Infill Development in Nigeria: A Sustainable Development Strategy?

Abubakar Siddiq Usman[1*], Muhammad Ali Chiroma [2], Adamu Harir Isa [2] & Farouk Umar Yaya [1]

[1] Department of Urban and Regional Planning, Faculty of Environment Design, Ahmadu Bello University, Zaria, Nigeria

[2] Department of Urban and Regional Planning, Abubakar Tafawa Balewa University, Bauchi, Nigeria

ausodangi@gmail.com

Abstract

Sustainability has increasingly become an important aspect of consideration by planners and urban managers since the publication of Brundtland report of 1987 and the Rio Earth Summit of 1992. It is considered as one of the greatest challenges facing urban planners in the 21st century, especially for cities of the developing countries like Nigeria with an extraordinarily high growth rate; which was projected to be the third globally by 2050. Recent arguments have been in favour of compact city model as the most effective solution in achieving sustainable urban development. In an attempt to achieve sustainable urbanisation and urban development, Nigerian government in the late 1980s adopted the infill development as a strategy for sustainable urban development. This paper examines the application of infill development strategy as a tool for sustainable urban development in Nigeria and explores how it can contribute towards sustainable neighbourhood planning and development. For purpose of this study, Ibrahim Taiwo Housing neighbourhood, Maiduguri was selected as a case study. Data were collected using mixed methods involving questionnaire survey, interviews, personal observation, and document search with descriptive analysis as the main method of analysis. The study indicates that the absence of public facilities such as green open spaces due to infill, coupled with the changes made to the original neighbourhood plan lead to disappointing results. This appears to be due to a number of factors: the lack of adherence to neighbourhood sustainability development criteria; the increased in number of households, the relative scarcity of public open spaces such as schools and green areas, the conversion of the only primary school into secondary schools, and the increased in number of vehicle ownership per households. Nevertheless; the study concludes that for a city to achieve sustainability, its urban neighbourhoods, the component parts of the city must be sustainable.

Keywords: Sustainability, Urban Neighbourhood, Infill Development, Sustainable Neighbourhood Criteria, Nigeria.

Introduction

According to the United Nations (UN), with prevailing population trend, two-thirds of the world population would be urban by 2050. This trend in urban population dynamics is more pronounced in cities of the developing countries (Heilig, 2012). Efforts at achieving sustainable urban development have thus become one of the key challenges for urban policy makers, managers, and planner in developing countries like Nigeria, where population growth rate is extraordinarily high at 5%; and currently the 7th largest country in the world and projected to be the 3rd largest country in the world by 2050 (United

Nation, 2015). According to UN (2014) "Managing urban areas has become one of the most important development challenges of the 21st century. Our success or failure in building sustainable cities will be a major factor in the success of the post-2015 UN development agenda." Sustainable development has, therefore, become an important aspect of consideration in urban planning and design in the 21st century (Porter, & Hunt, 2005).

Although sustainability is mostly considered at the city level rather than the neighbourhoods, nevertheless infill development as a sustainable strategy mostly takes place at the neighbourhood level (Choguill, 2008). Therefore, achieving city sustainability requires that its component parts - the urban neighbourhoods must be sustainable, (Luederitz, Lang, & Von Wehrden, 2013). Interestingly, the last two decades have witnessed a greater concern toward neighbourhoods' sustainability within the research community (Choguill, 2008; Luederitz *et al.*, 2013). Numerous approaches exist that define principles for guiding sustainable development processes of urban neighbourhoods (Hamedani, & Huber, 2012).

Several approaches from different perspectives highlighted aspects that are considered fundamental for the development of sustainable urban neighbourhoods (Luederitz *et al.*, 2013). These range from social aspects (Ahmed, 2012), to ecological issues (Li, Wang, Paulussen, & Liu, 2005), the cultural dimension (Joubert, 2004), and economic circumstances (Jones, 2009). Other approaches point to economic and social determinants (Kauko, 2011). Common to all these approaches is the desire for the attainment of sustainable urban neighbourhoods, through the development and redevelopment (Turcu, 2012) of new and existing neighbourhoods. However, recent arguments have been in favour of compact city model as the most effective solution in achieving sustainable urban development (Williams, 2004).

