) basic modules, spatial and non-spatial analytical models. [79], the non-spatial model estimates the precise land use requirement whereas spatial simulates land cover changes through; predicting land use requirement, land policies restriction, setting land-use types, and Spatially distribute the sustainability of each of the land-use type. Spatial allocation handles the empirical analysis of existing land-use pattern. CLUES model application allows the authors to analyze world cultural and natural heritage sides with comprehensive knowledge of its landscape changes, its base land use pattern and interlinked between casual factors. [80], stated that life cycle assessment LCCO2A is a tool for environmental protection. 2015-2050 is the targeted building zero carbon emission and the built environment under United Nation CAP 21 UN climate change conference in Paris. [2], environmental Kuznets Curve is the stylized facts process of economic growth and dynamic of the environment and then later fall or decrease the movement per capita income passes a certain level of the threshold. Environmental impact is expressed in the intensity of use term population growth and household sizes are the determinants of urbanization recently discovered. Additionally, the socio-cultural and economic situation affects the development of urban areas which consequently to the natural environment.

[81], there are three (3) principal dimensions of sustainable development: environmental dimension which covers all constructions processes, the social dimension which involves human satisfaction, institutional dimension shows the government efforts and economic dimension depicts efficacy in production. Brundtland report of 1987 definition of sustainable development cover development that satisfies the present generation needs without preventing the future generation to attain their needs. [82], stated that the prediction of vegetation covers with the aids of Remote Imagery is essential in natural resources management. Point intercepts sampling techniques are the major methods employed in the assessing or evaluating vegetation cover information, although it is relatively very complex. There are 2 major terminologies employed which include: (a) Any –hit cover; this is intercepts from any canopy (b) Top-hit cover which deals with first plants intercept. Green building concepts in Brazil required the following issues; financial issues, technical issues, and training issues. [2], added that strict urban planning regulations together with higher taxation of the property could be effective in mitigating and providing measures that could reduce consumptions.

III. METHODOLOGIES AND FRAME WORK

3.1 Study Area

Kano Metropolis is geographically located within Latitudes 12 º 25 ᴵ to 12 º 40 ᴵ N and Longitude 8º 35ᴵ to 8º 45ᴵ E. It is the most developing and urbanizing cities and commercial center of the Northern Nigeria. It has annual growth rate of 3% with population of (3.5 million, 2010) projected to (4.3 million 2018). It is highly crowded with 1000 people per square kilometer (KM^2). Its climate is wet and dry base on Koppen's classification [83], [84]) and [85]. Reasons for site selection is on the facts that 4 categories of the study could be used and each category with 2 case studies. Economic activities, population, vegetation covers, and pattern of land-uses could be considered for the categories and in all case study areas. It has 1000 people per square Kilometer Square which makes it the most crowded and very densely populated in the country. [83], rapid urbanization processes going on from past decades also is a strong reason. United Nations comment that major cities of Kano and Lagos together with other major cities has an annual urbanization rate of 3.61% within 2015 and 2018. In addition, it is the commercial center of 19 Northern states of Nigerian. [86] Kano Metropolis is the most commercialized and industrialized metropolis in the Northern Nigeria that attract influx of migrants from and outside the region. The aim of the study is to unveiled Rapid Urbanization and CO, CO_2 emission in Kano metropolis Nigeria with to emphasis to carbon monoxide and dioxides emissions with a view to making further detail study. Figure 1a shows energy sources in Kano Metropolis Nigeria while, figure 1b portrays ºC locational maps of Kano State and the study area.

