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Influence of Travel Time and Cost on Relative Accessibility of Centres in Delta State, Nigeria

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Abstract
This paper evaluates the influence of travel time and cost on relative accessibility of centres in Delta State, Nigeria. The data collected for the period between 1976 and 2016 were based on existing government documents. The result shows that there is some relationship between travel time and cost factors and distances, while high speed is observed to be concentrated within a given distance band (about 20.3km) but beyond 25.5km average driving speed is low probably the result of interruptions in route. Based on the findings, recommendations that would enhance equitable transport development in the study area that will increase accessibility, save time and reduce cost were proffered.

Keywords: Accessibility, Cost, Travel Time, Centres, Distance, Link

Introduction

The ability to access places of opportunities is dependent on the land use distribution, the transportation network connecting homes and activity sites, and socio demographic – dependent mobility (Niedzielski & Bischmann, 2014). Accessibility indicators are used as a planning tool to capture accessibility variations in the assessment and development of social, land use, and transportation policy. A number of metrics have been proposed to understand patterns of unequal access that typically fall under overlapping three pairs of contrasting notions of accessibility; place – versus person – based, normative versus positive, and potential versus actual (Karner, 2018; Zhang et al, 2021; Liu, 2022 & Ryan et al, 2023).

Variations in accessibility for different people in different locations might arise from the dynamic nature of the people – space – transportation triad. What is less explored is how these dynamics, resulting from the confluence of changing urban structures, diverging mobility resources, and socio economic transformations, might reveal unusual accessibility experiences based on unexpected travel time and distance relations. Quite simply, longer (shorter) distances can be traversed in shorter (longer) travel times than would be expected given a specific people – space – transportation situation (Cheng et al, 2024; Cheng et al, 2020 & Agbenyo et al, 2017).

Different approaches exist in the literature to implement accessibility measures. An important difference lies between studies based on potential accessibility versus actual accessibility. Calculating potential accessibility requires making assumptions about ravel behaviour, such as travel time thresholds or preferences for destinations. This approach is often used in situation where there is no reference to actual travel behaviour (Niedzieiski & Boschmann, 2014; Atubi, 2019a and 2019b).

Accessibility rather than distance is a key explanatory variable for the location of most facilities and services, in particular for everyday services such as education. The concept of accessibility does not have a single meaning, although most of them refer to the ease with which it is possible to reach a destination.

Therefore, accessibility may therefore vary between individuals depending on their capacity and aspirations even when the individuals coincide in space and time (Salado, 2004; Atubi, 2012f).

Urban accessibility has been increasingly recognized as a valuable metric for assessing the benefits associated with transportation and land use systems (Geurs and Van Wee, 2004; Levinson & King, 2020). As a result, accessibility has been receiving growing attention from researchers and transportation agencies, particularly in the context of public transportation planning (Farber & Fu, 2017; Mayaud et al, 2019; Pereira, 2019).

The strategy for the empirical investigation of policy interactions is to study the journey to work. Researching the journey to work has received considerable attention from scholars as it provides a gateway to better understand several features of accessibility and equity across urban regions (Zhao & Howden-Chapman, 2010; Watkins, 2016; Talbot et al 2022; Sang et al, 2011; Niedzielski & Boschmann, 2014; Cui, et al, 2019; Atubi, 2019c; 2021b, 2021c).

Accessibility of (access to) resources and amenities is also a determinant of social equity in a city. The inclusion of the end- user in the design of an urban centre is imperative (Chen & Akar, 2016; Clarke, 2012; Donovan, 2011; Atubi, 2021e).

Likewise, access to a range of employment options both within the central business district (CBD) and inter – local centre or out to main employment hubs, such as airports hospitals, schools, and industrial centres, must be considered. To be genuinely accessible public transport systems need to work for all (Chandra et al, 2016; Atubi, 2023d).

The increasing interest in accessibility defined as the ease of reaching valued destinations (Atubi, 2023d) observed to day consistently leads to the assessment of existing and the search for new effective and optimal ways of measuring it. The diversity of socio economic life, the increasing mobility and the increasingly diverse mobility options mean that finding universal and comparable measures of accessibility in many aspects is becoming increasingly difficult.