Compact city is generally defined as a relatively high-density; mixed-use that encourages walking and cycling with clearly defined boundaries (Williams, Burton, & Jenks, 2000). It is an urban redevelopment process, whereby existing buildings, vacant land and open spaces are developed or redeveloped at higher densities, otherwise known as urban 'intensification', 'consolidation' or 'densification' (Sultana, 2008). The compact city concept was developed to improve the quality of life without expense to the next generation, (Dantzig, & Saaty, 1973) which is in line with current principles of sustainability (Lee, Kurisu, An, & Hanaki, 2015). The major arguments in favour of the compact city model are that; compact cities are judged to be environmentally sustainable in terms of transportation. The argument is that high population densities and mixed-use allow people to live in close proximity to work, commercial and recreational facilities. Thus, it is expected that it will encourage walking and cycling thereby reducing the overall demand for vehicle travel. This will ensure efficient use of energy that will therefore promote environmental sustainability (Williams *et al.*, 2000; Williams, 2004). It is also believed to be environmentally sustainable in preserving rural land through the reduction of sprawl development (Williams, 2004; Sultana, 2008).

In terms of social sustainability; it is argued that as cities grew to be more compact with mixed uses, people of varied socio-cultural background comes together, (Dempsey, Bramley, Power, & Brown, 2011). This it is argued create diversity, social cohesion, and cultural development (Williams, 2004; Sharifi, & Murayama, 2013). It is also believed to be equitable in terms of accessibility to social facilities and services (Bramley, Dempsey, Power, & Brown, 2006; 2007). Economically, the model supports local employment opportunities through the provision of services and businesses. In addition, the compact city model, it was argued is cost effective as it

reduces the cost per capita of infrastructure provisions, such as roads, drainages, water supply, electricity and street lighting.

Also the United Nation, Department of Economic and Social Affairs (UN, DESA) in 2014, state inter alia: "Providing public transportation, as well as housing, electricity, water and sanitation for a densely settled urban population, is typically cheaper and less environmentally damaging than providing a similar level of services to a dispersed rural population." (UN, DESA, 2014).

Nigeria like many other African countries is already facing numerous developmental challenges in meeting the needs of its growing urban population. Since independence, in spite of the limited success, the successive Nigerian governments and its urban community have invented alternative systems (formal and informal) in dealing with these challenges. These include but not limited to, the development of open space and vacant land, more intensive use and conversions of existing development through the sub-divisions, infill development, and land use change or conversion (Olotuah & Bobadoye, 2009; Adetokunbo & Emeka, 2015). Infill developments were initially limited Government Residential Areas (GRA). These GRAs were designed as low density with plots sizes of 2000 square meters (100m x200m), or more with abundant open space and recreational areas (Jiboye, 2011). The hitherto serene GRA housing environment thus become medium and high density with high concentration of road traffic leading to a decline in the residents' quality of life (Ayotamuno, Gobo, & Owei, 2010). It was not until the oil boom period of the 1980*s* that the infill developments becomes widespread extending to institutional staff quarters and government low-cost housing estates of medium and high density (Ayotamuno *et al.,* 2010). This is due to the pressure on the available urban land resources and the inability of government to provide serviced layouts to its teeming population at the urban fringes.

In Nigeria, however, the adaptation of the infill development strategy had been extensively carried out in all Nigerian urban centres from independence to the present date. Consequently, the new town planning agenda become associated with compact development. Therefore, this study was instigated by the fact that infill development is vital planning tool for achieving sustainable urban development through compact development.

The objective of this paper is to assess the infill development programme in promoting sustainable urban neighbourhood in Nigeria, against a set of sustainable neighbourhood's criteria. The study, therefore, seeks to examine the impacts of infill development in a planned residential neighbourhood and its implications for urban neighbourhood sustainability.