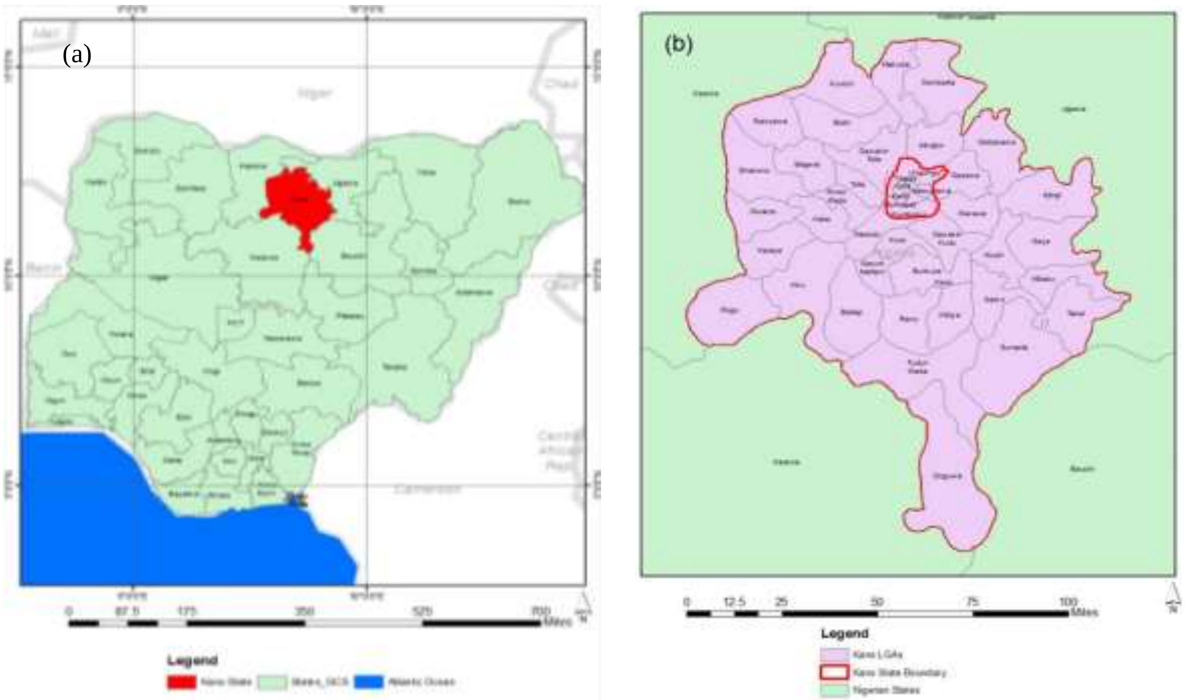

Figure 1: Showing (a) Nigeria and its 36 States Figure, (b)Kano State and its Local Governments

3.2 Conceptual Framework

Preliminary study shows that Kano Metropolis is witnessing rapid population growth together with intensive commercialization which is leading to a high rate of housing and building construction which is promoting high rate of urbanization together with land uses changes. These dramatic urban growths consequentially are affecting environmental in term of air quality, vegetal cover reduction, water pollution and haphazard land uses changes and non-conforming land uses conversion mostly residential land use to commercial land use and circulation. Figure 2 provides urban growth and its environmental impacts driving forces together with is direct environmental impacts on air quality.

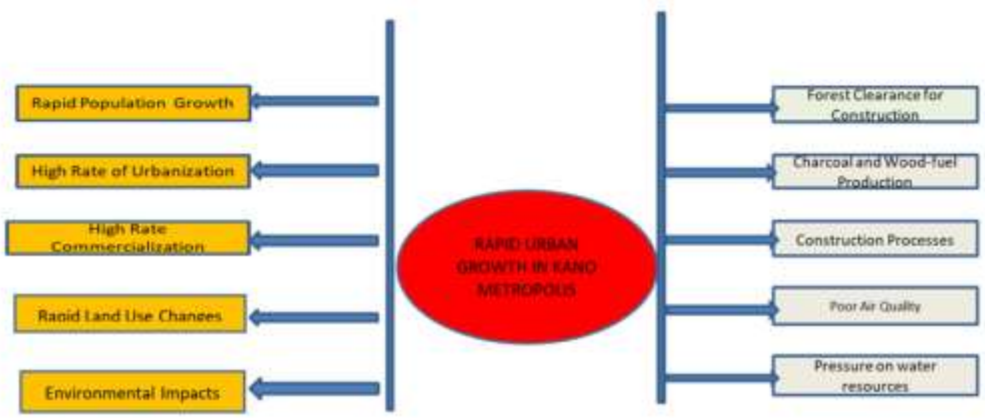

Figure 2: Show Schematic Conceptual Framework of the Study

3.3 Methodologies

The research systematically collected data in four, five and seven local governments areas in the metropolis. This was done through eight local governments areas within the Kano metropolis was considered as the case study. Four categories were formed, and each category covers two local governments areas within the metropolis. In each category, three stations were systematically selected considering population of a neighborhood and the activities within built up areas. Carbon sensor (Carbon Monoxide Analyser 707), gas sensor by Crown Cone and Global Positioning System (GPS) was employed for the research. Carbon dioxide (CO_2) and carbon monoxide (CO) indoor and outdoor emission was sensed and recorded, temperature and humidity were recorded by the Carbon Sensor (SD Card data Loger CO_2/Humidity/Temp/Data Recorder MCH-383SD). Global Positioning System (Germin E Trex Legend H Handheld GPS) on the other hands was used during field work to determine the Coordinates: Northings and Eastings. The result was presented in tabular and graphical forms. Photos/ pictures was used as supportive ingredients to the analysed result. In addition, the literature review covers theoretical syntheses of carbon society models, policies and principles, housing sector carbon emission and mitigations strategies, urbanization in developing nations, urbanization in Africa, urban growth in Nigeria and environmental challenges of housing sectors and environmental strategies as solution to environmental challenges. Figure 3 gives conceptual flow charts of the study while figure 4 provides images of the carbon sensing employed for the study.

