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Optimal Energy Performance Using Passive Design Strategies for Mixed-Use Building in Kaduna, Kaduna State

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Abstract

Apparently, needs and priorities of cities suggest the kind of growth in terms of design, planning and development strategy that suit their stride for creating a resilient and self-sustaining city. The accommodation of mixed- use building against the single-use neighbourhood zoning is an attestation to the desire of people for an all-inclusive building configuration. Noteworthy is the urban renewal development for regenerating Kaduna state proposing mixed-use building concept as a vital component of the scheme. Thus, the need to ascertain factors necessary to be considered in the design of mixed-use building in order to develop guide leverage on energy efficiency and the exact needs of the inhabitant within the locality towards attaining a sustainable city. Therefore, this study aims to establish passive design strategies for an optimal energy performance in the design of mixed-use building in kaduna, kaduna state. The study adopted focused observation and questionnaire survey for data collection. The observation checklist of Twelve (12) mixed-use building were purposely observed across Kaduna town. These were content analysed using descriptive statistics to establish emerging features and the ensuing inference. Also, the data from 148 randomly surveyed respondents to the questionnaire were analysed using descriptive statistics with empirical evidence. The findings revealed obtainable categorical forms and features that could influence the energy efficiency in the design of mixed-use building in the study area. Notably, the developed guide adequately considered energy efficient configurations relevant to mixed-use and it is expected to promote liveability and create resilient and self-sustaining city.

Introduction

The alteration in the industrial production process from emission of toxic substances and technological advancement in the 20th century are some of the reasons for the change of urban building configuration from single to 'multi-use'. Therefore, movements relating to the improvement of the built environment ranging from the Congress for the New Urbanism, Smart Growth and the Compact City clamors for mixing of land use and its being a component underlying their vision and ideas. This has led to the concept of mixed-use development taking a center stage in urban planning and real estate development over the past decades (Herndon, 2011). There are several reasons for the resurgence of mixed-use development; among the reasons for this renaissance is the traffic congestion and desire for sense of place. Additionally, to the city planner reduction in automobile demand, boost to public transit, urban sprawl reduction, preservation of open space and economic development are motives for embracing mixed-use development. Also, the developers are progressively anticipating and proposing mixed-use

development due to the change in consumer needs, gain access to greater density and explore synergies mixed-use creates through provision of complementary uses (Rabianski, 2009).

Additionally, the persistent increase in world population as well as migration from rural to urban centres in reoccurring decimal are of great concerns to development (Filani, 2012; Bhargava, 2018). In Africa, Nigeria is one of the most populous country and Kaduna state is one of the famous and fastest growing states in the northern part with a large percentage of its resident elite. This growth in population and concentration of intellectuals has extreme impact on the environment, economy and social activities of the state. Therefore, there is a resultant demand for effective infrastructural provisions and developmental needs that are vital and necessary to cushion the ever-increasing population. Also, the increased rate of building development in the urban area occasioned by expansion and utilization of land is alarming and chaotic (Braimoh and Onishi, 2007).

Meanwhile, to attain sustainability of mixed-use building concept and of course built environment in generally consideration of energy demand is important. This is because energy is a vital factor that determines the socio-economic growth and quality of life all over the world (ASHRAE, 1990; Kousksou et al., 2014). The effects of increase in demand for energy are resources depletion, greenhouse gas emission, global warming which has attracted a lot of global attention. According to Asimakopoulus et.al., 2012 buildings are found to be responsible for about 30-45 percent of global energy demand. For instance, in the UK the energy use and greenhouse gas emission produced by the building industry is about 40-50% (Perez-Lombard et al., 2008; Bouchlaghem, 2012; DECC, 2013). Meanwhile in United states energy used in the building sector is responsible for 40% greenhouse gas emissions. In Nigeria, within the urban dwellers were about 40% have access to electricity, consumption is about 48%, 40% and 12% for electric supply for appliances, cooling and lighting respectively (UNDP, 2011).

It is therefore globally acknowledge based on the aforementioned evidences that the building sector and the existing building stocks are core to the global energy use (Rowe, et.al. 2008). Therefore, this study has identified the disorderliness of building development resulting into greenhouse gas emission and subsequently leading to global warming a serious problem that require attention. The need to ameliorate the disorderliness and negative impacts occasioned the birth of urban renewal plan which has mixed-use as part of its strategy. The provision of urban renewal plan for Kaduna state is a drive towards mitigating the deficit in the planning strategy that would also match the population growth and need of the urban centres within the state. Therefore, there is need to evaluate passive design considerations required for an optimal energy performance in the design of mixed-use building in kaduna, kaduna state towards creating a liveable community.

Background Study

The Resurgence of Mixed-use development

Building development in the past years has not be solely single or mixed-use Angotti and Hanhardt (2001). Single use development or separation of functions according to most reviews are assertion and philosophy of Le corbusier and the ciam charter of Athens (Van der Woud 1983). This was firstly criticized on global trend and scale by Jane Jacob, (1961). Seemingly, leading to proffering mixed-use has tool for urban rebirth in the 60s and 70s (Rowley, 1996). Thus, the foundation and resurgence of mixed-used could be linked to Jacob, (1961) assertions (Grant, 2002, Hoppenbrouwer and Louw, 2005; Rabianski *et al.,* 2009 and Rowley, 1996). The study stated that mixed-use constitute a fine-grained mixture of uses, preferably two uses that is pedestrian aligned. Mixed-use development thrived into the twentieth century majorly at transit centers and intersection (Artscape, 2013: Arizona, 2013). However, its concept and occurrence has been self-evident prior to this time.