Research Method

For purpose of this study, Ibrahim Taiwo residential neighbourhood, Maiduguri was selected as a case study. The choice of Ibrahim Taiwo residential neighbourhood was based on the following reasons; firstly, it was a plan urban residential neighbourhood of medium and high density; and secondly, it was a planned infill development. Data were collected using mixed methods involving questionnaire survey, interviews, personal observation, and document analysis. The data were analysed using descriptive statistical tools as the main method of analysis. The study included a set of primary surveys ranging from household surveys to mapping. For the household survey, a stratified random sampling was adopted using housing typologies as the criteria for selecting samples. Efforts have been made to ensure that the selected samples are uniformly distributed throughout the neighbourhoods. Factors such as travel patterns, vehicle ownership; income; density and use; household type and size that are considered relevant to urban sustainability, were included in the household survey. Since the study explores

one case study with no 'control' case study, therefore evidence from which conclusions were drawn is limited.

Sustainable Urban Neighbourhood

Although the importance of sustainable urban neighbourhood in contributing to the overall city sustainability has now been emphasised, there is no consensus as to what constitutes an urban neighbourhood. The lack of consensus at defining urban neighbourhood is because of various criterions that are considered fundamental to the concept of urban neighbourhood. Several definitions that are considered essential to understanding the concept of the urban neighbourhood have been suggested. Yet, in none of these, is the population size and function of the neighbourhood specified. Ironically, the basic concern of sustainability is to provide urban neighbourhoods with specific functions that promote sustainable lifestyles (Choguill, 2008). There are four major criteria that are fundamental to the concept of sustainable urban neighbourhood, viz 'economic', 'social', 'environmental', and 'technical' (Choguill, 2008). These criteria are similar to those used in sustainability analysis at the city level (Luederitz *et al.*, 2013).

Neighbourhood Sustainability Criteria

The neighbourhood sustainability criteria are fundamental to the attainment of the sustainable urban neighbourhood. However, these criteria are interrelated and are not mutually exclusive.

Economic sustainability as a criterion refers to the actual economic benefit both in terms of reduction of transport and infrastructure cost, and employment opportunity within the neighbourhood. The ability to walk to a central focal point is basic to the neighbourhood and would eliminate many daily vehicle trips. The neighbourhood population should be sufficient enough not only to support neighbourhood shops, for local shopping but also provide employment for neighbourhood residents. Similarly, the environmentally sustainable criterion, which refers the existence green open spaces within the neighbourhood, augmented by schools and other neighbourhood amenities, serve as a forum where neighbourhood members both old and young meet, thus encouraging social interaction.

The next criterion is social sustainability, which is generally concerned with the level of social cohesion within the neighbourhood as a result of personal interaction among residents (Hirschfield & Bowers, 1997). Thus encouraging public participation is a matter of concern to the neighbourhood sustainability. The central locations of shops and other supporting services provide an avenue for community social interaction. The fourth and final criterion; technical sustainability, this refers to the relationship within neighbourhoods and between neighbourhoods and the city. Neighbourhoods with defined boundaries, enhances social interaction, while minimised through fare improved security, especially children's' safety, which is "an essential prerequisite for a stable and sustainable neighbourhood" (Shaftoe, 2000; 2012).

The Study Area Location

Maiduguri (Yerwa), the capital of Borno state is located in the north-eastern part of Nigeria within the Sudan Savannah of the Sahel region, at latitude 11.85o N and Longitude 13.05o E, with an altitude of about 300 meters above sea level. It lies on a relatively flat undulating plain that slopes gently toward Lake Chad. Its landform is characterised by the Bama Ridge (the shoreline of the ancient Lake Chad), River Ngadda, and its tributary River Ngaddabul. Maiduguri apart from being an important centre of Kanuri culture and Islamic scholarship is also the principal trading hub for north-eastern Nigeria. This coupled with its strategic position make it a

destination for tourist and business from neighbouring Republics of Chad, Niger and Cameroon. These activities serve as magnets that attract more and more people to the city (Figure. 1).

