Spatio-Temporal Patterns of Development and Household Travel Characteristics in Ilesa, Osun State, Nigeria

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Abstract

The rapid urbanization process of towns and cities has become a universal phenomenon that draws attentions of city planners and urban researchers, both in the developed and developing countries but more elaborate in the former than the latter. This study therefore examined the spatio-temporal patterns of city development and travel characteristics of urban residents of Ilesa. To this end, the study utilized structured questionnaire to gather information about the travel distance and the modal choice of 1,200 urban residents. In addition, satellite imageries of Ilesa taken in 1986, 1998, 2002 and 2008 were used as sources of primary data to complement the administrative maps of 1948, 1965 and 1977. These cartographic materials were employed to determine the growth extent of the study area. The findings revealed that the expansion of Ilesa was alarming between 1948 and 2008 at 57.4% when the built-up area of Ilesa attained a net increase of 52.4 $\text{KM}^2$ to reach 62.7 $\text{KM}^2$ in 2008 which was nearly sixty times of that in 1948 and meant an annual average expansion of 1.05 $\text{KM}^2$. This study reveals that there is long distance travel between residential areas and other urban land uses which rely on automobile trips. This is corroborated by the prediction of urban extent of the study area estimated to be 23540 hectares by 2050, meaning that the radius of commuting distance would be 235.4km$^2$. The study therefore advocates for constant review of city master plan through the use of dynamic tools such as Geographic Information Systems and Remote Sensing techniques which offer a strong capability for monitoring city development.

Keywords

Urbanization, Medium-sized cities, GIS, Travel characteristics.

Introduction

Urbanization trend in Nigeria is not a recent phenomenon. Thus the growth and development of cities in Nigeria is very similar to the urbanization process in other African countries. The South western part of Nigeria has the highest Urbanization level (Mabogunje, 1962; Aloba, 2004). A significant proportion of Nigerian Cities are found in South Western Nigeria whose existence dated back to the 7th and 10th centuries (Mabogunje, 1962; Aloba 2004). These cities include Ile-Ife, Oyo, Ijebu-Ode, Ibadan and Ilesa. These cities are developed as a result of pre-industrial activities in their economic and social orientation (Aguda, 1994; Aloba, 2004).

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This study is very important in understanding the patterns, forms, structure and evolution of land use characteristics and its emerging problems in a rapidly developing city in Southwestern Nigeria. Before the advent of automobile, the principal modes of transport were mostly by foot, cart and horse and so, various urban land uses were arranged in concentric form. During this period, the urban households travelled short distance to reach different activity centres. The subsequent city expansion engendered segregation between residential and other urban land uses which consequently relied on automobile with complex traffic congestion, road accident and long distance commuting by urban residents (Newman and Kenworthy, 1999, Ogunsanya, 2004). Research efforts into the evolution, forms, structures, patterns and characteristics of land use are concentrated on the major urban centres like Lagos, Ibadan, Port-Harcourt, and Kano. Studies of this nature are very few in medium sized cities of Osogbo, Akure, Ondo, Ile-Ife and Ilesa and elsewhere in South Western Nigeria (Adetunji, 2010). This study is designed to bridge the gap by focusing on the study of spatio-temporal patterns of city development and associated travel demand problems in a medium sized city of Ilesa, Nigeria.