Energy consumption and optimization of energy use in built environment

According to Rai (2004) population growth and the needs for a pleasing living environment has risen the demand for energy consumption thereby promoting the call for environmental sustainability which

is a major challenge of 21st century. Seemingly, built environment has a considerable linkage to hazard emanating from environmental and social challenges like materials resources depletion as well as greenhouse gases emission resulting from huge energy consumption (Doughty &Hammand, 2004; Kasozi&Tutesigensi, 2007; Mazria, 2003; Perez-Lombard, Ortiz, & Pout, 2008). Also, Perez-Lombard & Pout (2008) and Brown (2010) established that transportation and industrial sectors account for less energy consumption compared with buildings. Therefore, the huge energy consumption attributed to buildings sectors has influenced a lot of research into the consumption capabilities of buildings in order to abate its environmental consequences. However, the complex nature of building process is inhibiting the investigation of energy use in building (Haapio and Vitaniemi, 2008) because energy is used in a building throughout its life cycle (WBCSD (2011). Accordingly, Wouters & Loncour, 2005; Kanagaraj & Mahalingam, 2011; Zhao and Magoules, 2012) recognised vital drivers influencing energy use in building to include climate, architectural design(building) and occupants' factor.

It is established by Ravetz (2008) and DEEC (2013) that both commercial and administrative building constitute a high index of energy consumption globally. Sadrzadehrafiei et al, (2012) also corroborated energy consumption rate of office building at about 70-300KWh/m^2 which is 10-20 times above residential sectors. Therefore, optimizing energy usage at this time is crucial to achieve environmental sustainability. Meanwhile mixed-use building is a combination of several uses that includes residential, commercial, administrative, cottage industries and several other uses. It could be inferred that the cumulation of energy consumption in mixed-use building due to combination of several use /activities will be high. This shows the importance of mixed-use research towards energy efficiency in building. The consideration of the architectural design (building) and occupants' behavioural factor as indicated by Zhao & Magoules, (2012) as critical to energy efficiency in building is paramount.

Scale of mixed-use Concept

Appreciable description of scale as regards mixed-use building could be advanced from the realm of thinking and definition of Jane Jacob (1961), Urban land institute (ULI), 1987 and more empirical within the practical documents of Amsterdam city planning DRO (Van Den Hoek,2008). According to Rowley (1996) none of this definition is exhaustive, specific and definite. This is because Jacob (1961) describe mixed-use from neighborhood scale through a fine-grained mix of uses. It proposes physically and functionally integration of at least three different uses that generate revenue (Foord, 2008; Herndon, 2011). Summarily, the scale of mixed-use ranging from building, block, neighborhood, district, city and region are probable determinant of how mixed-use is defined and approached. Therefore, the three studies highlighted above perhaps summarily constitute the crux meaning of mixed-use. This is the maximization of available land with a well-thought-out multiple use structures, which should be well incorporated with one another and each use sufficiently attracting demand or having a primary use creating a possibly secondary use (Niemira, 2007 and Van Den Hoek,2008). After a suggestive clear principle of what mixed-use portrays, it is important to understand factors that are germane to the concept. the modification of the concept to focus on building scale is important to this study due to the fact that the renewal plan in Kaduna the study area focused on building scale.

The Kaduna Renewal Plan

Nigerian urbanization process has witnessed massive incursion of rural population into the urban centers, accelerated by perceived opportunities abound in these centers. These continuous growths in city population infringes on the physical development and infrastructural needs. Accordingly, United Nations Population Fund predicted that about 61% total world population would resident in cities by 2030 (UNFPA, 2007). Kaduna state in the northern part of Nigeria witness this increasing population growth in its urban area due to its strategical location and historical influence. Among the resultant

effect of population growth without commensurate development and infrastructural growth is disorderliness of building development and the environment. In view of this, the Sustainable Development Goals (SDGs) by United Nations advocates the creation of cities and communities that are sustainable (UN, 2014). Therefore, the need to regenerate the city to a sustainable state condition is paramount. The aforementioned forms the basis for the development of urban renewal plan for Kaduna state. In this regard, among the component of the renewal scheme is the restructuring of the city through improvement of the infrastructural deficit and development of mixed-use building. The Kaduna urban renewal plan intends to create a functional city that provides mixed-use both in horizontal and vertical dimension depend on area. The major reason for this is to minimizing the challenges posed to urban centers by population explosion. This infer the acceptance of mixed-use phenomenon in Kaduna state, which has been an integral part of developmental strategy overtime (Herndon, 2011). The renewal plan specified areas along kabala doki to Barnawa new river Kaduna bridge, Rabah road to Rigasa train station and Mohammed Buhari way for mixed-use. Figure 1 below shows map of Nigeria highlighting Kaduna state.

