

Discrete Choice Models and Individual Travel Constraints in Nigeria: A literature review

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ABSTRACT

Travel constraints in contemporary Nigeria have affected all sectors of the economy.. This trend had impacted small traders in terms of higher cost of doing business, and individual travel behavior over time. Insecurity and travel time constraints had affected the growth of the entrepreneurial environment in most cities in Nigeria. In some regions trade and commerce have experienced very low performance. Most of the Northern Eastern states and big commercial centers in Kano, markets are completely non-functional due to high security alerts.

Aims: To highlight a myriad of problems in the movement of goods and people resulting from the growing insecurity on Nigerian roads, and lack of private sector participation in road building has increased the burden of government in its traditional public finance role and growing need for safe transport in Nigeria.

Study design: This study examines some literature on discrete choice models and travel-based models..

Place and Duration of Study: Examines literature and contemporary travel constraints in Nigeria from 2000–2012, with the growing ethno-religious crisis in different parts of Nigeria.

Methodology: Review of literature.

Results/observations: The working of these models is effective where the choice set is not constrained, and the independent irrelevant alternatives (IIA) may not include options/alternatives with a “lesser evil” definitions choice decisions in a developing country-case. In advanced market economies, infrastructure has been a springboard for creating and enhancing trade hubs that promotes trade and commerce. A high Infrastructure gap exists in less developed countries as a result of fiscal policy issues, high population and the process of prioritizing development programs.

Conclusion: In a typical developing country like Nigeria – a low middle income country, most literature has been concerned with the lack of productivity of roads:

(i) accessibility, the ability to access safe transport in terms of cost and travel time and (ii) connectivity, to be able connect or link up some routes with a high degree of insecurity on these roads.

Keywords: Discrete choice models, travel behavior, travel constraints, road infrastructure, insecurity.

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23 1. INTRODUCTION

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25 Modelling travel decisions is an integral part of demand analysis. There are various
26 methods/models of measuring consumer behaviour in different economic and non-economic
27 activities. Modelling process involves disaggregation of individual travel behaviour overtime
28 for instance. It is important to measure individuals or household, because the choice or
29 decision is individualistic - all aimed at utility maximization. Analysis **is done** towards
30 observing individual consumer behavior. According to Ben-Akiva [1], models that involve
31 discrete choice are also referred to as disaggregate models, meaning that the decision-
32 maker is assumed to be an individual. The importance of this is to be able discover what
33 criteria **are used by** individuals in choosing from alternatives or from the choice set.
34 **According to Luce [2], probabilistic choice models have roots in a microeconomic model**
35 **(consumer behavior) in which the decision maker exhibits rational decision power to reach a**
36 **desired outcome. The rationale for observing measures taken by consumers in utility**
37 **maximization forms the core elements of microeconomics.**

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39 **Utility is composed of systematic part and the stochastic component – observed and**
40 **unobserved (probabilistic). The probability that an individual will choose an alternative j**
41 **given by explanatory variable x_i , and the characteristics of the individual i** Models with
42 probabilistic decision rules show that in the probability distribution, the assignment of a
43 probability P_x to each outcome x are equally likely to occur. This supports heterogeneity of
44 human behaviour which suggests that the decision rule should include a probabilistic
45 dimension due to the prevalence of uncertainty elements.

46 Some of the models – the deterministic model for instance, suggest that an individual has
47 perfect knowledge of choices. Wernd [3] opined that a model is deterministic iffy, any two
48 solutions that agree at one time agree at all times. However, due to mutually exclusive
49 nature of events or choices, such events or choices cannot occur at the same time, for
50 instance the choice of a transport mode, a choice between a **car or motorbikes (which**
51 **are preferred means for finding difficult locations in crowded cities in Nigeria) or other choices**
52 **that explained a socioeconomic phenomenon – employment and unemployment, or for**
53 **residential mobility which most recently is increasingly becoming a problem in Nigeria due to**
54 **crisis-prone locations – locations that are defined according to ethno-religious**
55 **considerations. Take Jos (a town in North-central geopolitical zone in Nigeria), due to the**
56 **erratic nature of the crisis, the choice for residential mobility is restricted according to the**
57 **above mentioned criteria.** Thus all elements in the choice set are important in probability
58 theory, that events $E_1, E_2, \dots, E_n$ are said to be mutually exclusive if the occurrence of any
59 one of them automatically implies the non-occurrence of the remaining.