Theoretical Point of Departure

Theoretically, several theories have emerged in the literature to explain the spatial structure of cities, patterns and processes of city developments in the world (Adetunji 2010; Aloba, 1986; Aguda, 1994; Naess, 2004; CNU, 2002). However, three ecological theories are very crucial to the explanation of the process of city development. These theories are the Concentric zone theory of Burgess (1925), the Sector theory of Hoyt (1939) and the Multiple Nuclei theory of Harris and Ullman (1945). The Concentric zone theory of urban growth propounded by Burgess (1923) states that urban land use are arranged in a concentric form so as to minimize the travel demands of people in a settlement with low level of transportation, the important activities which harbour frequent needs of people is located closer to the centre of the city. Other Land uses are arranged around this centre in the order of their decreasing needs. As the city expands, the distance between the residential areas and the various activities centres increases and this puts more pressure on travel demands of the urban residents. With the growth of transport network, the concentric zone model became less popular. Thus, Homer Hoyt (1939) put forward the sector theory which recognizes the radial patterns of route developments away from the centre of the cities. According to him, the growth of the city usually takes place along such route. The result is the emergence of star-shaped land use that radiates from the centre of the city along particular sectors towards the periphery of the city. In multiple nuclei theory, Harris and Ullman (1945) suggest that rather than one nucleus, land use pattern can be understood in terms of development around multiple centres rather than around a single centre as observed by both the Concentric and the Sector theories. According to the multiple nucleus theory, transport terminals can generate many other smaller nuclei from which other minor roads can develop. Such nuclei become special traffic generator and attracting nodes. This leads to a complex urban land use and transport system, a reality of today’s urban structure (Aloba, 2004).

In an attempt to explain the urban form and household travel pattern, Volchenkov and Blanchard (2008) apply the simple trade-off models to dual graphs in order to predict the appearance of urban expansion with the local land-use scheme. The decisive factor for the emergence of star graphs is the supremacy of the centrality (integration) objective, while the physical (Euclidean) distance between graph vertices is of no importance. It is well known that the humbleness of physical distances is one of the major factors shaping the urban land use patterns. In return, the urban dwellers residing at the low density areas of the city depend on automobile to commute to different activity centres. In the absence of conscious planning, the emerging development often culminates in sprawling growth that tends to result in long distance commuting by urban residents. Though, urban expansion portrays improvement in the urban economies, yet the resulting development from sprawling affects planning. It is on this note that this study attempts to examine the patterns of development and household travel characteristics in Ilesa with the view to improving household accessibility to urban activity centres.

The Study Area

Ilesa city is located approximately on longitude 4° 5’ and 4° 6’ East of the Greenwich Meridian and latitude 7°48t and 7°6’ North of the Equator. Ilesa Urban area is presently made up of two large local government areas of Ilesa East and...
The population of Ilesa has grown from 72,029 in 1952 when the first national population census was conducted in Nigeria outside Lagos to 165,822 in 1963, 138,953 in 1991, and 210,141 in 2006 (NPC, 2006). Ilesa is about 32 kilometers North-East of Ile-Ife (the ancient Yoruba town) with which it shares the same senatorial seat in the upper national legislative chamber, and it is about 30 kilometers south west of Osogbo, the Osun state capital (Figure 1).

Ilesa West. Both council areas are bounded in the north, west and south by Obokun, Atakumosa and Oriade local government areas respectively. The town covers a total area of about 4,828.12 hectares in 2008 (Adetunji, 2010). Ilesa is about 32 kilometers North-East of Ile-Ife (the ancient Yoruba town) with which it shares the same senatorial seat in the upper national legislative chamber, and it is about 30 kilometers south west of Osogbo, the Osun state capital (Figure 1).

Each unit of the forty quarters that made up of Ilesa is headed by a chief who presides over judicial matters at the lowest level of administration. According to Peel (1983), in the past they were the basic units of channel through which the Oba passed on information of public importance to the people. Each has a title which indicates his quarters. For instance, Lejofi and Lorinyin and are the heads of Ijofi, and Oke Iyin. The young men in each quarter are organized under Lorioro (head of young men) who is responsible to the chief of his quarters.

Evidence from the spatial layout of Ilesa shows that the palace is the focal point of the town as in other traditional cities in Nigeria (Mabogunje, 1968; Ogunsanya, 2004). It is set within its rectangular 51-acre grounds and surrounded by a high mud-brick wall, residence of the Owa, his personnel staff and manner of clients and dependants, location of the royal ancestors and the most potent shrines of the gods. The palace seems to have served as watershed for the seven roads that formed the armature of the capital’s settlement and then ran to the frontiers of the city. Ilesa communal structure may be derived from two coordinated principles; a spatial arrangement by quarters, and a political hierarchy of titles, both of which are focused on the palace (Peel, 1983).