Therefore, an increasing number of accessibility applications use travel time (or more broadly; the time of reaching one place from another) between specific points in space. In reality, travel time may be shorter or longer for the same distance covered, depending on the nature (resistance) of physical, social, economic or political obstacles (Niedzielski & Boschmann, 2014; Atubi 2023d).

Accessibility measures can focus on the number of daily facilities that could be accessed within a certain time or distance threshold, while accessibility indices can also refer to observed travel outcomes (Paez et al, 2010; Casas, 2007; Martens and Di Ciommo, 2017 & Atubi, 2019c).

Study Area

Delta State is bounded in the north by Edo State, the east by Anambra State, South-East by Bayelsa State, and on the Southern flank by the Bight of Benin which covers about 160 kilometers of the state's coastline (See Figure 1). Delta State is generally low – lying without remarkable hills and covers a landmass of about 18,050km^2 of which more than 60% is land. The state has a wide coastal built inter – laced with rivulets and streams, which form part of the Niger Delta. Presently, Delta State comprises 25 local government areas.

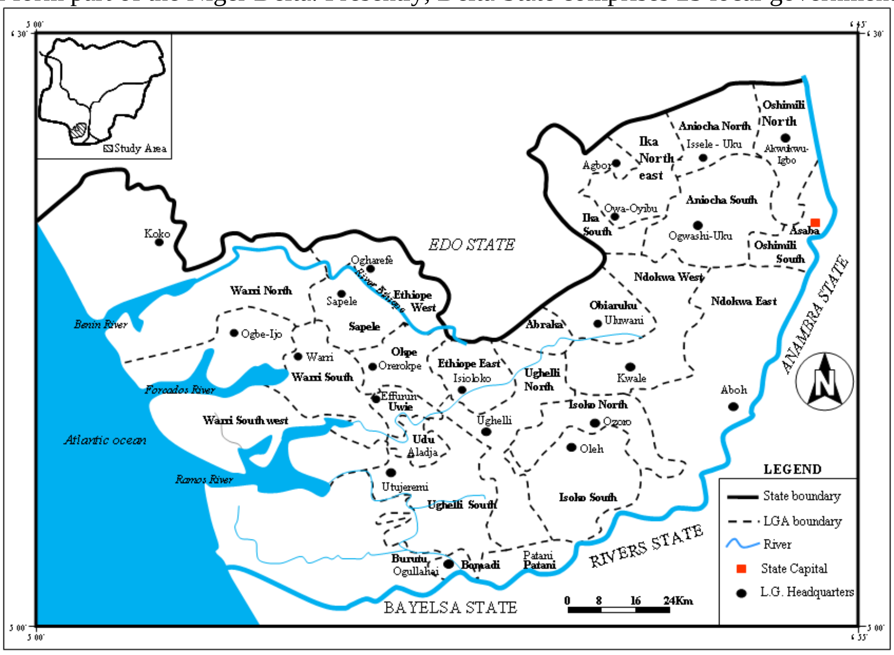

Figure 1. Map of Delta State showing study areas

Research Methods

The structural characteristics and accessibility of major centres to the road network was considered for a period of forty years 1976 to 2016. In developing the research design, areas that are accessible to the road networks and with population of 10,000 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, 50 major centres were identified.

Measurement of distance, time or cost is assumed to be between centres. The road distance appropriate scale given on the map to work out the actual distance. The main mode of transportation which data was based is the mini bus, tricycle (keke) and motorcycle (okada) which can be seen in every corner of Delta State. They were chosen for their relative access as they are capable of penetrating remote areas.

The time data represent average journey time by the Sienna model of Toyota and minibus or tricycle and motorcycle. This, it is believed reflects the nature of the road surface. On the other hand travel cost data are based on authorized fares by the national union of road transport workers (NURTW) which is the national trade union body that coordinates road transport fares throughout the country.