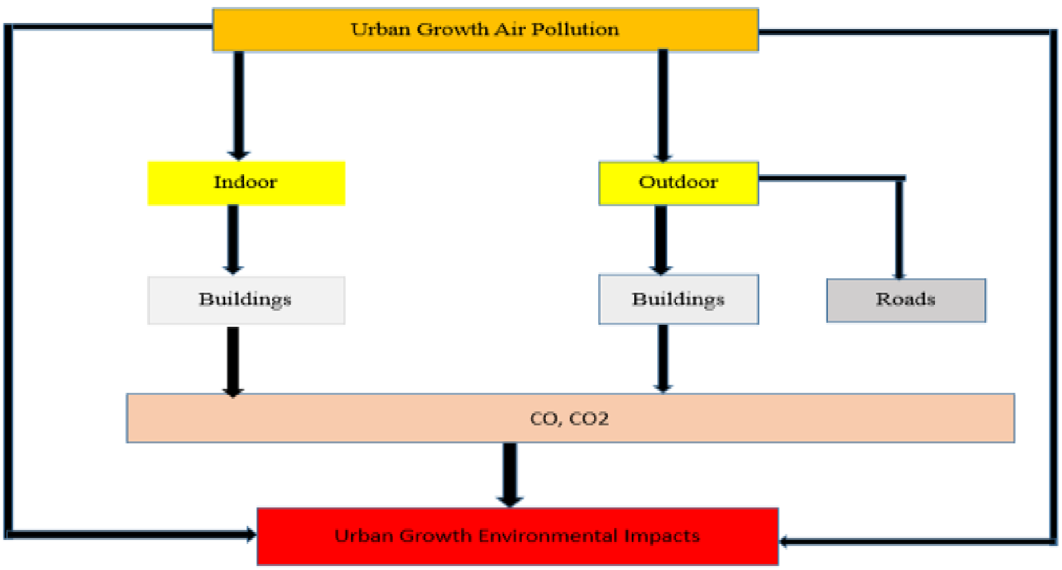

Figure 3: Indicating Conceptual Flow Chart of the Study

Figure 4: Carbon Sensing Device

IV RESULTS AND DISCUSSIONS

4.1 Energy Resources, Carbon Emission and Concentration

The field survey conducted uncovers that Kano metropolis residents rely on these energy sources. The energy sources are used for heating and cooling for domestics and other purposes. The study also shows that income level plays vital role in the residents' choice and purchase of the say energy sources. The study therefore categorized the population into three income levels. Low income earners rely on charcoal, wood fuels and kerosene. Middle income earners use charcoal, kerosene, and electricity while high income utilize electricity, LPG and diesel for heating and cooling. Both population and housing densities together with land use types play significant contributions in both indoor and outdoor carbon emission. Figure 5 shows major energy sources in the study area. The first three sources left of the figure are used by low income earners. Energy source from the left to the third to end of the right are used by middle income earners while the first three from the right are used by the high-income earners as reveal by the field work. This tremendously affects the carbon emission.