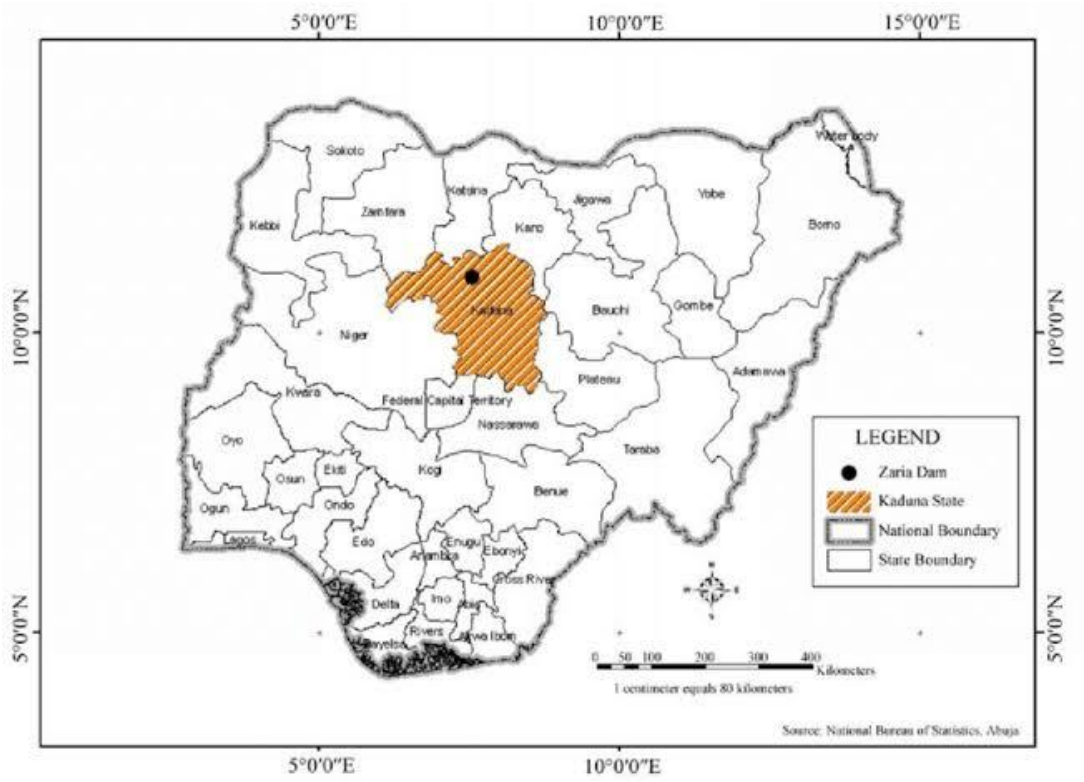


Figure 1. Nigeria, highlighting Kaduna State

Methodology

The pertinency of the phenomenon and its non-integration yet into the mainstream development in the study area dictates the use of case study research approach. This strategy according to Yin, (2003) provides clearer understanding of ideas. The strategy also include consultation with stakeholders involved in the revitalization process in the state. Similarly, the nature of the research question which focus on design considerations also guides in the use of survey strategy for the data collection method and process. As such, buildings were survey based on parameters that are in line with mixed-use

building concept. However, the sample size for the study was determined after saturation on the explored mixed-use building was reached. The saturation point is attained when it is observed that there were no any new emerging attributes (Kumar, 1999 and Creswell, 2012). Thus, twelve buildings across the areas specified for mixed-use building were purposely observed listing attributes such as Building location, building dimension, number of floors, functions combined, number of functions combined, arrangement of functions, policy and demand for mixed-use. The selected buildings represent a typical sample of mixed-use building and serve as a descriptive tendencies of mixed-use buildings features. The questionnaire form on the other hand, a total number of one hundred and sixty-two (162) questionnaire forms were distributed out of which one hundred and forty-eight (148) responded adequately to the questionnaire forms. The data obtained from the observation checklist was analyzed using descriptive method by means of content analysis which is in line with the principles of Miles *et al.* (2014). Thereafter, the result from the data are presented in figures. The findings from the questionnaire are analyzed using mean, frequency and standard deviation. Deduction from the outcomes shows an explicit mixed-use design features and means of optimizing energy use in mixed-use building.

Results and Discussion

Derivation of mixed-use features- nature and form contextual to Kaduna state

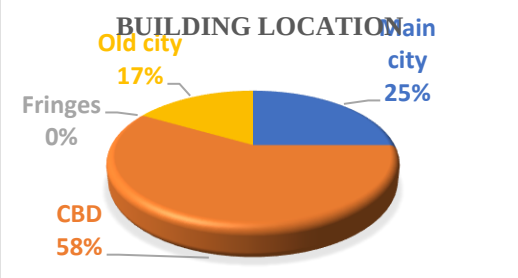
The data collected were documented using Microsoft excel which was thereafter content analysed. Therefore, the results of the nature and forms of mixed-use building in the study area were operationalized in subsequent sections after subjecting the eleven (8) variables to descriptive statistics.

Mixed-use building location

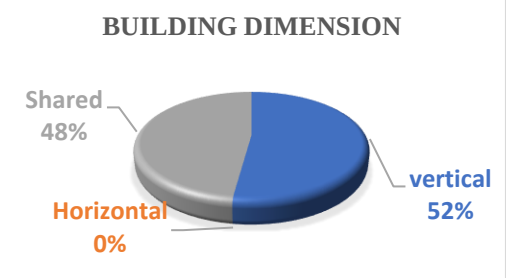
Predominantly the domains of mixed-use building location are categorised into main city, CBD (central business district), fringes and old city. The response to mixed-use buildings location examined by this study is presented in Figure 4.1a. The result shows a blend of the quadrille locations with the exception of the fringes. The configuration shows that 58% of mixed-use building observed are located at the CBD while 25% are within the main city area and 17% in old city. This indicates a concentration of mixed-use in the CBD and main city. The above analysis shows that none of the mixed-use observed falls within the fringes. Thus, infer that urban centres are the heart of the city due to high level of growth and development accompany it.

Mixed-use building dimension

Mixed-use building dimension (scale) were group into vertical, shared premises and horizontal dimensions. In all the mixed-use building studied, 52% are vertical, 48% are shared premises and none of the mixed-use building is at horizontal dimension as shown in Figure 4.1b. However, there are presence of horizontal development within the shared premises. This result is a reflection of the building location. The urban area experience massive and rapid development which makes land a very scarce commodity. Therefore, the geographical composition and availability of landmass determines the mixed-use building dimension.