Discussion of Results/Findings

Figures 2 and 3 presents travel cost and travel time valued graph representation of the network by 2016. It was found out that there is generally some relationship between link distance and travel cost. The correlation coefficient was calculated to be r = 0.86 . However, this is a global way of comparing the two. It would be more relevant to reduce the cost function to some uniform level. By dividing the link distance into the travel cost along such link we obtain the cost per kilometer along such link.

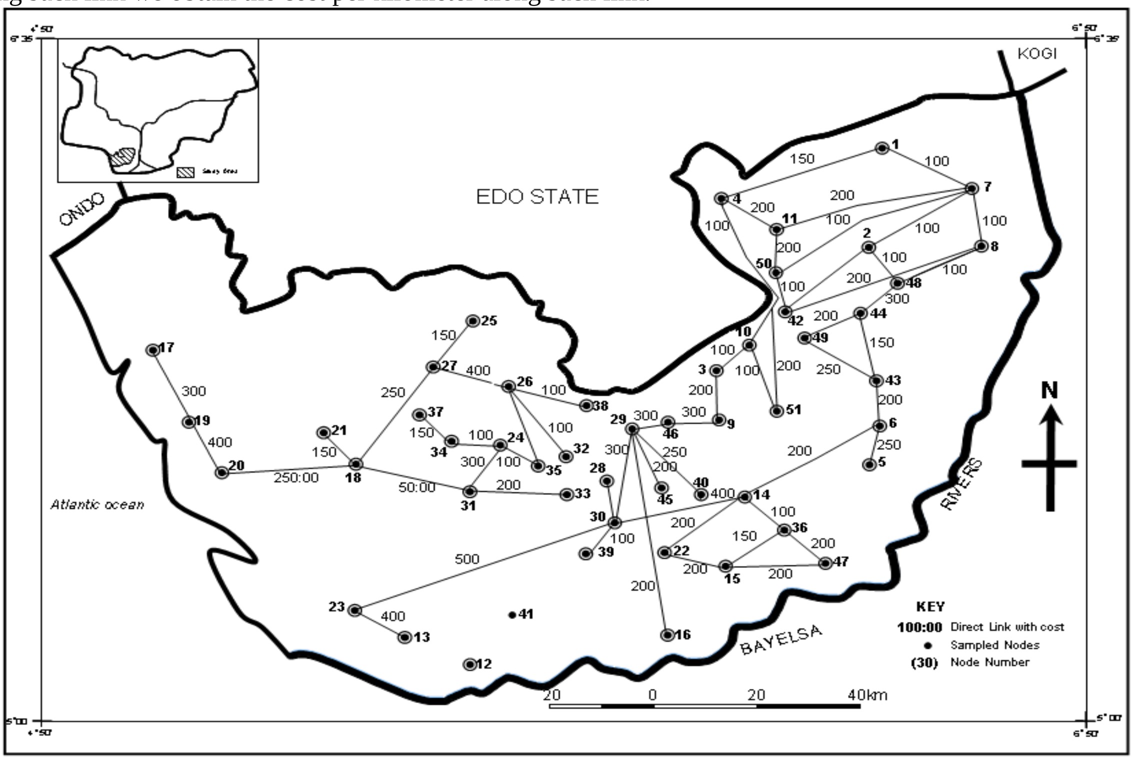

Figure 2. Graph Representation of Road Network in 2016 with Travel cost values
Source: Fieldwork (2016)