60 **Discrete choice models are important tools used in the analysis of choice when the**
61 **dependent variables take values 0, 1, 2, ...e. (dependent variable takes binary or multiple**
62 **discrete values** The discrete choice model (DCM) had been used as a tool of analysis and
63 prediction of travel decisions **and other socioeconomic activities or criteria for making a**
64 **decision, employment or unemployment for instance.** Discrete choice model predicts a
65 decision made by an individual (such as mode or route choice) as a function of any number
66 of variables [4], **that an individual's choice is based on certain probabilistic outcomes.** The
67 framework for a discrete choice model can be presented by a set of general assumptions. In
68 a typical discrete choice model, assumptions about the individual making the decision given
69 an array of alternatives or options available is made, the attributes defining benefits and cost
70 is **taken into consideration**, and actions taken by the decision maker which are referred to as
71 the decision rule – **the process used by the decision-maker to evaluate the attributes in the**
72 **choice set.**

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Utility theories are based on the assumption that individuals maximize their utility. This means that the individual gives each destination a utility value for travel decisions, and that the likelihood of an individual choosing a particular destination depends on the utility of that choice compared to the utility of all choices. In microeconomics, utility maximization is where the marginal utility per Naira (N) spent is the same for each of the goods. Shown as:

$$\frac{\Delta x}{\Delta y} = -\frac{MU_x}{MU_y} = -\frac{p_x}{p_y} \Rightarrow \frac{MU_x}{p_x} = \frac{MU_y}{p_y}$$

Given various transport types (modes), an individual or corporate individuals will maximize their utility where =

$$\frac{MU_{m1}}{p_{n1}} = \frac{MU_{m2}}{p_{n2}}, \text{ where } m1 = \text{routes throughout trunk A and}$$

$m2 = \text{routes through trunk B. The MU = marginal utility and P is the transport price.}$

$m1 = \text{transport through trunk A road and } m2 = \text{trunk B road, and MU is marginal Utility, while P is the transport price. In Nigeria, roads are classified into three, trunk A roads are federal roads, trunk B roads are state roads, while trunk C roads are local government roads. There are 34,340.95 km of roads – these roads are Federal Highway Network in the Six Geopolitical Zones of Nigeria [5]. Roads are paved and unpaved, and dictate preference of individuals in road transport choice..}$

Nigeria has significant infrastructure challenges. Challenges range from the growing gap in infrastructure stock, especially road networks for a growing population (between 2 – 2.3% per annum growth rate), the growth of new communities and residential segregation resulting current ethno-religious crisis. Low investment in infrastructure has been a strong case for Nigeria's inefficient productivity of roads (see figure 3) over the years both for new road projects and the maintenance of existing roads. There are endemic budget deficits and lack of efficient management of large infrastructures by the public sector finances, good political 'conscience' to undertake efficient infrastructure projects (in terms of the engineering work), thus most literature have strong views that Nigerian roads are not properly built [6] materials [7], engineering [8], institutional policies. The poor state of road infrastructure has had implications in the cost of operating vehicles. According to FERMA¹, car owners spend N219,500 (about \$1,464) for every 10,000 kilometers of road used. The implication of this is the resulting high cost of transactions in Nigeria. The state of the roads has resulted in travel constraints in terms of travel time, cost, travel mode choice, and especially the Northern Nigeria case that depends on transport vital supplies (goods) from major ports in the southern part of Nigeria.

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Accessibility in most Nigerian roads, including large rural populace that supply 60 percent of agro-allied goods, suffer most in need of accessibility to reach desired economic activities which affects their socioeconomic life. A measure that is often used is determining accessibility in a transportation analysis zone is:

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¹ Federal Road Maintenance Agency, a government body charged with road maintenance.

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 116 $Accessibility_{yi} = \sum_j Opportunities_j f(C_{ij})$
 117 Where :
 118 i =index of origin zones
 119 j =index of destination zones
 120 $f(C_{ij})$ = function of generalized travel cost (so that nearer
 121 or less expensive places are weighted more than farther or
 122 more expensive places).

123 Accessibility has several definitions in the context of the individual travel decisions in Nigeria.
 124 Urban Nigerians seem to be making decisions about security on roads, because availability
 125 and cost seem to be fairly overcome. In rural Nigeria, issues of availability and cost must be
 126 taken into consideration in the travel function. The choice may be based on "lesser evil".
 127 Security is highest in choice of mode. Take the contemporary Nigerian situation where some
 128 locations in Northern Nigeria cannot be accessed due to current security alarms. Travel is a
 129 constraint.