Mixed-use building location



Mixed-use building dimension

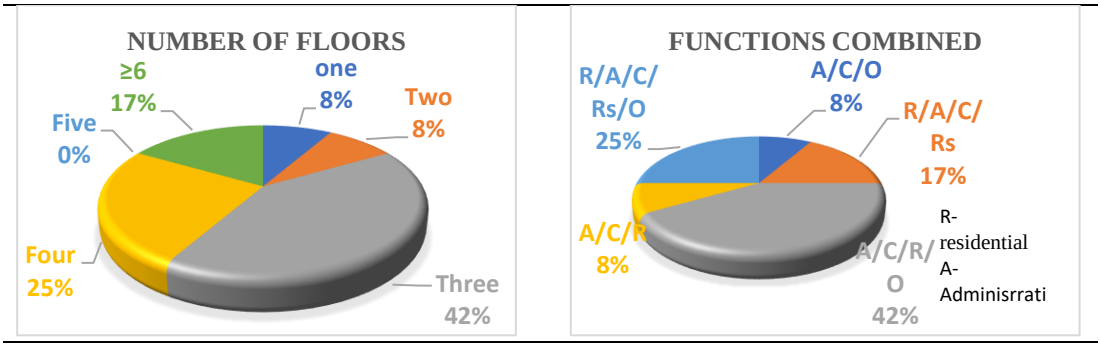
Figure 4.1

Numbers of floors in mixed-use building

The number of floors varies across the study area with three and four floors more prominent. Figure 4.2a shows that mixed-use of three and four floors recorded 42% and 25% respectively. This was followed by ≥ 6 floor which has 17%. The presence of most building prior to the renewal programme might have influence in the number of floors. It could be deduced from this finding that there is need for specification of permitted range for number of floors. This should take into cognisance the location, lifestyle and nature of the inhabitant. This is important because land which is a fixed asset need to be maximized where they are scarce. In furtherance to this, adequate planning and inclusion of stakeholders' in developmental process is vital for overall growth, acceptance and liveability of an area.

Functions combined in mixed-use building

Functions that could be combine in a mixed-use does not have an absolute guide. However, Figure 4.2b present categories of possible function combination of mixed-use building in the study area. The Figure shows the possibility of five categories of functions combination with maximum of five functions. The result shows that 42% of functional combination includes administrative, commercial, residential and others category. This is followed by combination of residential, administrative, commercial, religious and others category which records 25% while a combination of residential, administrative, commercial and religious uses accounted for 17%. Furthermore, there is possible combination of administrative, commercial and other uses & administrative, commercial and residential. It could be deduced from this statistic that there is inclination towards administrative, commercial, residential and religious functions. Thus, peculiarity of an area will give clue to determine possible type of use to be combined during design stage. Summarily, three categories of functions combination are common in the study area. Category A – administrative, commercial, residential and other; Category B – residential, administrative, commercial, religious and others; Category C – residential, administrative, commercial and religious. Meanwhile, others in these categories include lounge, recreational facilities and restaurant.



a. Numbers of floors in mixed-use building **b.** Function combined in mixed-use

Figure 4.2

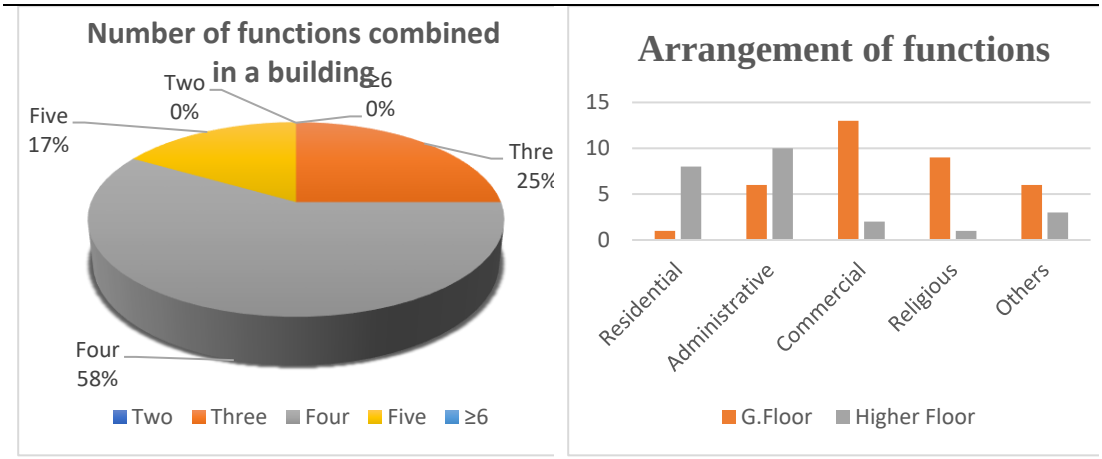
Number of functions combined in a mixed-use building

From Figure 4.3a, it was observed that combination of four function were prominent in the study area and recorded 58%. It is also significant to note that combination of three and five function has 25% and 17% respectively. This outcome shows non-definiteness in the number of functions that could be combined in a mixed-use building. However, it is important to determine compatibility of functions based on location during the initial stage of planning. Notwithstanding non-specific number of functions that could be combined in a mixed-use building, this study reveals possibilities of two - five functions.

This is line with Rowley, 1996; Grant, 2002; Hoppenbrouwer and Louw, 2005; and Rabianski et al., 2009 assertions on great urban environment having more than two functions.

