Relationship between Road Distance Accessibility and Functional Index of Facility Occurrence in Lagos Island, Nigeria

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Abstract
The central aim of this paper is to find out the relationship between road distance accessibility and functional index of facility occurrence in Lagos Island, Nigeria. In particular it seeks to find out areas that have below or above average level of occurrence of facilities relative to the level of accessibility. Using both simple regression analysis and Pearson’s Product Moment Correlation Coefficient, it was found that no strong relationship...
between road distance accessibility and occurrence of facilities could be established (i.e. \( r = -0.14 \)). Based on the findings, recommendations that would enhance equitable transport development in Lagos Island were proffered.

**Keywords:** Distance; road; accessibility; functional index; facility; Lagos Island

**Introduction**

It is essential to appreciate that the purpose of transport is to provide accessibility, or the ability to take a journey for a specific purpose. Transport is not consumed for its own sake, but it is merely a means to an end (a derived demand) (Hoyle and Knowles, 1992; Atubi and Onokala, 2004a, and 2004b).

However, studies of accessibility are more concerned with issues of efficiency and equity with respect to location of public facilities. An efficient location of public facilities is defined as that which gives the minimum total systems cost of operation and travel of a given level or volume of service. Equity in location of public facilities on the other hand is one which promotes greater equality of conditions (Rich, 1979; Chandra et al, 2000).

Thus in the U.S.A. accessibility studies in the late 1970’s and 1980’s seem to centre on or emphasis access to public facilities as observed in Lineberry (1977), couller (1980), Mclafferty and Gosh (1982) Rosenberg (1983) and Meyer (1995).

In Nigeria several studies on accessibility tend to be related to urban centres or urban based activities. Thus Weinand (1973) in a study of development in Nigeria observed that spread effects of concentration of development are limited to the vicinity core areas while much of the periphery is virtually immuned to development impulses. This study is supported by other studies from other developing countries (Robinson and Salih, 1971; Gilbert, 1975; Atubi and Ali, 2006; Atubi, 2007a).

Other works on accessibility in Nigeria include Bardi (1982) and Abumere (1982). Both arrived at the conclusion that accessibility declined from the state capital of Benin-City to the peripheries of the state as well as accessibility of major centres to the bus transport services in Enugu (Ali, 1998) and accessibility and occurrence of public facilities in Lagos Island, Nigeria (Atubi, 2007a).
Study area

The study area is located within Lagos State. Lagos State is situated at the South-Western corner of Nigeria and is a coastal state. Lagos Island, which is the study area, is one of the 20 Local Government Areas in Lagos State (see Fig. 1). Lagos Island is the second largest urban complex in Nigeria after Kano and claims 2% of the nation’s population on a less than 0.2% land area.
FIG. 1: Map of Lagos State Showing the 20 L.G.As and the Study Area
Source: Lagos State Ministry of Environment and Physical Planning (1999)
Methodology/materials collected

In developing the research design, areas that are accessible to the road network and with a population of 1000 and above were taken as activity centres. The choice of nodes was therefore, based on population size. Based on the adopted operational definition of major centres, 30 major centres were identified (see Figure 3). In order to classify the major centres, data on six areas of central facility provision were collected namely: Medical, educational, market, postal services, banking and administrative headquarters. The choice of these facilities was based on the fact that they are capable of generating home-to-facility travels. Data on travel time and cost were collected both by personal observation and oral interviews.

To ascertain if a relationship exists between accessibility and functional indices of facility occurrence in the study area Pearson’s Product Moment Correlation Coefficient Statistics (r) was employed.

Discussion of results/findings

Appendix 1 shows the calculation of the correlation between road distance accessibility and functional index. The correlation coefficient (r) is given as \( r = -0.14 \) which shows that it is negative and at 1% probability level is not significant (Appendix 2 and 3). The negative correlation coefficient shows that the greater the accessibility index value (hence the less accessible the centre is), the lower the level of facility occurrence. This is consistent with observations in the study area.

Although the coefficient of correlation proves insignificant at 1% level, it is important to approach the correlation with some caution as there is a tendency for large sample size to indicate high coefficient. We would rather say that the coefficient indicates that the association between accessibility and functional index is not strong. It was also observed that a good number of centres with low accessibility have high functional index and vice versa. Areas with the shortest road distance to all parts of the study area do not have more facilities. This is further discussed in analysis of residuals.