Figure 1: Map of Nigeria showing Maiduguri
Source: Google Maps, (2015)

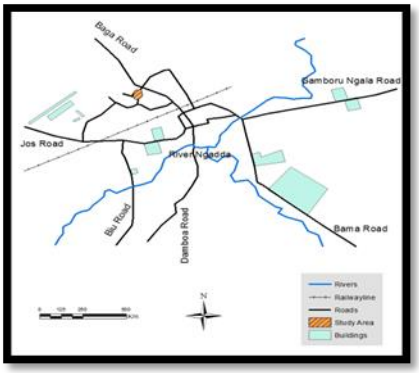

Figure 2: Map of Maiduguri showing Ibrahim Taiwo Estate
(Source: Adopted from Max Lock, 1976)

Ibrahim Taiwo Estate (ITE) - Federal Low-cost residential estate - is one of the planned neighbourhoods within Maiduguri, located along Baga Road (Figure 2). It occupies approximately 60 hectares of land is bounded by Bolori ward to the east and south, Pampomari Housing Estate to the south and west, and Zajiri/Umarari wards to the north. The ITE consist of 850 housing units of semi-detached houses and apartments blocks with ample open space for children playgrounds, parking lots, and gardens. The population of ITE is estimated at 8,500 persons by 2002 with an average household size of 10 persons and a net density and gross building density of 340 and 141 persons per hectare (pph) respectively. The residential density was estimated at 34 and 14 dwellings per hectare (dph) for the net and gross density respectively.

Results And Discussion

Pre-Infill Plan: 1977 - 2002

In planning the neighbourhood, the radial pattern interlaced with the grid system was adopted with only one external linkage with no thoroughfare traffic. The external access road links the ITE with Baga Road to the north forming an internal loop of 19 metres wide (with a 1.5-metre pedestrian walkway on both sides) with no direct access to the individual housing unit. Two minor access roads of 11 and 9 metres wide respectively) that serve as access to the various housing units connect directly from both sides of the internal loop. These minor access roads either ends up as a cul-de-sac or parking lot of apartment blocks. All the roads within the neighbourhood are designed with a 1metre drainage channel on both sides