Arrangement of functions in mixed-use building

In multi-story mixed-use buildings studied, the arrangement of functions shows that function that involves general public are usually on the ground and lower floors. This is important for ease access and circulation which is paramount due to influx of people as a result of unrestricted nature of activities. Figure 4.3b illustrates the arrangement pattern of mixed-use building in the study area with commercial, religious and other function among which is a restaurant occupying mostly the ground and lower floors. Administrative functions are found to occupy mostly the middle floors while residential are on the highest floors. However, there are possibilities of residential use at lower floors especially when the mixed-use is at shared premises or horizontal dimension. Succinctly, mode of operation of activities determines arrangement of functions. Commercial activities for instance entail influx of people, therefore areas designated for commercial are unrestricted compared to residential area which need to be serene is achievable in higher floors in vertical mixed-use building.



a. Number of functions combined in mixed-use building

b. Arrangement of functions in mixed-use building

Figure 4.3

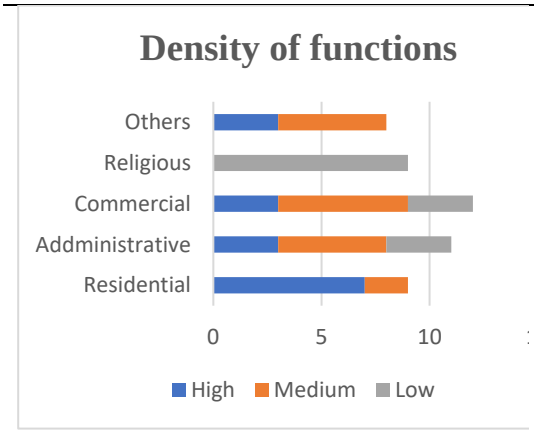
Density of functions in mixed-use building

Density of function has to do with rate of occurrence, volume and number of unit space of functions contained in a building. This is important to determine density of function that suit a location. Density of function for this study is measured based on high, medium or low categories as shown in Figure 4.4a. The most recurring function in the study area is residential function followed by administrative and commercial. This indicates the order of priority of function in the study area. The presence of other functions like lounge and restaurant suggest the needs of the inhabitant that are keen for/to the development and sustainability of the area.

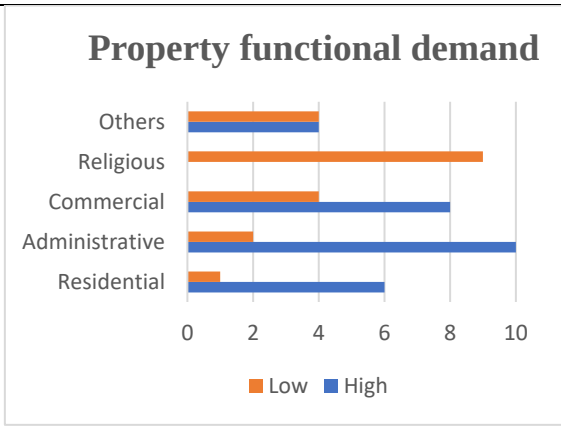
Function demand in mixed-use building

The functions demand for in a mixed-use building is influenced by locational needs. Figure 4.4b indicates the existence of higher demand for administrative spaces because the study area is in the city

capital. This coupled with the fact that majority of the mixed-use building studied are located in the main city and CBD area influenced the demand for administrative use. The rate of demand was followed by commercial and residential uses. However, though the request for religious use appears lower it remains significant. This is possibly due to high population of Muslim in the study area and the needs to offer obligatory five daily prayers which some fall during the working hours in case of administrative and commercial use.



a. Density of functions in mixed-use building



b. Property functional demand in mixed-use building

Figure 4.4

Implied outcome of evolving nature and form of mixed-used building

The outcome of the analysis on variables reveals categorical mixed-use nature and forms in the study area. Inferences drawn from the findings therefore is based on location. It is established that main city and CBD in the urban areas are where mixed-use are commonly located. Equally, the relatively abundant of landmass in the study area necessitated the prominence of vertical with a touch of shared premises dimension options of mixed-use building. However, there is need to maximise land which is a fix asset through improvement on the verticality due to continual growth in population.

Furthermore, the combination of administrative, commercial, residential and others are more prominent in the study area. Notwithstanding the prominence of these functions the ordering of functions differs according to needs of the inhabitant. Therefore, consideration of aforementioned uses is paramount for a liveable mixed-use in the study area. It is obvious combination of three and four functions is more common but there is possibility of combing more functions. Also, functions are mixed within floors and the hierarchy in functions arrangement across floors from lower to higher floor are Commercial – Administrative - Residential. This is because higher floors are predominantly private area while lower floors are more public. Though this might not be applicable in the case of horizontal or shared premises dimension according to Salami, 2017. Nevertheless, users' need, compatibility of uses and lifestyle of inhabitant are factors that needs to be considered while determining functional mix in mixed-use building.

The three functions of residential, administrative, commercial and others shows significant densities of Residential > Administrative = Commercial = Others. However, there are evidence of function that are high in demand but with less intensity, this guides in terms of allocation of space during design process. In summary, the findings show the need for enacting regulation on mixed-use building based on empirical evidence due to diverse need which are grounded on location.

Passive design considerations and optimal energy performance mixed-use building

The data collected were documented using SPSS and thereafter descriptive statistics were used to present quantitative description in a manageable form. The study utilized mean, standard deviation and frequency to make meaning from the variables considered. Therefore, the results of the respondent demographic, occupant's attitude to lighting, ventilation, office equipment and air-conditioning towards optimal energy performance mixed-use were operationalized in subsequent sections.

Demographic of the respondent

The variables which includes gender, age and education level are used to generate demographic data used to describes the characteristics of the respondents. The result shows in Table 4.1 and 4.2 indicates that male gender is 39.2% while female is 60.8%. Thus, the data on occupant's energy behavioural pattern in mixed-use building emanates from both gender with age range between 31-50 years having the highest response of 43.9% followed by age range 19-30 years having 28.4%. This infer that majority of respondent are at their productive phase of lives and one of the most crucial age range. Their enthusiasm at these age ranges might influenced their behavioural pattern towards use of energy.