130 Although accessibility-enhancing strategies expand the range of choice for individuals and
 131 increase the possibility of connectivity, they do not ensure that individuals will actually
 132 choose some modes or a road network due to several travel needs and costs [9].
 133 Accessibility have many components - connection, movement, cost, time, and comfort.
 134 Mobility is sometimes defined to have the same meaning with accessibility. Mobility
 135 according to Picket et al [10] is the quality or state of being mobile and "mobile" as "capable
 136 of moving or of being moved readily from place to place". This is important because it guides
 137 an individual into making a choice given that U is utility is:

$$P_{ij} = P_r[U_{ij} > U_{ij'}] \quad \forall j' \neq j$$

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 141 The probability P_{ij} of individual i choosing from product j from a set of products and making
 142 comparisons from the choice set (U_{ii} , and $U_{ii'}$). However, The response probability depends
 143 not only on the utility differences U_{ij} and $U_{ij'}$, but also on the random utility difference
 144 portrayed by other decisions not observed across the population. Take for instance that our
 145 product is a transport mode (deciding a type of transport) or types of vehicles available,
 146 while the probability of choosing a car is: $P\{\text{car, bus, and bicycle}\}(\text{car}) = P\{\text{car, bus, bicycle}\}$
 147 $(\{\text{car, bus}\}) P\{\text{car, bus}\}(\text{car})$ going from various types of vehicles to finally a car. This is the
 148 Luce model. The model is important in dealing with uncertainty. Instead of identifying one
 149 alternative as the chosen option, it assigns to each option an alternative, a probability to be
 150 chosen [11].

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 152 The objective of this study is to highlight the many sided travel constraints and its effects on
 153 the travel decision of individuals, especially small traders and other groups that daily needs
 154 to make travel decisions – how it affects cost of doing business in Nigeria. The rest of this
 155 paper is structured as follows: Section 2 is the survey of literature on some travel-based
 156 models, Section 3, selected policies, public programmes, and effects on Road transport,
 157 Section 4, review of transportation policy and constraints and Section 5, is conclusion and
 158 recommendations
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2. Literature Review

2.1 Random Utility Discrete Choice and Geography of Transport.

Choices are made rationally and depend on a variety of factors and attributes/characteristics. Generally, we cannot measure or predict choices exactly because, as a researcher we may not be able to observe or measure every characteristic of the individual, product, or the choice situation that affects choice behavior. In a developing country like Nigeria, the choice set for instance may be limited such that the process of estimation may be an uphill task due to an array of 'sub-characteristics' dictated by the characteristics of underdevelopment. For instance transport mode available may be animals (donkey, horse or camels) even in situations that are time bound – transporting a pregnant woman to a hospital 10 kilometers distance. These situations exist especially in Northern Nigeria, especially in the Northeastern and Northwestern geopolitical zones; which are regions that have borders with some countries - Niger, and Chad. However, if we can observe some information about the individual, the product, or the choice situation, we can use available information to help predict choice. In random utility models we presume that the utility u_{ij} provided to individual i by product j is composed of a deterministic component v_{ij} , which can be calculated based on observed characteristics, and a stochastic error component ϵ_{ij} , which is unobserved, so that:

$$U_{ij} = V_{ij} + \epsilon_{ij}$$

The probability P_{ij} of individual i choosing product j from a choice set is:

$$P_{ij} = \Pr(U_{ij} > U_{ij'}) \text{ for all } j' \text{ is not equal to } j$$

$$= \Pr [U_{ij} + \epsilon_{ij} > \{V_{ij'} + \epsilon_{ij'}\} \text{ for all } j' \text{ not equal to } j]$$

Note that V_{ij} is the deterministic component and ϵ_{ij} , the unobserved part.

Random utility models take its roots from the rationality of the consumer, a concept used in consumer theory in economics - that the decision maker has a perfect discrimination capacity, choosing the best from a set of alternatives. Manski & Lerman [12], identified four different sources of uncertainty: unobserved alternative attributes; unobserved individual characteristics (also known as "unobserved taste variation" in Handbook of transportation science)²; measurement errors; and proxy, or instrumental variables. Utility is modelled as a random variable in order to reflect the uncertainty element. In most cases, travel choices are made among finite number of discrete alternatives that exhibit choices that are probabilistic. Examples of such models are such by Luce [2], and belong to the family of models with probability decision rules.