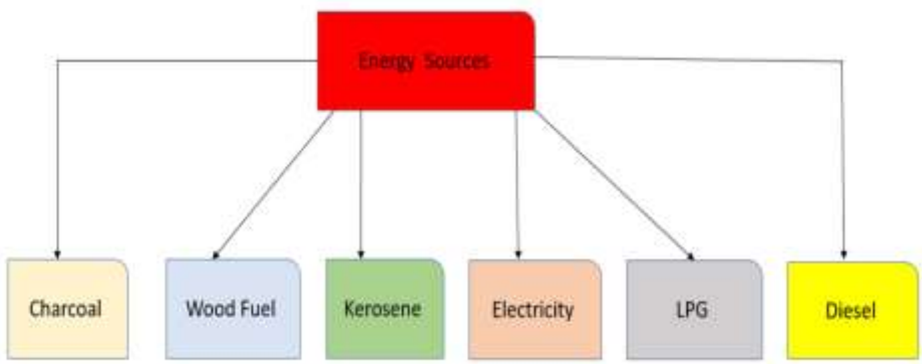

Figure 5: Showing Energy Sources in Kano Metropolis Nigeria (KNMA) in 2019

4.1.1 Indoor and Outdoor Carbon Emission and Concentration

Table 1 below shows the field survey for the carbon monoxide sensing employed in 12 total reading stations for the metropolis. Six local governments namely Dala, Gwale, Fagge, Tarauni, Nassarawo and Kumbotso were selected based on political boundaries. Both indoors and outdoors were collected in each sampled local government as tabulated in table 1 above. The result depicts that Fagge has the highest outdoor CO 12 ppm, followed by Gwale with 11 Ppm and Kumbotso with exactly 10 ppm. Besides, Tarauni depicted outdoor CO of 9 ppm, Dala Recorded 8 ppm, but Nassarawo recorded the least with precisely 4 ppm. In contrary, the indoor record reveals that Gwale has the highest with 10 Ppm, follow by Fagge with 7 Ppm, Tarauni and Kumbotso closely recorded 6 Ppm and 5 Ppm while Dala and Nasarawa maintained the least with 3 Ppm each. The literature study, on the other hand, unveiled that, Nigeria, like other developing countries of Africa, is faced with numerous environmental challenges as the products of dramatic urban growth. Table 1 below portrays indoors sensed carbon monoxides.

Table 1 Indicating Indoor Carbon Monoxides Records

Type of Carbon	Locations	CO Ppm	Coordinates	
			Northings	Eastings
Indoor	Dal	03	12.006267	8.429228
Indoor	Gwl	10	11.990798	8.496323
Indoor	Fag	07	12.001191	8.421289
Indoor	Tar	06	11.976998	8.561400
Indoor	Nas	03	11.985182	8.545517
Indoor	Kum	05	11.966362	8.2922833

Source: Field Survey,2019

Figure 6 below spelt out clearly between indoor and outdoor records widely differed. Indoor records are far lesser than outdoor record. The field study stated the following as factors affecting carbon emission in KNMA; culture and traditions, types of energy for uses for domestics cooking, heating, and cooling, energy sources together with level of, income as well and travel behaviors. Outdoor carbon emissions related activities are more obvious than the indoor carbon related activities. Table 2 below highlighted the carbon monoxides outdoor sensed records while figure 6 indicates comparison of CO_2 within and among Stations in Categories.

Table 2 Indicating Outdoor Carbon Monoxides Records

CarbonType	Locations	CO Ppm	Coordinates	
			Northings	Eastings
Outdoor	Dal	08	12.006327	8.429228
Outdoor	Gwl	11	11.992942	8.512677
Outdoor	Fag	12	12.006691	8.526255
Outdoor	Tar	09	11.977580	8.564703
Outdoor	Nas	04	11.989377	8.281566
Outdoor	Kum	10	11.963607	8.089330

Source: Field Survey, 2019

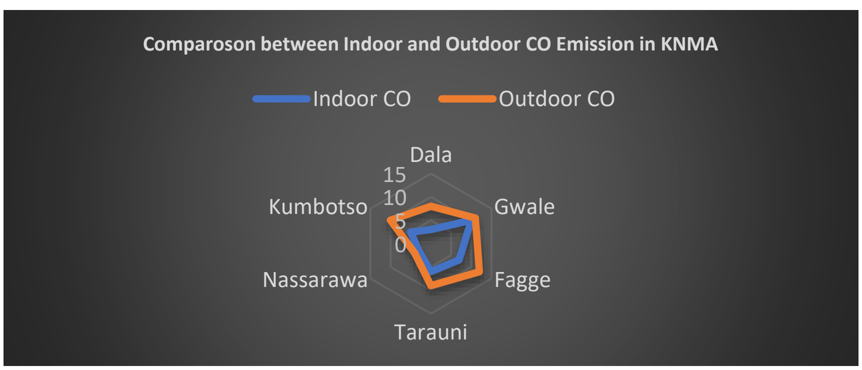

Figure 6: Showing comparison of CO within and Among Stations in Categories

4.1.2 Indoor and Outdoor Carbon Emission and Concentration

Table 2 below indicates carbon monoxides and dioxides, temperature, humidity, and coordinates. It demonstrates that carbon monoxides records vary within stations in each category. It shows widely differences among the stations. The line graph unveiled that station A in Kumbotso local government is more than the values of station B and C if sum up together. This indicates that the CO_2 is very high and thereby the air pollution within that station A is poor. The air is poor because its records is above air quality indicator stipulated standards. The trend is maintained in Kano Municipal where station B significantly records one and the half records of the sum records of station B and C. The air quality in station A is above air quality standard. Additionally, the records in Tarauni local government also shows station A maintain the highest record but with minimally and marginally record value when observed carefully. The bar chart if carefully observed also highlights that.