Table 4.1 Gender of the respondents

Gender					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Male	58	39.2	39.2	39.2
	Female	90	60.8	60.8	100.0
	Total	148	100.0	100.0	

Table 4.2 Age of the respondents

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-18years	16	10.8	10.8	10.8
	19-30years	42	28.4	28.4	39.2
	31-50years	65	43.9	43.9	83.1
	above 50years	25	16.9	16.9	100.0
	Total	148	100.0	100.0	

The educational qualification of respondent shows that 49.3% of the respondents had tertiary education while 29.7 had up to secondary education as indicated in Table 4.3. This shows the supposed level of exposure and competence of respondent to issue under-study.

Table4.3 Educational level of the respondents

Educational level					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary	15	10.1	10.1	10.1
	Secondary	44	29.7	29.7	39.9
	1st degree	73	49.3	49.3	89.2
	Masters and above	16	10.8	10.8	100.0
	Total	148	100.0	100.0	

Occupant's attitude to lighting

The mean of individual variable and standard deviation (SD) is shown in Table 4.4 The SD indicate how far the individual response deviate from the mean. Also, the SD shows how spread out the response are. In the study area the total valid response for occupant's attitude to lightning (n-148) shows a range mean average between 3.07 – 3.80 with a standard deviation range of (1.100 – 1.433). This infer that individual respondent on average were a little over 1 point away from the mean. Thus, the coefficient of variation which is used to measure variability in statistics, shows how much variation from the average (mean).

where CV (coefficient of variation) = standard deviation / mean

Where CV ≥ 1 indicates a relatively high variation

CV <1 infers a relatively low variation

This means that the distribution with a coefficient of variation higher than 1 is considered to be at high variance whereas CV lower than 1 is considered to be at low variance.

Table 4.4 Mean, standard deviation and coefficient of variation for occupant's attitude to lighting

S/N	ITEMS	X	SD	CV
1	Using of daylighting penetration materials for glazing reduces dependent on artificial lightning	3.54	1.27	0.3587
2	Lights in the building are usually left on after working hours	3.30	1.23	0.3727
3	Day –light is often not used for building operations	3.74	1.18	0.3155
4	Occupants often forget to switch off lights when temporarily out of building.	3.50	1.19	0.340
5	building lights are usually left on over the weekend	3.31	1.23	0.3716
6	Corridor lights are usually switched off during the day	3.57	1.01	0.3081
7	Toilets lights are usually left on after use	3.32	1.17	0.3524
8	Stores lights are rarely switch off when not in use	3.07	1.37	0.4462
9	Building users often request for energy efficient light fittings	3.80	1.10	0.2894
10	Occupants don't switch off some lights when alone in the workplace	3.59	1.43	0.3983
11	Users often make requests for maintenance of lighting fittings.	3.57	1.13	0.3165

Occupant's attitude to ventilation and air-conditioning

The result of the standard deviation (SD) indicate how far the individual response deviate from the mean. SD is also used to measure variability; it tells how spread out the response are as shown in Table 4.5 The total valid response for occupant's attitude to ventilation and air-conditioning (n- 148) shows a range mean average of 3.29 – 3.77 with a standard deviation range of (1.024 – 1.290). This infer that individual respondent on average were 1.157 point away from the mean which is 3.53.

Table 4.5 Mean, standard deviation and coefficient of variation for occupant's attitude to ventilation and air-conditioning

S/N	ITEMS	X	SD	CV
1	The use of thermal resistance materials for the building envelope reduces the need for artificial cooling device	3.56	1.21	0.3398
2	Natural ventilation is rarely used for building operations	3.70	1.25	0.3378

3	Windows are usually left open when Air-conditioners is on	3.54	1.23	0.3474
4	Air-conditioners and fans are used simultaneously in the building	3.57	1.02	0.2857
5	Air-conditioners/fans are usually left on when temporarily out of workplace.	3.53	1.05	0.2974
6	Occupants often make requisition for servicing of air-conditioners when due	3.77	1.08	0.2864
7	Air-conditioners are usually left on in the building after working hours	3.51	1.10	0.3133
8	Air-conditioners/fans are often left on while out of building.	3.58	1.20	0.3351
9	Doors are occasionally left open while Air-conditioners is working.	3.46	1.09	0.3150
10	Occupants rarely use fans for indoor comfort in place of Air-conditioners	3.53	1.09	0.3087
11	Air-conditioners and fans are often left working over the weekend	3.53	1.17	0.3314
12	Open workspace design reduces unit number of air-conditioning system	3.29	1.29	0.3920

Occupant's attitude to office equipment

The result of the standard deviation (SD) as shown in Table 4.6 indicate how far the individual response deviate from the mean. The total valid response of occupant's attitude to office equipment (n- 148) indicates a range mean average of 3.47 – 3.75 with a standard deviation range of (1.016 – 1.268). This infer that individual respondent on average were 1.142 point away from the mean which is 3.485.

Table 4.6 Mean, standard deviation and coefficient of variation for occupant's attitude to equipment

S/N	ITEMS	X	SD	CV
1	Laptop, Monitor, CPU and other electrical appliances are usually left on even when not in use	3.75	1.02	0.2720
2	Machines are usually unplugged after use	3.55	1.20	0.3380
3	Power source are usually switch off when computers are fully charged	3.63	1.20	0.3287
4	Refrigerators are often left working even when empty	3.47	1.21	0.3487
5	Refrigerators often left on when contents are already frozen.	3.68	1.27	0.3451
6	Televisions are often left working when out of workspace	3.49	1.19	0.3409

The descriptive statistic outcome of all the items considered indicates a coefficient of variation that is less than 1. This imply low variation to the mean because the data points are not farther from the mean. Furthermore, the SD of all the items are small which indicates that most of the items are clustered about the mean.