Meanwhile, the calculated regression equation is as shown in appendix 4. It is of the form:

\[
\log (F_I) = 0.548 \log (RAI) 1.897 - - - - - - (1)
\]

Where: \( F_I = \) Functional index,
RAI = index of road distance accessibility

From the map of figure 2 it was observed that areas of positive residual, which mean areas that tend to have more facilities than the assumed level of distance accessibility, are widely distributed throughout Lagos Island: not all nodes with high level of accessibility have excess number or type of facilities. Rather it was observed that there are two areas of positive residuals. The first are those areas which have high accessibility indices and also correspondingly high functional indices. These are identified as II, III, IV and VI or Tinubu areas, Bamgbose, C.M.S. (New Marina) and Sand-Grouse areas respectively. the second are those areas with low accessibility indices but high functional indices relative to the surrounding centres. These are marked by I, V and VII. They are identified as Olowogbowa, Tafawa Balewa and Odulami areas respectively.

Fig. 2: Positive and Negative Residuals from the Regression of Functional Index on Accessibility
Within the first group it was observed that the network of roads is quite high and nodes are found at short distances from each other. Driving time within the centres in this group ranges from 3 minutes in Tinubu areas to about 15 minutes in Adele – Nnamdi Azikiwe axis. For these areas it may be plausible to say that high level of accessibility is a contributory factor in attracting the concentration of facilities. Thus, Broad Street with the sixth highest accessibility index also possesses a good number of first order facilities – specialist hospitals, a large daily market and commercial banks. The same may be said to some degree of C.M.S. (Old Marina) and Adeniji Adelel. For these centres, it may be said that accessibility indices establishment of facilities and establishment of facilities demands improvement of accessibility.

In the second group it was however noticed that there is a wide variation in levels of accessibility associated with positive residuals. This range from Offin (Ai = 313.7). Nonetheless we cannot say that road distance accessibility is an important factor in the establishment of facilities. This is especially true when we consider such centres in this area as Olowogbowo, Offin and Tafawa Balewa. Uniquely, Olowogbowo has the fourth greatest functional index both in number and type of facilities. Yet Olowogbowo is at the verge of the periphery of the study area. So its importance has not much to do with its accessibility to other parts of Lagos Island.

In the analysis of areas of negative residuals which indicate areas having less than expected level of facility occurrence, we also notice a wide distribution of centres throughout Lagos Island. In fact, the areas of negative residuals are around the areas of positive residuals. We have centres that are peripherally located marked by high accessibility indices such as Ilubiri (Ai = 258.7), Force Road (Ai = 293.4) and Race Course (Ai = 291.3) which have low indices of facility occurrence. This may look like neglect if we can consider distance accessibility alone. However, these centres have low population and this could account for the level of facility occurrence (See Figure 3 and Appendix 1).
Fig. 3: Location of Sampled Major Centres in Lagos Island Local Government Area

Policy implications/recommendations

One strategy would be to provide those services which centres lack based on extensive surveys of what are available and what are needed. This centre based approach might prove more useful if the people are guided to choose out of their preferences.
To ease traffic flow along the routes, better road network characteristics must be ensured. For example, the roads have to be better connected to improve their accessibility, also roads have to be widened to more lanes to increase their carrying capacity and these are especially true for the routes headed to the Island. Better road network characteristics would not only lead to a faster flow of traffic along the routes, it would also make for a well structured road network system and also a faster pace at curbing congestion problem in the study area.

In a pilot survey it was found out in Idomota the major facility the centre desired was a commercial bank while at Nnamdi Azikiwe it was a hospital. In these centres the nearest commercial bank for Idumota is located at Martins street, and for Nnamdi Azikiwe the nearest hospital is located at Idumota providing them with these facilities would reduce the distance travelled to obtain these services. This suggestion can be achieved by purchasing structures on the ground. Moreover; landuse intensity here is quite high and this is marked by the great concentration of skyscrapers along these centres.