In probability theory, Luce's choice axiom states that the probability of selecting one item over another from a pool of many items is not affected by the presence or absence of other

² Manski, C. F., & Lerman, S. R. (1977). The estimation of choice probabilities from choice based samples. *Econometrica: Journal of the Econometric Society*, 1977-1988.

items in the pool. Selection of this kind is said to have independence from irrelevant alternatives (IIA) - whether A or B is better should not be changed by the availability of X, which is irrelevant to the choice between A and B. In a typical developing country, the working of 'irrelevant alternative' can be looked upon as the so called 'lesser evil' choice. Where an individual is constrained to make a choice that endangers their health. Consider a choice where the individual has perfect knowledge of a route that could endanger them – the choice of migrants to Europe on the high seas, where most travelers are in danger of death, with few escapes. The decision maker is aware of the dangers from media or life stories. Thus IIA is contentious, it is controversial for two reasons: first, some theorists find it too strict an axiom; second, experiments and others have shown that human behaviour rarely adheres to this axiom, and thus the working of it is strict of human rational behaviour [13]. The "elimination by aspects" approach proposed by Tversky [14], on the other hand, supposes that decision makers follow a particular heuristic (experience-based techniques) during a process of sequential choice. Options are described by their attributes and, at each decision stage, the individuals eliminate all the options not having an expected given attribute, and so until only one option remains.

Discrete choice models are used in the analysis of choice and takes values from 0, 1,2....e (take multiple discrete choice values). In typical binary choice models, decisions are limited to two options, to accept or decline, where y – a discrete variable, which equals to 1 if an individual accepts an alternative and 0 if an individual declines. In most developing economies, sometimes decisions are based on the difficult choices, either due to limitation a choice set or the fact that such options are the last resort, but individuals are compelled to make some form of decisions in all circumstances. The disadvantage of the linear probability model (LPM) is that it could, given $\text{pr}(y = 1 | x)$ that is > 1 or < 0 for some values of x , which does not make much sense, thus LPM is only intended to approximate the true probability for a limited range of x values, and that its constant marginal effects are preferable to those of the binary probit or logit model, which are functions of the values of all elements of x . The LPM will produce predicted probabilities that are too extreme (close to zero or one) even for moderate values of x and the estimated β that stay 'in bounds' [15]³

The multinomial logit (MNL) model is widely used as one of the family of discrete choice models due to its closed-form choice probabilities and its consistency with the random utility maximization (RUM). Multinomial logit models are used to model relationships between a polytomous response variable (>2 discrete outcomes) and a set of regressor variables. The model is preferred for this review because we are able to observed an array of options that may exist, especially that there exist many discrete outcomes despite the constraints that exist in Nigeria due to varying reasons. Identified constraints are security relate, fiscal issues related observed in lack of maintenance of roads and risks associated with some routes around locations in the Northern Nigeria – Northeast, Plateau, Kaduna, Gombe, Bauchi, Sokoto and some state in Southern Nigeria.

Prominent features in different geopolitical zones in Nigeria are the typology of the regions. In landlocked areas of Africa, preventable occurrences of deaths, complication in a pregnancy case, the decision (0) means death. In rural Nigeria, the prevalence of deaths as a result transport accessibility abounds in Nigeria, preventable death [16], mortality [17],

³ Christopher F Baum, Yingying Dong, Arthur Lewbel, & Yang, T. (2012). A simple alternative to the linear probability model for binary choice models with endogenous regressors. [This presentation is based on the work of Lewbel, Dong & Yang, Comparing features of Convenient Estimators for Binary Choice Models Economics] Working Paper No. 789, Boston College, Boston College, This presentation is based on the work of Lewbel, Dong & Yang, 1-82.