Materials and Methods

Both primary and secondary sources of data were used for this study. The primary data involved the use of structured questionnaires to elicit information on travel characteristics of urban residents which include distant travel and modal choice to different activity centres which is highly paramount to the spatial growth of the city. In each of the 11 traffic analysis zones identified in Ilesa by Adetunji (2010), all the buildings were numbered and one in every tenth building was randomly selected. Only the head of household was selected for interview. Similarly, the secondary data which include maps and satellite imageries were utilized. The details of maps and Satellite Imagery utilized for this study are as follows:
(i) Settlement maps of Ilesa 1948, 1965, 1977 and 1998 on scale 1:50,000; obtained from Ilesa West and East Local Government Areas.
(ii) Landsat TM of Ilesa 1986;
(iii) Landsat ETM+ of Ilesa 2002; and

Methods of Data Processing
The settlement maps were scanned in ILWIS format and subsequently imported to the ILWIS environment. Therein, the maps were georeferenced with the coordinates of selected ground control points generated during the field observation through the use of GPS. Similarly, on the satellite imageries, the boundary of the study area was delineated using submap operation technique. Thereafter, the submaps or subimages were subjected to digital image processing which include enhancement and filtering to improve the pictorial quality and contrast of the images using linear stretch contrast and majority filtering techniques. This was followed by georeferencing of the images using map to image registration. With respect to the purpose of this study which intends to assess the urban development trends among others in the study area, the built-up layer, road network and rivers were digitized on temporal basis.

Data Analysis
The Spatio-temporal pattern and trend in urban development of the study area was carried out using the formula stated below:

\[ \text{LUDI} = \frac{(U_b-U_a)}{U_b \times T} \times 100 \]

Where LUDI represents the annual rate of change, Ua and Ub represents extent of urban expansion at time a and time b. T represents the length of time in year from time a to time b.

Further attempt was made to predict the extent of urban development in the study area by 2050 using population projection method adapted for this purpose. The study adopted this technique because Oyinloye, 2003; Adegboyega, 2008 and Farinde, 2009 applied this technique for similar urban studies and found it suitable. The formula is therefore stated below:

\[ B_n = B_0 \times (1 + r/100)^n \]

Where \( r \) represents rate of urban expansion

- \( B_n \) represents new built-up Area Value
- \( B_0 \) represents previous built-up value

\( n \) represents number of years from \( B_0 \) to \( B_n \)


Results and Discussion
The built-up area of Ilesa was 530 hectares in 1948. This period witnessed the establishment of public utilities such as telephone services in 1909, the Wesley Guild Hospital, now Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) in 1912 and Obokungbusi Townhall which was built within the palace ground in 1934 while the public library was built in 1932. All these urban facilities were located within the walking distance of urban residents. The average commuting distance of urban residents was 5.3 km (table 1 and Figure 2).

Between 1948 and 1965, the Spatio-temporal change of urban expansion of Ilesa as depicted by table 1 and figure 3 shows that the built-
Table 2: Dynamic change in urban space for the built-up area of Ilesa

Up area of Ilesa expanded by 760 hectares between 1948 and 1965. During this period, the first women training college and Ilesa Waterworks were established in 1952, Electricity supply began in 1956 and Atakummosa market, a regional market for Ijesa people and many other urban centres in Southwestern Nigeria was established in 1959. The radius of distance travel was 12.9 km². The provision of these facilities in Ilesa constituted centripetal forces that drew the people from countryside to the city to afford them access to the facilities.

In the period between 1965 and 1977, Ilesa began to house the state government branch offices of various Ministries which include Ministry of Works and Transport, Mining and Power, Agricultural Natural Resources, Local Government and Chieftaincy Affairs, Health, Trade and Industry. Others were Prisons Department, Town Planning Authority, the Nigerian Police and Internal Revenue Department. Before 1967, only one administrative Division in Ijesa Land was in existence and it was Ilesa. The establishment of these departments in Ilesa seemed to have increased the built-up areas of Ilesa by 580 hectares.