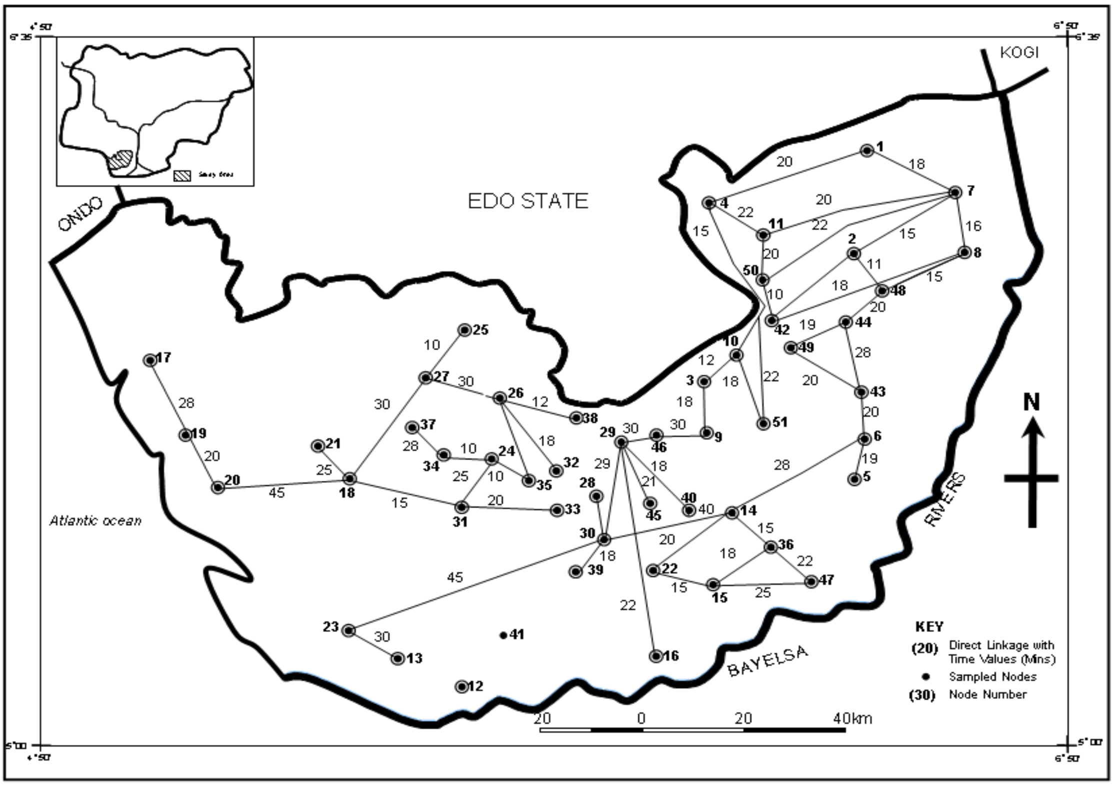

Figure 3. Graph Representation of Road Network in 2016 with Travel values
Source: Fieldwork (2016)

The correlation between link distance and per milometer cost was found to be (r = -0.45). This shows that the cost per kilometer is not directly related to distance. Perhaps other factors are more important.

In table 1, we calculate the frequency distribution of per kilometer cost along 56 links observed. The general observation from this table is that there is a difference in per km cost between long and short distance journeys. We observe that for journeys over 11.1km, the per km cost falls between N100:00k and N200:00k, while journeys under 11.1km the cost is between N300:00k and N400:00k. Furthermore, the journey's under 5.00km the per km cost falls between N100:00k and N150:00k.

Table 1. Frequency Distribution of per kilometer cost of travelling over 56 links

	Frequency of per km cost (₦)					
Link distance (km)	**0-100**	**101-200**	**201-300**	**301-400**	**Over 400**	**Total frequency**
0 - 5.0	1	0	1	1	0	3
5.1 – 10.1	15	5	4	4	0	28
10.1 – 15.2	2	5	1	2	0	10
15.3 – 20.3	2	3	2	3	1	11
Over 20.3	0	0	2	0	2	4
Total	**20**	**13**	**10**	**10**	**3**	**56**

Source: Fieldwork, (2016)

This shows that per kilometre cost tends to be higher over short distances than over long distances. Although this may be a hidden cost (that is, travellers do not normally pay in per kilometre costs), yet the higher cost of short distances may have the effect of making intermediate centres less accessible as travellers would not like to break their journeys for fear of incurring extra costs.

Travel time can be differentiated into transit time and waiting time. Transit or driving time describes the period a traveller takes off from the park at the origin point and alights at the park on arriving at his destination point. Waiting time on the other hand refers to the time the traveller waits for the vehicle to arrive or to be fully loaded.