**Conclusion**

The strategy of constructing new links or expanding the width of the roads or increase the number of lanes to improve accessibility may involve heavier financial investment. Thus, a proper cost benefit analysis may be needed to determine the desirability of such investment as this would help to increase accessibility, reduce cost and time to other centres.

**References**


APPENDIX I

LOGARITHMIC TRANSFORMATION OF ACCESSIBILITY AND FUNCTIONAL INDICES DATA

<table>
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<tr>
<th>Node No.</th>
<th>Accessibility Index (RAI)</th>
<th>Log (RAI) = X</th>
<th>Functional Index (FI)</th>
<th>Log (FI) = Y</th>
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\[
\sum x = 73,891818 \quad \sum y = 37.4850939 \\
\sum x^2 = 182.316441 \quad \sum y^2 = 56.0592696 \\
\bar{x} = 2.4630606 \quad \bar{y} = 1.24950313 \\
\sigma x = 0.1044547 \quad \sigma y = 0.3955683 \\
\Sigma xy = 92.08256785 \\
\]
APPENDIX 2

Correlation between road distance accessibility index (rai) and functional index (FI)

Correlation Coefficient ($r_{xy}$) is given as

$$r_{xy} = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{n \sum x^2 \cdot (\sum x)^2} \times \sqrt{n \sum y^2 - (\sum y)^2}}$$

$$= \frac{30 \times 92.0825679 - (73.8912)(37.435094)}{\sqrt{30 \times 182.316441 - (73.8912)^2} \times \sqrt{30 \times 56.0592696 - (37.485004)^2}}$$

$$= \frac{-7.3648}{51.24410196}$$

$$= -0.1437 \text{ (Approximately -0.144)}$$

Hence the correlation coefficient ($r_{xy}$) between road distance accessibility and functional index is -0.144.

Test of significance for the correlation coefficient between rai and FI

The student’s test is given by

$$t = \frac{r \sqrt{n - 2}}{\sqrt{(1 - r^2)}}$$

Where $r = 0.14$

$n = 30$

Hence $t = \frac{0.14 \sqrt{28}}{\sqrt{(1-(0.14)^2)}}$
\[ t = \frac{0.741}{0.990} = 0.75 \]

Ho: There is no relationship between accessibility and functional index.

Hi: There is relationship between the two.

Table value n-2 degree of freedom

\[ 30 - 2 = 28 \]
\[ 0.01 = 1 - 0.01 = 0.99 \]
\[ = 2.47 \]

But \( t \) 0.01 < \( t \) calculated

Hence at 0.01 probability level we cannot reject Ho but state that there is no significant relationship between accessibility and functional index of facility occurrence.

**APPENDIX 3**

**Calculation of single regression equation of functional index (FI) and road distance accessibility (RAI)**

The regression of \( Y \) (Log FI) on \( x \) (Log RAI) is given by

\[
(y - \bar{y}) = r_{yx} \frac{(6y)}{6x} (x - \bar{x}) \quad (\text{Theakstone and Harrison, 1970, p. 90})
\]

Where

\[
Y = 1.249 \\
X = 2.463 \\
Oy = 0.396 \\
Ox = 0.104 \\
ryx = -0.144
\]
Hence $y - 1.249 = -0.144$  

$y - \bar{y} = r_{yx} \frac{(0.396)}{(0.104)} (x - 2.463)$

i.e $Y - 1.249 = -0.548 (x - 2.463)$

$y - 1.249 = 0.548 + 1.349$

$y = -0.548x + 1.897$

Hence regression equation becomes

$\text{Log FI} = -0.548 \ \text{Log RAI} + 1.897$.

**APPENDIX 4**

**Calculation of standard error and confidence limits of the FI – RAI**

Standard error of $y$ on $x$ (S.E$y$ on $x$) is given as:

$\text{S.E} = \frac{y}{\sqrt{1 - (r)^2}}$ for estimate of $y$.

S.E $\quad = \quad 0.396 \ \sqrt{1 - (0.144)^2}$

S.E $\quad = \quad 0.396 \times 0.989$

$\quad = \quad 0.392$

Hence at 68% coefficient limits or 1 (S.E) the regression equation would be:

$\text{Log FI} = 0.548 \ \text{Log RAI} + 1.897 \pm 0.39$