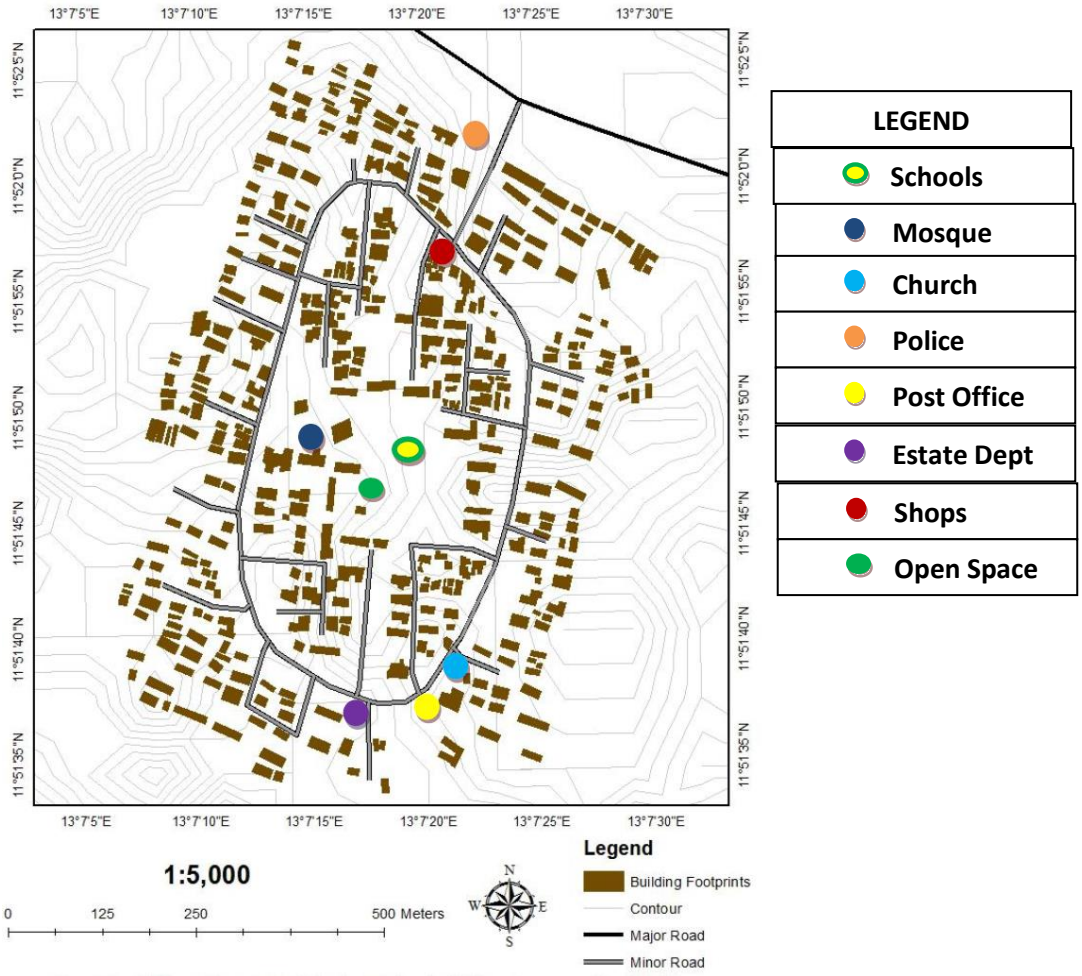

Figure 3**:** Pre-Infill Plan: 1977 – 2002
Source: Adapted Google earth satellite imagery/ Field Survey 2013, 2002

In terms of land use both the primary school, playground and a central mosque were centrally located to serve as a focal point, while other public uses such as police station, estate office, church, and post office were distributed within the neighbourhood (Figure 3). The only commercial land use within the ITE neighbourhood is a small shopping complex located at the intersection of the external access road and the loop. Although no study has been conducted on the sustainability of ITE neighbourhood, the neighbourhood seems to exhibit certain sustainable urban neighbourhood attributes in its planning and design. Thus, the planning and design of the ITE neighbourhood prior to the infill can be said to adhere to sustainable neighbourhood criteria**.**

Post-Infill Plan: 2002 - 2013

In other to accommodate the growing number of urban populace, the Borno State Government in 2002 adopted the infill development as a strategy for the redevelopment of the ITE residential neighbourhood. A total of about 10.3 ha made up of 208 plots (183 residential and 25 commercial) of various sizes were introduced as infill plots (Figure 4, table 1). As shown in Table 2, there is an increase of about 10.3429 (17.5%) and 0.5599 (0.78%) for residential and commercial uses respectively. The survey indicates a drastic decrease in

open spaces from 16.5 to 5.5 ha, a decrease of 66% in real terms and 18% in the land budget. It is interesting to note that the only public primary school within the neighbourhood have been converted into a secondary school, leaving the neighbourhood with only a private primary school.