Table 3 Revealing Carbon Monoxides and Dioxides, Temperature, Humidity and Coordinates of Sampled Local Governments in Kano Metropolis Nigeria

S/N	Locations	CO Ppm	CO_2Ppm	T ºC	H %rh	Easting	Northing
1	NAS	03	80	40	44	…………	…………
2	NAS	22	78	36	49	…………	…………
3	NAS	03	79	32	67	008.58000	11.98569
4	TAR	05	78	40	44	008.56254	11.97771
5	TAR	19	82	36	51	008.36437	11.97855
6	TAR	18	74	37	55	008.56914	11.97820
7	KUM	08	75	37	53	008.51816	11.94290
8	KUM	11	184	37	48	008.51768	11.94624
9	KUM	10	16	34	54	008.51744	11.94849
10	KMC	28	91	36	58	008.5242	11.96400
11	KMC	11	156	36	49	008.52364	11.96493
12	KMC	03	17	38	41	008.52300	11.963526

Source: Field Survey, 2019

The study uncovers trends of temperature within and among categories. Looking at the figure 5, it can be inferred that the temperature record is proportionately closely related within and among the categories. Unlike the CO_2 records stations C in both Nassarawo and Tarauni local government areas portrays the hottest station with $40^{o}C$. If the figure 5 is looked again, it could be understood that the lowest temperature record in KNMA is $32^{o}C$ and the highest is exactly $40^{o}C$. This clearly uncovered that, though the records were taken during wet raining season with cloud effects to the sunshine. One to two meters was used from the emission sites during carbon sensing. Major sites include commercial activities of food processing such as meat roasting, beans cake making and rice doughnuts. In addition, the study also significantly shows that emission through commercial and private generators for power supply for commercial cell phones charges and industrial and domestic purposes aid the temperature variation across the categories. Figure 5 is Showing comparison of the carbon sensed records within and among categories while Figures 7 and 8 are revealing temperature and humidity records within and among categories. Figure 9 indicates humidity comparison.

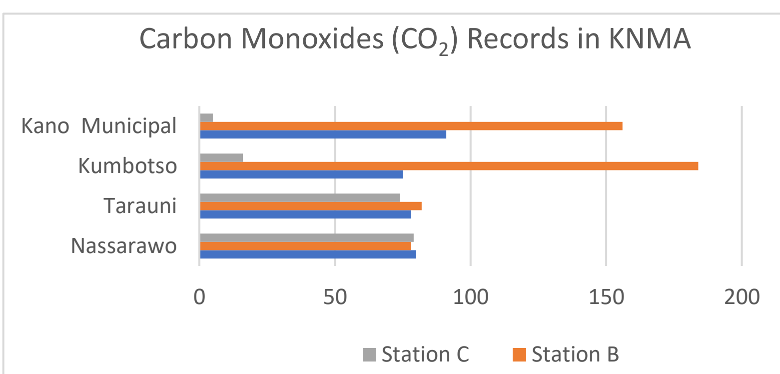

Figure 7: Demonstrating comparison of CO_2 within and Among Stations in Categories in Ppm

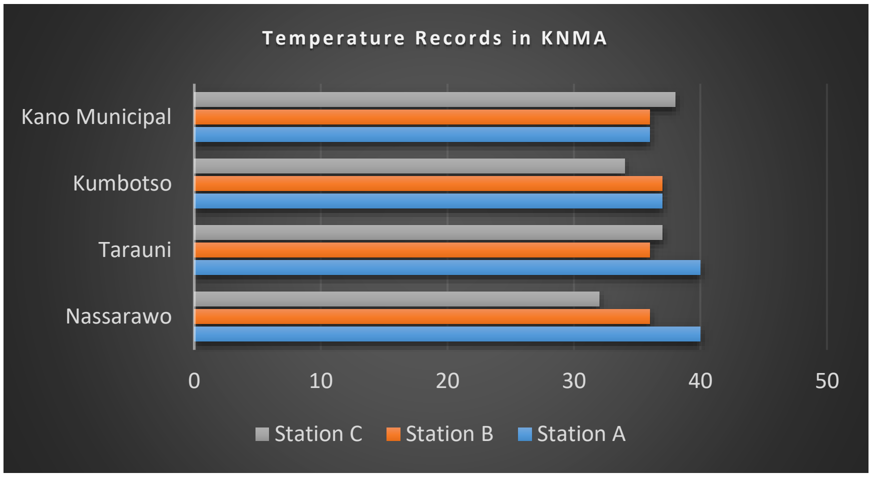

Figure 8: Demonstrating comparison of Temperature within and Among Stations in Categories in ^{o}C