Conclusion and recommendations

Conclusively, the disorderliness of building development and the resultant greenhouse gas emission that subsequently leads to global warming are serious challenge that impair city growth and development. A genuine attempt to mitigate the deficit in planning and building development occasion the urban renewal plan for Kaduna state in which mixed-use building is part of the planning strategy. Thus, developing the perquisites for optimal energy performance mixed-use building was the focus of

this study. This was achieved through identifying nature and forms of mixed-use building and the corresponding energy behavioural pattern of the inhabitant. Subsequently, the aforementioned inspired an evolving nature and form of mixed-used building and the determinants necessary to achieve a mixed-use building that is energy efficient. The use of scientific system of enquiry to implicitly decode users need inform the fundamental requirements for an energy efficient mixed-use building design. The outcome of the study affirms divergent locational needs and suggest peculiarity in needs as a basis for nature and form of mixed-use building. Thus, verticality of mixed-use building synonymous to cities in developed clime is applicable to the study area with some element of shared premises dimension due to the fact that land is a fixed and scarce resources.

It also recognises the combination of three to four functions of administrative, commercial, residential and others as more prominent. The hierarchy in functions arrangement across floors from lower to higher floor are Commercial follow by Administrative then Residential. Thus, the aforementioned functions show significant densities. Furthermore, configuration of building with daylighting penetration features, façade and glazing will improve building operation and aid energy efficiency. Also, workspace design that allows partitioning wall and energy efficient light fittings are passive cooling strategies. Others are design of tight thermal resistance envelope to prevent leakage of cool draft through the building skin and good maintenance culture of energy use equipment. Similarly, this study also fused pervasive greenery which involves blending nature into building. This is because asides the aesthetic pleasing nature of green spaces, it also mitigates the harsh heat of the tropical sun and the technological complexity of the building materials that are utilized in the building. Therefore, its application on the lobby, in the open spaces within the design and on the rooftop of the proposed design. Fundamentally, the outcome of this research provides a typical model for practise and policy design for a mixed-use building.

The need for an energy efficient building is crucial in order to achieve liveable environment. The increase in population and its growth at exponent rate is increasing the demand for energy and a larger percentage from buildings and built environment. Therefore, the study recommends that the fundamental requirement highlighted as nature and form of mixed-use with energy efficient parameters highlighted should be articulated during design process and policy design for mixed-use building. Finally, continuous research to develop empirical and evidence-based design is important as guide to the implementation of mixed-use building. Thus, periodical review of mixed-use research is recommended in order to appraise current practise and identify innovative ideas and experience thereby accommodating changing realities. This study has demonstrated the inevitability of mixed-use concept in the growth and development of city in Nigeria Hence, this is an attempt suggesting adoption of features and energy efficiency guides identified for the benefit of inhabitant and for an overall sustainability of mixed-use building and built environment.

References

Angotti, T. and Hanhardt, E. (2001). Problems and Prospects for Healthy Mixed-use Communities in New York City. Planning Practice & Research, 16(2): 145-54

Arizona, (2013). Complete Neighborhoods for healthy, safe and affordable living, unpublished course outline pup 544, spring semester Arizona state university.

Artscape DIY Resources (2013). Approaches to creative Placemaking. www.artscapediy.org/.

ASHARE (1990). ASHARE Position Statements, *ASHARE Journal*, 32 (52).

Asimakopoulos, D.A., Santamouris, M., Farrou I., Laskari M., Saliari M.,.Zanis G, Giannakidi G., Tigas K., Kapsomenakis J., Douvis C., Zerefo, S.C.,.Antonakaki, T Giannakopoulos C., Modelling the energy demand projection of the building sector in Greece in the 21st century, Energy Build. 49 (2012)488–498.[2]

Beckman, G. (2013). How mixed-use building create healthy, sustainable cities. Interview by Brian Barth.

Bhargava, A. (2018). Sustainable Urban Environment-Conceptualization and Policy Parameters. SF J Environ Stud, 1 (1).

Braimoh, A. K., & Onishi, T. (2007). Spatial determinants of urban land use change in Lagos, Nigeria. Land Use Policy, 24 (2), 502-515. Retrieved January, 2017 from https://doi.org/10.1016/j.landusepol.2006.09.001.