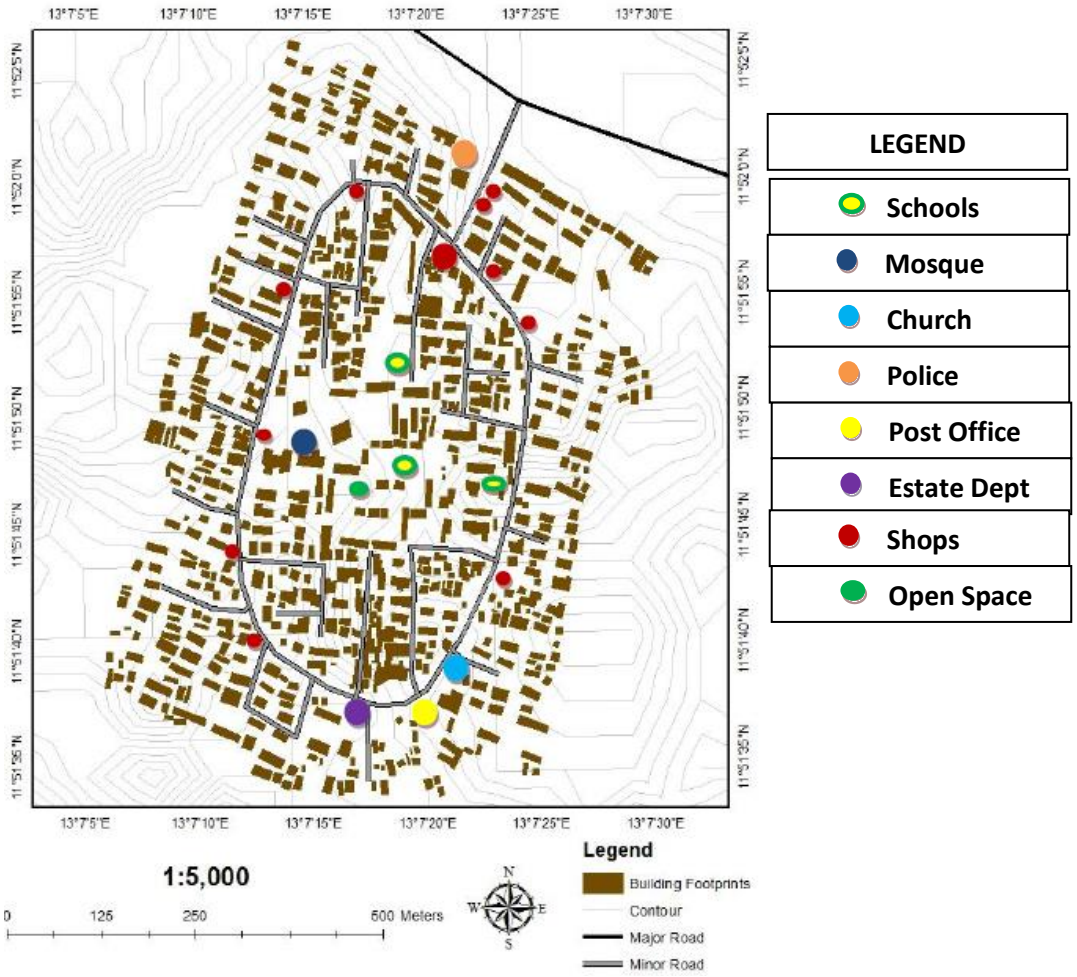

Figure 4**:** Post-Infill Plan: 2002 – 2013
Source: Adapted Google earth satellite imagery/ Field Survey 2013

In terms of density (both population and building) show an appreciable increase the survey reveals. In 2013 the estimated population of ITE neighbourhood stands at 12,450 persons – an increase of 3,950 persons. This gives the neighbourhood a population density of 207pph (post-infill) from 141pph (pre-infill) and a gross building density of 14 dph (pre-infill), 21dph (post-infill), and a net building density of 34dph and 36dph for pre-infill and post infill respectively as table 2 indicate. The study indicates that the increase in population density is much higher than that of the building density. This might not be unconnected with the household size and number of households per house as shown in table 3.

Table 1: Comparision between Pre and Post-Infill Land Use in ITE Neighbourhood

S/No	Land Uses	Pre-Infill Plan 1977 - 2002		Post-Infill Plan 2002 - 2013		Difference (Ha)	Difference (%)
		Ha	%	Ha	%		
1	Residential	24.6028	40.00	34.9457	57.488	+10.3429	+17.50
2	Commercial	0.0900	0.14	0.5599	0.92	+0.4699	+0.78
3	Public Use						
a	School	3.5364	5.80	3.1749	5.55	-0.3615	-0.60
	Primary School	3.5364	5.80	-	-		
	Secondary Schools	-	-	3.1749	5.55		
b	Police Station	0.7913	1.30	0.7913	1.30	0	0
c	Post Office	0.2460	0.40	0.2460	0.40	0	0
d	Estate Office	0.2940	0.50	0.1200	0.20	-0.1740	-0.30
e	Mosque	1.5035	2.50	1.7590	2.90	+0.2555	+0.40
f	Church	0.8750	1.40	0.8750	1.40	0	0
Sub total		7.2462	11.9	6.9662	11.75	- 0.2800	- 0.50
4	Open Spaces	16.5594	27.00	5.5065	9.00	-11.0529	-18.00
5	Circulation						
a	Road Network	10.3839	17.00	11.1260	18.00	+0.4721	+1.00
b	Drainage	1.6983	2.80	1.6102	2.60	-0.0881	- 0.20
c	Utilities	0.2067	0.34	0.0726	0.11	-0.1341	- 0.23
Sub total		12.2889	20.14	12.8088	20.71	+0.2499	+ 0.57
TOTAL		60.7873	100.00	60.7873	100.00	-	-