Between 1977 and 1986, the rapid expansion of the city ushered in the establishment of institutions of higher learning such as Oyo State College of Education, now Osun State College of Education and School of Health Technology to cater for the educational needs of the urban youth. Many industries that generated considerable pattern of movement between the residential areas and workplaces were established. These industries were Abiobe Plastic industry, adjacent to Osun State College of Education, Adediran Wire and Steel Industry along Akure Road, International Breweries at Imo and Yinka Oba Foam along Ijebu-Jesa road. The emerging urban population growth culminated in acute shortage of housing that led to the opening of Ilaie quarters and low-cost housing along Osogbo road, for urban residents. The total area covered by Ilesa in 1986 was 2230 hectares. This was evident in table 2 with urban expansion percentage at its highest (143.4%) in the early period i.e. 1948 -1965 but dropped to 19.3 percent within 1977 and 1986 (see figure 4).

Moreover, the expansion area increased further by 90 hectares in 1998-2002 periods with 2.7 percent but spontaneously increased by 2810 hectares in 2002-2008 periods (figures 9 and 11). The urban expansion continued to dwindle down from 1948 to 2002, that is, from 3.5 percent to 0.7 percent according to the table. This suggests that urban development in Ilesa was in strict compliance with the existing but rather old master plan in the periods. However, the rate of urban expansion skyrocketed to 7.5 percent between 2002- 2008 period (figure 4) which was described to be alarming and even higher than the average national population growth rate of 2.83 percent suggesting that the intermediate city was experiencing sprawling growth. This seems to have confirmed the viewpoint that big and small towns and cities in developing countries are experiencing sprawling growth (Yeh, 2003; Adegboyega, 2008) By using average expansion rate

### Table 2: Dynamic change in urban space for the built-up area of Ilesa

<table>
<thead>
<tr>
<th>Periods</th>
<th>Expansion Area in (ha)</th>
<th>Expansion Area in (KM²)</th>
<th>Expansion (%)</th>
<th>Expansion Rate (%)</th>
<th>Annual change Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948-1965</td>
<td>760</td>
<td>7.6</td>
<td>143.4</td>
<td>3.5</td>
<td>8.4</td>
</tr>
<tr>
<td>1965-1977</td>
<td>580</td>
<td>5.8</td>
<td>45</td>
<td>2.6</td>
<td>3.8</td>
</tr>
<tr>
<td>1977-1986</td>
<td>360</td>
<td>3.6</td>
<td>19.3</td>
<td>1.8</td>
<td>2.14</td>
</tr>
<tr>
<td>1986-1998</td>
<td>1140</td>
<td>11.4</td>
<td>51.1</td>
<td>2.8</td>
<td>4.3</td>
</tr>
<tr>
<td>1998-2002</td>
<td>90</td>
<td>0.9</td>
<td>2.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>2002-2008</td>
<td>2810</td>
<td>28.1</td>
<td>81.2</td>
<td>7.5</td>
<td>13.5</td>
</tr>
</tbody>
</table>
Figure 4: Showing the Expansion rate and Annual Change rate

Figure 5: Showing the Built-Up Area in 1965
Source: Author’s Image Analysis, 2010

Figure 6: Showing the Built-Up Area in 1977
Source: Author’s Image Analysis, 2010
level of civilization of Ijesa people and strict compliance with the planning regulation seems to have curtailed the rapid expansion of the city as this study reveals that expansion rate continues to fluctuate from 3.5% in 1965 to 0.7% in 2002. This shows that the urban developers comply strictly with the master plan that regulates the expansion of the city. However, the capability of this instrument was put to test within the period of 2002 and 2008 when the expansion rate jumped up from 0.7% to 7.5%, leading to low density development at the urban fringe which heavily depends on automobile. This suggests that the use of master plan, which is static in nature, as instrument of urban development regulation is inadequate to cope with the rate of city expansion in developing countries. Thus, there is need for the physical planning of the city to embrace more dynamic master plan that would incorporate Geographical Information System (GIS) which has the capability to monitor different land uses so as to minimize long distance commuting between residential areas and various land uses.