access to maternities [18], and, travelled time [19], these studies argue that maternal mortality can be prevented if women access health facilities, but in most cases deaths occur for women and children who live 10 – 15 kilometers from the nearest maternities or health centers. In parts of the Niger-Delta (the oil producing bloc of Nigeria), the south-south zone, travel constraints accounted mostly by numerous creeks and environmental degradation as a result of oil exploration work. Transport prices are high, thus travels constrained exist apart from the environmental factors. For instance in the past 3-4years, travel restriction was as a result of Niger-Delta militants 'war' with the government such as Omofonmwan [20], in the northern Nigeria, especially the far north, there are desert conditions and porous border that has an impact on the population of border towns apart from security threat and growth of underground economies – including a thriving forex market for various currencies - the CFA (African French currency equivalent), locations for export of stolen vehicles and many such activities. According to Flynn [21], it is like a community of people – various nationalities, security officers, traders all engaged in 'legal' economic activity. Life in the border town has placed a price differential with other part of the country. There are high security threats in Nigerian border towns too – with more than 1497 [22] illegal borders, mobility is through various terrains. Recently, it has become a battleground for religious insurgents (Boko haram, al-Quaeda in the magrib etc.), crisis that spill from Mali to Nigeria and countries in the subregion.

It has been stated that Nigeria has a wide range of constraints, public finance issues dictates access to new roads and maintenance which affects travel time . In the northern parts, it has been also stated that such terrains range of desert conditions that affects the life span of roads (although there other conditions – corruption which affects quality of roads). There also other terrains related wetlands typography in the middle belt states of Nigeria also exist. In the Southern parts, landlocked areas, high erosion, little accessibility due lack of new roads..

2.1.1 Building a Multinomial Logit (MNL): A Hypothetical Case.

We summarize these constraints:

Individual choice may be influenced by risks on some roads,(RI), bad roads may be due to lack of maintenance even though using motorbikes may be faster than cars, buses etc, may affect travel time or that this road may be the only link to the location,(TT), landlocked locations (LL), news roads may be gateways to hospitals or capitals of state or local government in case of outbreaks, (Li), bush paths may be used for animal transport, (At).

Due to the size of the choice set, we build a model using the multinomial logit model. The multinomial logit model is applied in modelling relationships between a polytomous response variable and the use of MLE to estimate the product of the probabilities of the chooses alternatives given the conditions of the binary independence (individual preferences, IIA) criterion – $l(\theta) = (\beta_1, \dots, \beta_j) = \prod_{i=1}^n Pr$ defining the estimators and the vectors of measurements, given that the Pr =probability, with n the number of explanatory variables.

$$\text{The equation of the MNL} = \Pr(y_i = 1 | x_i) = \frac{\exp(x_i \beta_j)}{1 + \sum_{j=1}^J \exp(x_i \beta_j)} \text{ for } j > 1 \dots \dots \dots (1)$$

The logit model is a log ratio of the probability of choosing mode to the probability of not choosing another of the options. y_i =random variable that indicates the choice made, x_i =vector of characteristics to the j th individual, while β_j =vector of coefficient.

To show the case of the conditions for choice available to individuals in a typical Nigerian scenario j 1.2.3.4.5. made up of the choice set – alternatives that the individual can choose

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given various characteristics or features of each. Some of the options are absolute, meaning that the choice set for individual may just be one alternative, but generally, a typical Nigerian may be faced with choice sets that has these elements (Ri, TT, LL, Li, At)

- i. Ri = Risks on particular roads
- ii. TT= Bad roads due to lack of maintenance and affects travel time
- iii. LL= land locked locations
- iv. Li= new roads that may be gateways made through public investment in such projects.
- v. At= Bush paths

From equation 1, we build a model for the 5 explanatory variables or choice set.

$$P_r(y = j | x_i) = \frac{\exp(\beta'_j \times x_i)}{\sum_{j=1}^J \exp(\beta'_j \times x_i)}$$

$$= \frac{\exp(\beta_{.0j} + \beta_{.1j} \times x_{j1} + \beta_{.2j} \times x_{j2} + \beta_{.3j} \times x_{j3} + \beta_{.4j} \times x_{j4} + \beta_{.5j} \times x_{j5})}{\sum_{j=1}^5 \exp(\beta_{.0j} + \beta_{.1j} \times x_{j1} + \beta_{.2j} \times x_{j2} + \beta_{.3j} \times x_{j3} + \beta_{.4j} \times x_{j4} + \beta_{.5j} \times x_{j5})}$$

The multinomial logit model shows each response probabilities with k=5 once an individual know the probabilities for j=1, 2,3,4,5). Note that the choice of an individual is motivated by cost elements and desired to travel (to reach a destination) but the constraints are placed by these factors. These constraints in contemporary Nigeria are the security threats associated with ethno-religious threat in various regions. Marginal effects may result by examining changes in either a restoration of peace in Nigeria and better investment to attain Vision 2020 which affirmed that 90% of movements (people and goods) in Nigeria is by road transport. This state is applicable with the Millennium Development Goals, since efficient infrastructure results in economic growth (infrastructure-led growth) and results in a reduction in income inequality (encourages commerce and entrepreneurship) as observed by Nietto-Parra [23]- the fundamental goals of the MDGs.