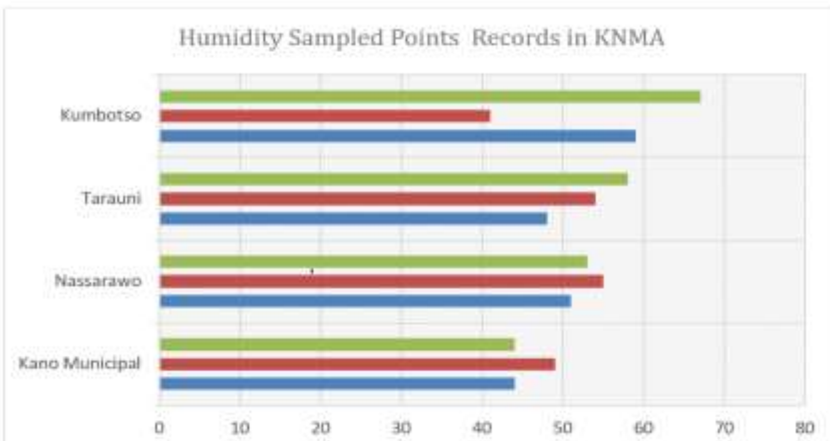

Figure 9: Illustrating Comparison of Humidity within and Among Stations in Categories in %rh

4.1.3 Carbon Emissio, Temparature and Humidity

Table 4 below showed local governments and its records patterns. Nassarawo local government Area has the following records with regards to the Carbon Monoxides Station B records is four times of the sum of station A and B when combined. Carbon Dioxides records provide station A with (80 Ppm) while Station B and C are closely with (78 and 79). In addition, temperature records reveal wide variation between stations. Station A is 40, then station 37 while Station 32. Additionally, Tarauni is another local government Area covered during the field Survey, Carbon Monoxide demonstrates Station B (19 Ppm, 18 Ppm) while there is very wide gap between the two stations with Station A left with (05 Ppm) only as its total emission. In addition, the carbon monoxide data sensed shows quiet close value among the variable Stations with station B being the highest with 82Ppm, station A and C follow with 78Ppm and 74Ppm, respectively. The temperature in the study area indicates station A with 40 ^{o}C then Station C with $37^{o}C$ but station B has the lowest value of exactly 36 ^{o}C. Humidity record highlights station C as the greatest value (55%rh), station B has values closely with station C (51%rh), while station A is 44% rh.

Furthermore, Kumbotso local government on the other hand has the following, with regards to Carbon monoxide, station B has (11 Ppm) when observed carefully, it is higher than both station A and C. Station C (10 Ppm) on the other is greater than station A (8 Ppm). In addition, Carbon monoxide depicts closely trend with the former. Station B maintain the greatest value (184 Ppm), then station A (75 Ppm) while station C (16 Ppm). Furthermore, temperature and Humidity records has very similar records Station B has Temperature and Humidity values as (37 ^{o}C, 48 %rh) as the highest, follow by Station A with Temperature records as ($37^{o}C$) but it records lease Humidity as (53). On the contrary Station C has Higher Humidity records when compare with station A (54%rh, 34 ^{o}C). Three stations were stated an in the table in Kano Municipal Local Government Area. Station A has the highest

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record of carbon monoxide with exactly (28Ppm), followed by station B with (11ppm) but station C depicted only 03Ppm, respectively. This shows the rate of emission in station A has highest emission among the three stations. On the contrary, with regards to temperature records, station C is the highest, followed by station B the Station C. The humidity records on the other hand provides station A as the highest, follow station B the Station C. Station A Northing and Easting represent (11.96400, 008.5242), Station B Northing and Easting covers (11.96493, 008.52364). Lastly Station C demonstrates (11.963526, 008.52300) as its Northing and Easting. Table is showing studied local government and respective records while Figure 10 is demonstrating pattern carbon emission in the sampled local governments.

Table 4: Showing Local Governments and its Records Patterns

Nasarawa Local Government Area

S/N	CO Ppm	CO_2 Ppm	T °C	H %rh	Easting	Northing	Stations
1	03	80	40	44	....	....	A
2	22	78	36	49	....	....	B
3	03	79	32	67	008.58000	11.98569	C

Tarauni Local Government Area

S/N	CO Ppm	CO_2Ppm	T °C	H %rh	Easting	CO Ppm	Stations
1	05	78	40	44	008.56254	11.97771	A
2	19	82	36	51	008.36437	11.97855	B
3	18	74	37	55	008.56914	11.97820	C

Kumbotso Local Government Area

SN	CO Ppm	CO_2Ppm	T°C	H %rh	Easting	Northing	Stations
1	08	75	37	53	008.51816	11.94290	A
2	11	184	37	48	008.51768	11.94624	B
3	10	17	34	54	008.51744	11.94849	C