Generally the waiting time is affected by such variations as traffic values, mode of transport and route. Although waiting time may increase the total journey time, it is the driving time, when the traveller has actually boarded the vehicle that determines the time he reaches the destination. The length of time a traveller takes to reach his destination may have a lot of influence on the ability or even willingness to use a particular facility.

Like travel cost two types of driving time can be calculated along the same link – i.e. direct driving time between two major centres, say Asaba and Warri, assuming the driver does not stop enroute and the time considering that driver stop at intermediate centres. Based on these two values of driving time 56 links were considered. It was not however easy to record this direct time accurately as drivers often had cause to stop for various purposes: refuelling, alighting passengers, police checks, etc. nonetheless the figures presented in Appendix C gives us a true estimate of actual time spent in travelling. Again the driving time so identified is a function of many variables such as the road surface traffic flow, the condition of the vehicle and even the personal disposition of the driver. Because of these factors more detailed data and investigation are necessary to throw greater understanding on the issue than the present study can contain. Here, only a single reading of driving time along a particular link was recorded.

To further investigate the importance of time we can also calculate the average driving speed along each link by dividing the link distance by the driving time. This is given in kilometre per minute (kmpm) . The average speed may reveal variations in the nature of the road surface.

The mean driving speed for all nodes of the network was calculated to be 0.57 kmpm approximately 34kmph. The average driving spend was found to be significantly related to the link distance (r = 0.71).

However, when the frequencies of observed speeds are grouped according to link distances as given in Table 2 we observe the following points - that majority of the links are concentrated within a distance band of 10.2 – 15.2 km which collectively make up about 56.41% of the observations, that high average driving speeds of over 0.56 kmpm (or 33 kmph) are not common with short distances of under 5.0 km. Rather, speeds of over 0.56 kmpm occur within a distance band of 20.3 and over 25.3 km which makes up about 23.07% of total observation. Ironically on distances of over 25.3 km drivers tend to operate on average speed of under 0.56 kmpm. This apparent low speed on long distance journeys may be attributed to constant stops encounter and the road surface.

Table 2. Frequency distribution of average driving speeds with link distance

	Frequency of average driving speed (km/min)					
Link distance (km)	**0.00-0.10**	**0.20-0.30**	**0.31-0.41**	**0.42-0.52**	**Over 0.52**	**Total**
0 - 5.0	0	0	0	1 2.6%	1 2.6%	2 5.13%
5.1 – 10.1	0	5 12.8%	1 2.6%	1 2.6%	0	7 17.95%
10.1 – 15.2	1 2.6%	7 17.95%	2 5.13%	0	0	10 25.64%
15.3 – 20.3	0	10 25.64%	1 2.6%	0	0	11 28.21%
20.3 – 25.3	0	0	2 8.1%	2 8.1%	1 2.6%	5 12.82%
Over 25.3	0	0	1 2.6%	3 7.7%	0	4 10.25%

Source: Fieldwork, (2016)

Finally, low average speed of under 0.10 kmpm (i.e. 6.0 kmpm) is found within short distances of under 5.0 km. It constitutes about 5.13% of the links. This observed general pattern of average speeds would imply that drivers tend to drive faster within a short distance of 0 – 5.0 km but beyond that their average speed may be reduced by other obstructions such as carrying “half-way” passengers, or refuelling. This would mean that travellers for long distance journeys may not arrive at their destinations as early as they expected if the journey were direct. Thus we find that the Issele-Uku – Agbor road has higher average speed (1.1 kmpm or 66 kmph) than the journey from Effurun to Warri with average speed of about 33 kmph.

Another implication of the observation is that nodes in the study area located at short distance journeys may be just as disadvantaged as those at long distances journey as drivers tends to operate on relatively low speeds. But another factor in addition to the constant need to alight Passengers enroute could be urban traffic. The combined effect of all this is to extend driving time beyond the expected.