Source: Field Survey, 2013

The study also shows an increase of about 1% in road network as more access roads were needed for the infill plots, thereby obstructing the existing system of pedestrian walkways (Figure 4, table 1). This, in turn, encourages car use, especially for short trips, increased traffic congestion, and thus contributing to air pollution the planned infill development can thus be criticized for lack of sustainable neighbourhood development criteria in its planning and design. Another access road that links the neighbourhood with Pampomari to the south was provided, thus creating thoroughfare traffic. This not only leads to a considerably increased in vehicular traffic but also traffic congestion and conflicts.

Though the study shows a significant difference between the pre and post infill in their land use composition as shown in Table 1, however the land use mix entropy for both pre and post infill of 0.37 and 0.48 respectively is less than half (Table 2). This indicates that the land use composition is below a desirable level as the closer to 1 the land use mix entropy is the better the composition (Soltani & Bosman 2005). The availability of diverse housing types makes it possible for households of different background to live together. The study shows that 62% of housing types for post infill are single-family apartment type houses, made up of one, two and three-bedroom apartment type (Table 2). According to Katz (1994):

Table 2: Urban Form Features

Variable/Factor	Description	Pre Infill	Post Infill
Urban form features			
Mixed Uses	Land use mix entropy	0.37	0.48
Population Density	Person per area (per/ha)	141	207
Building Density	Gross Density	14	21
	Net Density	34	36
Residential Net Density	Person per residential area (per/ha)	348	360
Housing Type (%)	3 bedroom Semi-detached	18.8	15.5
	2 bedroom Semi-detached	27.6	22.6
	3 bedroom Apartment	-	15.8
	2 bedroom Apartment	26.8	24.0
	1 bedroom Apartment	26.8	22.1

Source: Field Survey, 2013

"Within neighbourhoods, a broad range of housing types and price levels can bring people of diverse ages, races, and incomes into daily interactions, strengthening the personal and civic bonds essential to an authentic community." It is therefore expected that a wide-ranging housing type will more likely lead to sustainable urban neighbourhood by accommodating household of different socio-economic background. This is not the case with the post infill development as the study indicates.

In term of density, population, building, and residential density are higher for post infill than the pre infill era. Though the study indicates increases in both building and residential density due to infill development, however, there are no significant differences between pre and post infill development. This is attributed to the conversion of open space to residential (10.3429 ha) and commercial (0.4699 ha) uses during infill development (Table 2).

It has been suggested that public facilities and services located in central areas with good mix use and access make public transport more reliable, encourages multi-purposes trips, thus leading to a reduction in both length and frequency of trips (Burton, 2002). Accordingly, mixed-use development provides an opportunity for a more diverse, high population and sizable commercial activity in close proximity to each other to facilitate viable public transit, cycling and walking (Appleyard, 19800. This enhances the viability, vitality and the perceived community security by attracting more people onto the street. A good mixed-use is one that offers a full range of human activities such as living, learning, working, recreation, and worship within the same neighbourhood and vice versa.

The study also shows that car dependency is more with 64% of households owning two or more vehicles with 72% being private cars (Table 3). These partly explain the reliance on private cars for both work and non-work trip (Table 3). Trip frequency is put at 6.3 with local trips within the neighbourhood and short trips of less than 2km accounting for 31% and 45% of total trip respectively (Table 3).