Kano Municipal Local Government Area

S/N	CO Ppm	CO_2 Ppm	T °C	H %rh	Easting	Northing	Stations
1	28	91	36	58	008.5242	11.96400	A
2	11	156	36	49	008.52364	11.96493	B
3	03	17	38	41	008.52371	11.96352	C

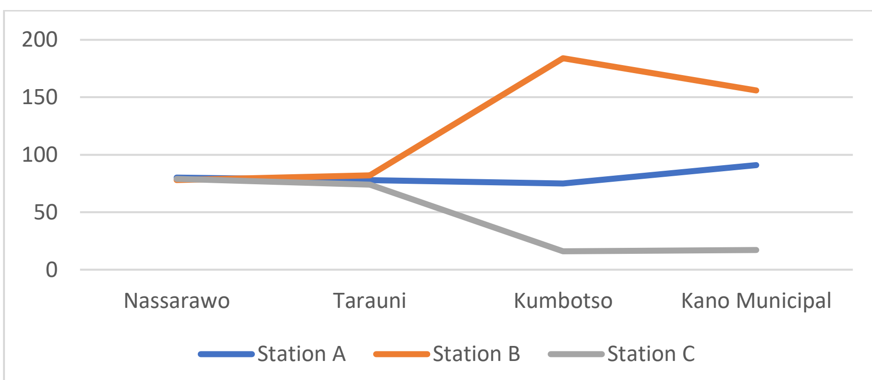

Figure 10: Demonstrating Pattern of Carbon Emission in the Sampled Local Governments in Ppm

Nielson et al (2020) stated that future sustainbility of energy sytem of building sectors is generally accepted as integral requirement for energy improvements as well as its efficacy.Sorkineas et al (2020), the resaerch dwells basically on how electricity markets could favourably influence , green gas , renewble heating together with liquids fuel markets in the future and how smoothly the later could positively influence the former. Cabrera et al (2020) comment that computer’s operating system (COS) is employed by energy planners it their energy plans in the basic processes of the tool for commding and executions

IV. DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

The study unveiled that carbon dioxides emission is higher in Kano Municipal (157Ppm) and Kumbotso (184Ppm) local governments. These records are above air quality standards. Air quality in the station is poor. Reasons for this is because of the intensity of carbon emission related activities are slightly higher than the two other local governments at the time of carbon sensing. However, all the local governments required carbon control because each has records close to the maximum air quality standards. In addition, Nassarawo local government recorded the highest Temperature of 40 Degree Celsius, Tarauni local government maintains 39 Degree Celsius. Furthermore, the study also reveals that energy consumption and its carbon dioxide emission also depend on the culture of people in relation to their sociology and psychology in respect to energy utilization as well as carbon emission. The result also demonstrates that; outdoor emission is greater than the indoor emission. The temperature is very high because the carbon sensing carried out was very close to the emission sources. Relative humidity was high because the readings was conducted in the raining season. The results could be compared with [87] work conducted in Kaduna Metropolitan area Nigeria, [80],[74] in housing sector in Nigeria and the work of [88] carried out in Ibadan Nigeria. Finally, the study depicts the needs for intensive research to be conducted on the environmental impacts of housing growth in Kano Metropolis Nigeria which will provides working documents for the preservation and conservation of the natural environment. The figure 11 below explains schematic flow charts of the major factors influencing indoor carbon emissions as reveals by the study. On the other hand, figure 12 portrays factors influencing outdoor carbon emission in the study area.

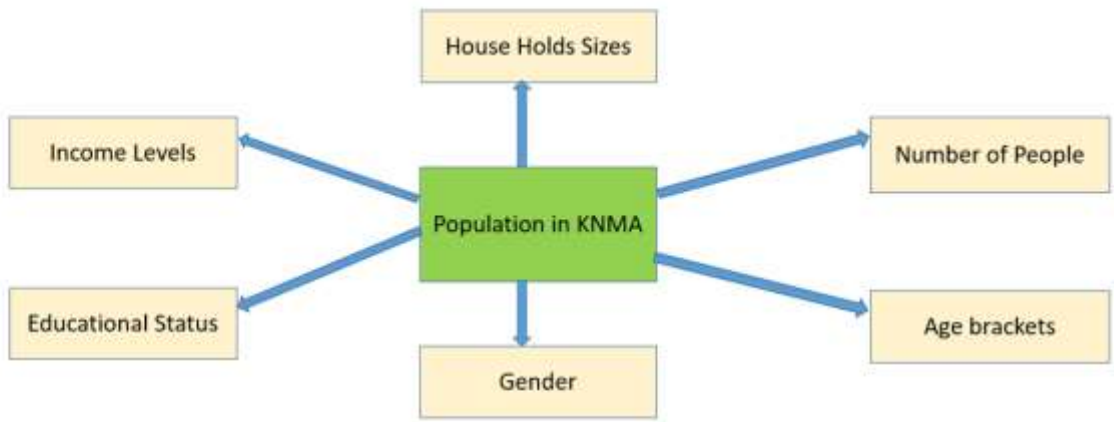

Figure 11 below explaining Schematic Flow Charts of the Major Factors Influencing Indoor Carbon Emissions