3. Selected Policies, Public Programmes, and Effects on Road Transport

3.1 Public Investment

Better roads provide the only scope for better access to markets, education, health care and social development for majority of African as opined by [24]. This is also the agenda of the National Economic Empowerment and Developments (NEEDs), Vision 2020 etc. The actualization of these programmes depended to a large extent on increase public spending on infrastructure. Fiscal policy and public investment in infrastructure is built around public finance theory that studies government's role in the provision of goods and services. Most literatures discuss or examine the increasing government spending on varying determinants that affect trends in public expenditures. Even though many such literatures examine the effects of Wagner's law. Wagner's Law states that, "as the economy develops overtime, the activities and function of the of government increases". The developmental agenda of government in developing countries still depends to a large extent on public

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finance, thus follows Wagner's treatise. However, as examine by researchers to be the fact that it does not show a causal relationship when the examination of GDP growth is examined with public expenditure levels, as in Fernandes [25], meaning that Wagner's laws did not actually measure that growth that spurs public spending overtime, rather, it merely recognizes a positive statistical association between those two variables. There are evidences that a government budget deficit, which has always been reflected in Nigeria's extra budgetary allocation, gives rise to adverse growth effects such as Bose [26], and this has been responsible to low rate of investment in transport related infrastructure over years. This has been seen in stock on roads in Nigeria, especially rural roads which provides the bulk of the population in rural Nigeria and has impacted on agricultural productivity and access to markets for agricultural goods according to Fakayode [27].

Public investment in road building or other infrastructures seems not to keep pace with the growth of the economies in the Sub-Saharan region. According to Estache [28], financial crisis created infrastructure gaps. Gaps resulted into high transport cost (for various transport needs), high costs of production, low quality output and other factors that inhibits growth of the economy overtime [29]. Most large investments in infrastructure were made to reduced high cost of transportation (accessing landlocked area, or barriers like a bridge). Thus the place of infrastructure according to the World Bank is significance to growth as was the case in the World Development Report [30], but recent concerns have been raised for bulk or large means for moving goods, the Nigerian railways for instance has sub optimally function below its actual capacity compared to the early parts of Nigerian independence to 1980s. The modal share between the Nigerian railways and others road transport has dropped such as Adesanya [31], Osuji [32].

3.2 Quality of infrastructure

Quality of infrastructure affects various aspects of the transport system. Quality of infrastructure affects the time dimension of travel time, and the travel time affects monetary outlays – the cost dimensions. If delivery time is uncertain, it affects total transaction costs. The more uncertain is delivery, the more inventories are needed as a buffer stock if demand fluctuations are unrelated to fluctuations in delivery time. Inventories are expensive both because they bind up capital and the value of the stored goods may depreciate over time, thus adding to the inventory valuation process in a typical accounting concepts. Measuring quality of infrastructure focuses on the country's ability to enhance the movement of both people and merchandise. Quality of infrastructure can be a proxy of costs because the researcher considers movements of goods either across the borders or within the country. According to De [33], the more uncertain is delivery time, the more inventories are needed as a buffer stock if demand fluctuations are unrelated to fluctuations in delivery time. To assess the impact of infrastructure like roads on trade between countries within sub-Saharan region, an index II, - Infrastructure Index is constructed. The Infrastructure index (II) is designed to measure the cost of travel across a country. The II examines land distance to determine the cost of going through a given infrastructure, say the length in kilometres and transport prices, and measures the relative distances considering a set of observables - commonly the geography of the transport, other barriers like customs checks and immigration requirements

Initial use of II, an index of a country's infrastructure stocks is determined (nine variables), using Principal component Analysis (PCA). The PCA is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possible correlated variables into a set of values of linear uncorrelated variables called principal components.