Brown, G. (2010). Architecture Industry; A hidden Culprit in Global Warming. Retrieved 04 April, 2010, from http://architecturalevangelist.com/green-architecture/the-architecture-industry-a-hidden-culprit-to-global-warming.html
Bouchlaghem, D. (2012). Architectural Engineering and Design Management sustainability themed issue, *Architectural Engineering and Design*
Creswell, W. J (2012). Educational research: Planning, conducting and evaluating quantitative and qualitative research. 4th edition by Pearson Education, Inc., Boston
DECC, Digest of United Kingdom Energy Statistics (2013). in: Department of Energy and Climate Change, London.
Doughty, M., & Hammond, G. (2004). Sustainability and the Built Environment at and beyond the City Scale, *Building and Environment*, 39, 1223-1233.
Ezema, I. C. & Oluwatayo, A. A. (2014). Densification as Sustainable Urban Policy: The Case of Ikoyi, Lagos, Nigeria. In: CIB W107 International Conference: Construction in Developing Countries and its Contribution to Sustainable Development, January 28-30, 2014, Lagos, State, Nigeria. http://eprints.covenantuniversity.edu.ng/id/eprint/2448.
Filani, M. O. (2012). The Changing Face of Lagos: From Vision to Reform and Transformation.
Report funded by Foundation for Development and Environmental Initiatives (Nigeria), and Cities Alliance. http://www.citiesalliance.org/sites/citiesalliance.org/files/Lagos-reform-reportlowres.pdf.
Foord, J. (2010). Mixed-use trade-offs: how to live and work in a compact city neighbourhood. *Built Environment*, 36 (1), 47-62. https://doi.org/10.2148/benv.36.1.47.
Gentin, M. (2009). All mixed up - A Critical Analysis of Mixed Use. (Unpublished B.planninng
thesis).
Groat L. N. & Wang D. (2013). Architectural research methods. 2nd edition. Published by John Wiley & Sons, Inc., Hoboken, New Jersey.
Haapio, A., &Viitaniemi, P. (2008).A critical review of building environmental assessment tools.*Environmental impact assessment review, 28*(7), 469-482.
Heath, T., Oc, T., & Tiesdell, S. (2013). Revitalising Historic Urban Quarters. Routledge,London.
Jacobs, J. (1961*). The Death and Life of Great American Cities*. New York, Random House.
Kadiri, K.O. (2006). Planning sustainable liveable cities in Nigeria. Research journal of social science, 1 (1): 40-50. Retrieved April 2016.
Kanagaraj, G., &Mahalingam, A. (2011). Designing energy efficient commercial buildings—A
systems framework. *Energy and Buildings, 43*(9), 2329-2343.
Kasozi, P., &Tutesigensi, A. (2007).A Framework for Appraising Construction Projects Using
Carbon Footprints*.Paper presented at the 23rd Annual Association of Researchers in*
Construction Management (ARCOM)
Conference, Belfast, UK.
Kousksou, T., Bruel, P., Jamil, A., El Rhafiki, T., &Zeraouli, Y. (2014). Energy Storage: Perspective and Challenges, *Solar Energy Matter*, Sol. Cell 120, 59-80.
Kumar, R. (1999). Research Methodology: a step by step guide for beginners. Sage publication. (3rd ed.). Los Angeles.
Mazria, E. (2003). It's the Architecture, Stupid!,*Solar Today*, May/ June. Retrieved from
http://www.mazria.com/publications.html.
Miles, M. B., Huberman, A. M., & Saldana, J. (2014). Qualitative data analysis: A method
sourcebook. CA, US: Sage Publications.
Niemira, M. P. (2007). The Concept and Drivers of Mixed-use Development: Insights from a
Cross-Organizational Membership Survey. *Research Review*, 4 (1): 53-56.
Norman F. (2003). Architecture and Sustainability from
https://www.fosterandpartners.com/media/546486/essay13.pdf.
Luna, R. R. A. (2010). A flexible infra-architectural system for a Hybrid Shanghai (Doctoral
dissertation, Massachusetts Institute of Technology). Retrieved January 2016 from http://hdl.handle.net/1721.1/57525.
Olayiwola, K. O. & Akinpelu, A. A. (2013). Analysis of Land Use Mixes for Sustainable
Mobility in Metropolitan Lagos: A Study of Ikeja Gra. 2nd National Conference organised by the school of environmental studies, Yaba College of Technology, Yaba, Lagos.
Passmore, D & Sorensen A. (2007). Mixed-use: what is it? Debates on urban form, term paper.
Accessed from dylanpassmore.com/mixeduse.pdf.
Perez-Lombard, L., Ortiz, J., & Pout, C. (2008). A review on buildings energy
Consumption information, *Energy and Buildings, 40*(3), 394-398.
Rai, G.D. (2004). Non- Conventional Energy Sources.Khanna Publishers, Delhi. Retrieved from http://www.amazon.in/Non-conventional-Energy-Sources-G-D-Rai/dp/8174090738.
Ravetz, J. (2008). State of the Stock- What Do We Know About Existing Buildings and their Future Prospects*? Energy and Policy*, 36 (12), 4462-4470.
Rowe, D., Day, J., Gard'ner, J., Judson, P. and McLenanan, S., 2008. Heritage Buildings and
Sustainability.Technical leaflet. Published by Heritage
Council.HeritageVictoria.http://www.dpcd.vic.gov.au/_data/...Sustainability_Heritage_te
ch_leaflet.pdf
Sadrzadehrafiei, S., Sopian, K., Mat, S., Lim, C., Hashim, H.S., Zaharim, A. (2012). Enhancing energy efficiency in office buildings in a tropical climate, Malaysia, *International journal of energy and environment.6* (2), 209.
Teddlie, C., & Yu, F. (2007). Mixed methods sampling: A typology with examples. Journal of mixed methods research, 1(1), 77-100. Retrieved April 2017 from https://doi.org/10.1177/2345678906292430.

United Nations (2014). The Road to Dignity by 2030:Ending Poverty, Transforming All Lives and Protecting the Planet. Synthesis Report of the Secretary-General on the Post-2015 Agenda. Retrieved October 2016 from http://www.un.org/disabilities/documents/reports/SG_Synthesis_Report_Road_to_Dignity_by_2030.pdf.

United Nations Development Programme (UNDP) (2011). Promoting Energy Efficiency in Residential and Public Sectors in Nigeria. Retrieved from http://www.ng.undp.org/content/nigeria/en/home/operations/projects/environment_and_energy/promoting-energy-efficiency-in-residential-and-public-sector-in-/

Wardner, P. A. M. E. L. A. (2014). Explaining mixed-use developments: A critical realist‟s perspective. In 20th Annual Pacific-Rim Real Estate Society Conference, Christchurch, New Zealand 10-22.

Wouters, P., &Loncour, X. (2005).Review of Selected Theoretical and Experimental Techniques for Energy Characterisation of Buildings.In M. Santamouris (Ed.), Energy Performance of Residential Buildings. London: James & James/Earthscan.

Yin, R. (2003). Case Study Research Design and Methods, London, Sage Publications.

Zhao, H. X., &Magoulès, F. (2012).A review on the prediction of building energy consumption.*Renewable and Sustainable Energy Reviews*, 16(6), 3586-3592.