Table 3: Socio-economic Characteristics and Travel Pattern

Factor	Description in (%)	Post Infill
Income Level per month	Less than N 50,000	65
	Higher than N 50,000 but less than N 250,000	31
	Higher than N 250,000	04
Primary Employment	Govt/administration	52
	Commerce	24
	Agriculture	09
	Others	15
Household size	Four or fewer persons	17
	Five or six persons	35
	Seven or more persons	48
Households per house	One household	10
	Two or three households	68
	Four or more households	22
Travel pattern		
Vehicle Ownership (%)	Without a vehicle	07
	With one vehicle	29
	With two or more	64
Type of Vehicle Ownership (%)	Private Car	71
	Tricycle	05
	Motorcycle	08
	Bicycle	16
Journey to work (%)	Public transport - Mini Bus	05
	Public transport - Tricycle	06
	Private car	77
	Cycling /walking	12
Non-work trips (%)	Public transport - Mini Bus	06
	Public transport – Tricycle	02
	Private car	81
	Cycling /walking	11
Trip frequency (number of trips per adult per day)		6.3
Local trips within the neighbour (%)		31
Short trips of less than 2km (%)		45
Short trips of more than 2km (%)		24

Source: Field Survey, 2013

Findings/Inferences

The promotion of compact mixed-use, through infill strategy within the ITE neighbourhood, is expected to reduce transport cost thereby promoting economic sustainability. Although the increase in commercial activities within the ITE neighbourhood has to a certain extent improve the neighbourhood's economic sustainability by providing employment, car dependency for the daily trip rather than decreased as expected has been on the increase. Two main reasons can be attributed; first, the lack of efficient and effective public transport system; and second the conversion of the only public primary school into secondary school as parents are forced to take their children to a school outside the neighbourhood.

Excessive car usage is regarded as the major cause of greenhouse emission that causes global warming. In ITE neighbourhood in addition to increasing dependence on private car usage as earlier mentioned, the introduction of additional access to the south has turned the neighbourhood into a thoroughfare, thereby attracting more vehicular traffic into the neighbourhood. This is not in tune with sustainability as a reduction in vehicular usage is a critical requirement for the attainment of urban neighbourhood

sustainability. Secondly, the drastic reduction in open spaces as the study reveals is not inconsonant with the idea of environmental sustainability.

Community interaction, social networks, and participation within these social networks are keys to attaining social sustainability at the urban neighbourhood level in particular and the city level in general. Shared public space such as school, children playground, places of worship, shopping areas, spaces in front of buildings etc plays a greater role in this regard. These shared spaces in most part are not available, and where available is restricted. For instances, the mosque, school, and their open spaces (for the playground) are closed after official hours and virtually impracticable to be utilised during the official period. Another issue that is of relevance to social sustainability is the wall around the building. These building walls apart from taking over the spaces in front of buildings, also limit children's play within the various compounds. Therefore in terms of social sustainability criterion, the infill strategy has failed in promoting sustainability.

The ITE neighbourhood has performed though with few exception relatively better in terms of technical sustainability. The neighbourhood fits relatively well into the larger city. Secondly, the building of walls around individual properties, though not in tune with social sustainability as earlier indicated, excluded vehicular traffic from building blocks. The resultant cul-de-sacs as a consequent of this enhance children's' safety and therefore an indications towards technical sustainability.

Conclusion

The study examines whether compact development through infill strategy leads to a sustainable urban neighbourhood in Nigeria. It reveals that, though there were a number of issues with the adoption of infill as an urban sustainable development strategy, the infill, if properly handle will lead to sustainable urban development. The paper argues that the policy thrust of the government lacks any conscious effort at improving urban sustainability at neighbourhood level. Rather the infill development policies were aimed at accommodating the rapid population growth.

It posits that, though city sustainability is incidentally dependent on the sustainability of its neighbourhoods, for the neighbourhoods to be sustainable requires the cooperation of the city. The paper suggests that for a city to achieve sustainability, its urban neighbourhoods, the component parts of the city must be sustainable.

In conclusion, the paper suggested that future planning and design of urban neighbourhoods in Nigeria should include sustainable neighbourhood criteria if sustainable urban development is to be achieved. This is believed will lead to a more pedestrian-friendly and reduced traffic, thus creating a sustainable urban neighbourhood with better air quality. It, therefore, calls for further research into the incorporation of these criteria into our planning and design of urban neighbourhoods.

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