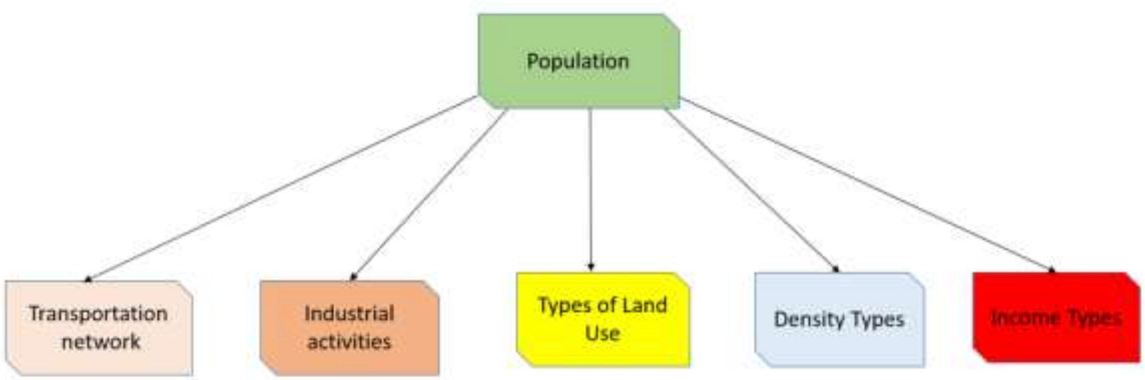

Figure 12: Portraying Factors Influencing Outdoor Carbon Emission in the Study Area.

5.2 Conclusion

The result of Six Local government records depicts concerning the fieldwork carbon monoxides sensing, the research finding reveals that Fagge has the highest outdoor CO 12 Ppm, followed by Gwale with 11 Ppm, this is due to high commercial activities in the local government area that is attracting high vehicular movements within the area. In contrary, the indoor record reveals Gwale as the highest with 10 Ppm, followed by Fagge with 7 Ppm, this is as a result of the life sociology and lifestyle of its dwellers as well as the energy sources usage, congestion as a result of very high population interaction. The result of four local governments with 12 sampled station indicates the CO_2 is very high in the three stations A and thereby the air pollution within that station A is relatively poor. The temperature records of the above 12 stations in KNMA ranges between 32^{o}C 40^{o}C and the relative humidity is within 41%rh to 67 %rh. The literature study, on the other hand, unveiled that, Nigeria is facing numerous environmental challenges as the products of dramatic Urbanization in relation to urban growth like other developing countries. The result clearly indicates that CO and CO2 emission in Kano Metropolis is based on the carbon emission activities within a given locality. Urban development control for buildings development permits in Kano metropolis should be an integral area of concern for the authorities for sustainable development and there are also the needs for further detail studies on these issues to be conducted.

5.3 Recommendation

Recommendations are made base on the identified problems and predicaments unveiled by the analyzed data and its results. There are strong needs for an in-depth study on this essential environmental issue. The study also unveiled the necessity with regards to effective development control, though the existing development control framework of Kano State Urban Development Authority (KANUPDA) is relatively fair. It requires more sophisticated spatial tools to effectively regulate the henceforth urban growth within the Kano metropolitan area by ensuring that building permit could be approved to the developers if developer satisfy the urban and regional planning rules and regulations. Zoning regulation, plot development ratio, setbacks regulation, incorporation of existing vegetation covers in the development, development should follow the train and existing topography. In addition, there is also strong needs for public campaign with regards to preservation and conservation of existing vegetation (trees) within the area, every household should be made to plant at least a tress within and outsides building premises. Additionally, environmentally friendly energy sources should be made readily available by the governments as a substitute to the traditional over dependents on the wood-fuel and charcoal that cause great environmental damages. Vertical development is to be encourage within the metropolis especially in all the three residential densities particularly in high densities zones. This is because, more natural topography and vegetation cover will be preserved together with green building concepts could easily be adopted. This will also ease locations and distributions of facilities utilities and services; it will also reduce excessive site clearance of the horizontal development. The research indicated that horizontal development in the metropolis is the major factor that causes distortion of the environment together with the ecosystem.

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