Figure 7: Showing Built-up Area of Ilesa in 1986

Figure 8: Showing the Built-Up Area of Ilesa in 1998
Effects of Urban Growth on Travel Characteristics

The rapid expansion of towns and cities usually leads to segregation between residential areas and different urban activity centres which exert more pressure on long distance travel which depends mostly on automobiles. In Ilesa, about 52.4 percent of the urban residents commute less than 2km to work, 31.3 percent travel between 2 and 4km while approximately 16.3 percent of the urban residents commute more 4 km to work on daily basis (table 3). Similarly, 46.7 percent of the sampled population commutes less than 2 km for their shopping trips. Further analysis revealed that 16.6 percent commute between 1 and three kilometers (1-3 km) for shopping trips. While 36.7 percent travel more than 3 km for the same purpose.

With respect to modal choice of urban residents to work in Ilesa, approximately 39.3 percent of urban residents walk to work, 15.3 percent commute by motorcycles, 30.3 percent rely on public transport, while 15.2 percent depend on their personal car (Table 4). This shows that there is high dependency on automobile trips because of long distance commuting between the residential areas and the workplace in the city.

Physical Planning Implication of the Study

The physical planning of the city is very essential so as to reduce long distance commuting which rely heavily on automobile that characterizes most of the major urban centres in Nigeria particularly Lagos, Ibadan and PortHarcourt. More importantly, some of urban facilities that meet daily needs such as markets, Banks and Hospitals should be located very close to the residential areas but must comply with urban planning regulations.

The dualization of Ife-Ilesa Expressway has increasingly paved way for low density residential development. The urban expansion is seriously tending towards the newly constructed highway in a haphazard manner which has adverse effect on the physical planning of the town. This trend needs to be changed because the expansion rate and annual change rate as depicted in (figure 7) require proactive measures to curtail uncoordinated urban expansion. The current urban development has culminated in sprawling growth which seems to have been inhibiting sound infrastructural planning. The residential areas of the urban development have started to enclose industrial activities against the zoning policies.

Rapid urban expansion into the rural fringes causes increase in land values in the sprawled zones and land fragmentation by speculators makes large scale assemblies difficult which consequently make coordinated physical planning difficult. Moreover, urban encroachment on the environmental sensitive areas such as wetlands that provide flood control and waste water renovation subject the urban dwellers to serious environmental hazards such as devastating urban flooding. In physical planning, environmental sensitive areas are non-developable areas that need to be protected but land developers seem to have continued to depict non-compliance with existing urban development regulations.

The sprawling growth culminates in high cost of infrastructure provision which has adverse fiscal impact on the urban administration. In addition, it generates physical costs such as increased traffic congestions, longer commuting time and more aggressive driving patterns.

Conclusion

The rapid expansion of medium-sized cities in the developing countries of the world, particularly Nigeria has not only led to the segregation between the residential areas and other urban land uses but has also culminated in long distance travel which depends on automobile similar to what obtains in most urban centres that are characterized by high traffic congestion. This study demonstrates that the expansion of Ilesa as a typical example of medium-sized cities in southwestern Nigeria is alarming with expansion rate of 3.5% between 1948 and 1965 while the commuting distance between residential areas and other urban land uses increased from 5.3 km$^2$ to 12.9 km$^2$ within the same period. The

<table>
<thead>
<tr>
<th>Urban Activities</th>
<th>Less than 2km</th>
<th>2 to 4 km</th>
<th>Above 4 km</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Works</td>
<td>52.40%</td>
<td>31.30%</td>
<td>16.30%</td>
<td>100</td>
</tr>
<tr>
<td>Shopping</td>
<td>46.70%</td>
<td>16.60%</td>
<td>36.70%</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3: Distance travel to Urban Activity centres.
Figure 9: Showing the Built-Up Area of Ilesa in 2002

Figure 10: Showing the Extent of Ilesa Urban Expansion in 1986-2002

Figure 11: Urban Land Use Map of Ilesa in 2008
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