The map on figure 4 contains some suggested new links to be constructed. They were made primarily on the basis that they will increase the accessibility, reduce cost and time to other centres. For example, it will normally take a traveller going to Warri from Kiagbodo some 107.2 km, but when a direct road is connected linking Warri to Kiagbodo it would definitely reduce cost, time and accessibility will increase. The same thing can be said of other centres like Bomadi to Forcados, Ogbe-Ijew to Kiagbodo and Burutu to Aladja.

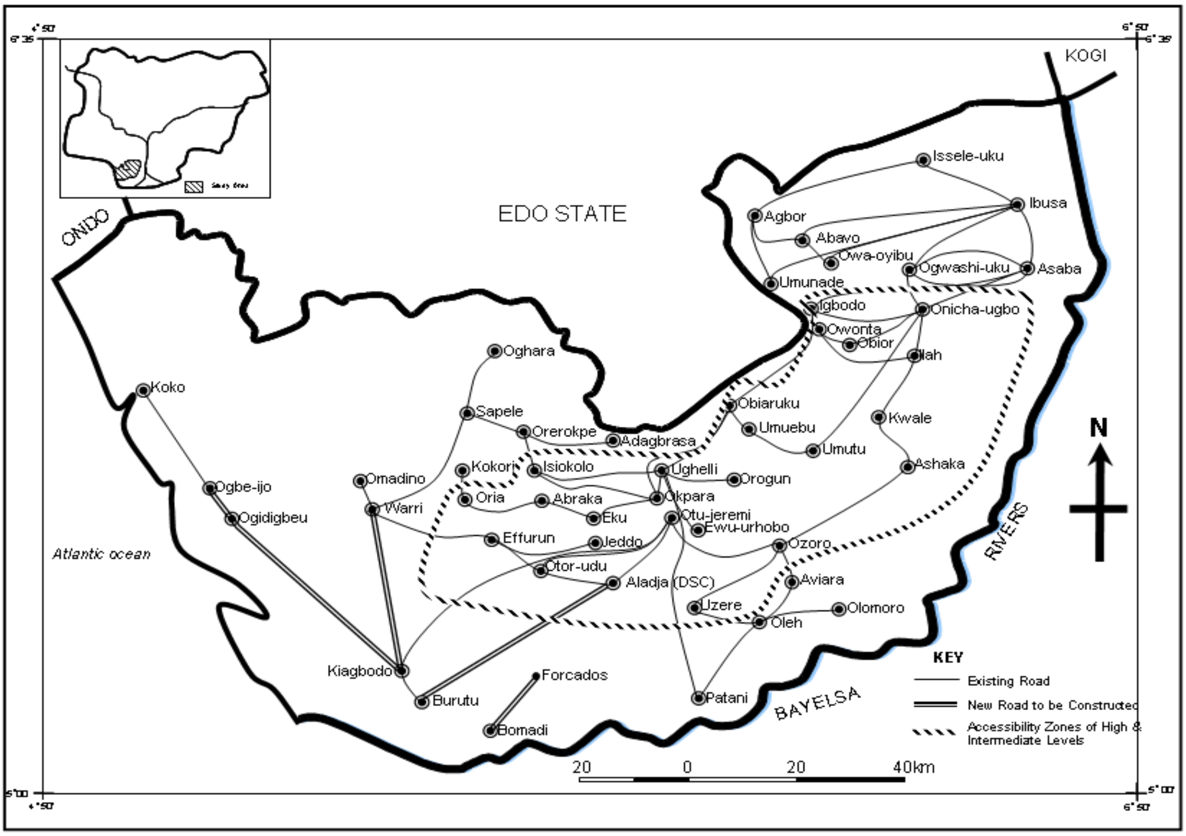

Figure 4. Suggested Road Improvement Projects
Source: Fieldwork (2016)

Conclusion

A fair distribution of accessibility to key activities is central concern for distributive justice in transport planning. This implies that disparities in accessibility and the negative effects associated with a lack of accessibility should be mitigated. Society nowadays makes intensive use of time and extensive use of space. This has implications for spatial planning of facilities and services since it is now essential to look at personal accessibility (in terms of time and choice) and not just physical distance.

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