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$$I_{ij} = \sum W_{kj} X_{kij}^4$$

Where I_{ij} is an infrastructure development index of the i -th country in j -th time, W_{kj} is the weight of the k -th facility in j -th time, and X_{kij} = unit free value of the k -th facility for the i -th country in j -th time point. Large volumes of studies looked at the relationship between trade and infrastructure have found a positive and significant impact of the quality of infrastructure of trade such as Clarke [34], Wilson [35], and Limao [36]. For example, Clark[34] estimate that if a country like Peru or Turkey improved sea port efficiency to the level similar to Iceland or Australia, it would be able to increase trade by roughly 25 per cent. However, these studies have focused either on an overall measure of infrastructure quality or on maritime transport infrastructure. In the current study, the main concern of infrastructure is to facilitate mobility, its productivity using the road efficient access as a determinant.

4. Review of transportation policy and constraints.

The activity-based approach to travel demand analysis views travel as a derived demand; resulting from the need to pursue activities distributed in space (see Jones *et al.*, 1990). Derived demand concept establishes a direct relationship – movements resulting from economic activity as opined by Mokhtarian [37]. Travel constraints, referring to problems that result from specific travel activity overtime. Most measurements in travel behavior are probabilistic, assigns a probability to each of the possible outcomes of a random experiment, It revolves around the availability (from a choice set) of transport mode or other aspects like accessibility, connectivity. Accessibility defines cost and duration (time), connectivity is used here to mean the ability to link up another access road or a schedule transport time

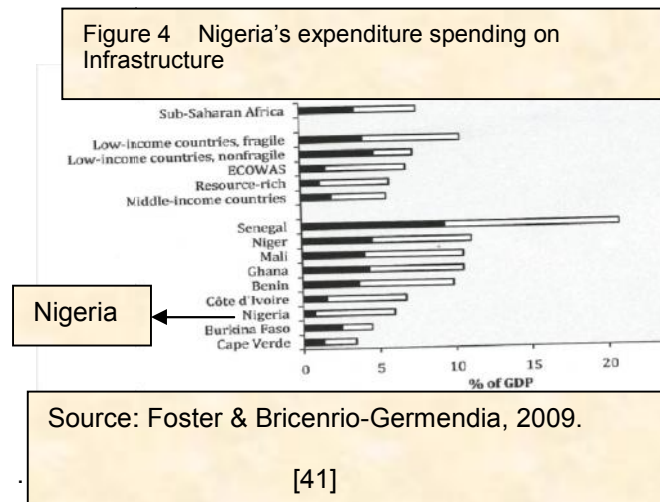
According to Awoyemi [38], Nigeria has experienced many of public transport programmes; at least last 20 years there has been increased usage of public transport. The growth in public transport has several determinants: (i). population growth, (ii).state creation that has introduced movements to some cities and evolution of some towns into 'semi urban cities', (iii) rise in public demand for 'democracy dividends' especially in mobility (mass transit buses) around towns for various needs, (iv). Vision 2020 philosophy of government, which has evolved from the NEEDs program, emphasizing the need and importance of the transport sector and the need to provide government assisted transportation program. It has also evolved as a tool for empowering the private sector through the provision of funds for acquiring buses. These factors have been responsible for growth of mass transit programs in Nigeria. However, there was a decline in personal mobility caused by scarcity of foreign exchange and severe import restrictions as with the case of mass transit funding Filani [39]. These, amongst other factors of risks on the Nigerian roads, most transport providers were affected – thus old fleet of transport on Nigeria roads accounts for this phenomenon. The restructuring programme by the Federal government with considerable investment in the bus fleet size had introduced the need for higher degree of mobility, since the transport policy of government points to the fact that about 90% of the travel needs of the people are met by road public transport which is in the transport policy as in [40]

The safety and convenience of Nigerian public transport, coupled with bad roads, due to neglects in maintenance and investment in rural roads especially, have been bottlenecks in the realization of the cardinal points of Nigeria's transport policy. Factors that have dictated travel behavior in Nigeria are:

- (1). The level of public investment is low compared to other regions in the Sub Saharan region (see figure 4).

⁴ as used by De, P. (2006) in "empirical estimated of trade costs for asia" (see references)

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We already explained that public expenditure spending in these countries has the highest prevalence of corruption.

- (2). High risks on the roads – arm robbery, road conditions etc.
- (3). Maintenance of public transit and general maintenance of fleet on Nigerian roads.
- (4). Poverty, especially in the rural sectors of Nigeria
- (5). Armed conflicts/ethno-religious environment in most of Northern Nigeria.

5. Conclusion.

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Discrete choice models (DCM) are vital tools for assessing different models travel behaviour over the years. Most (DCMs) have been vital tools for assessing travel-based models. These models are also referred to as disaggregate and probability models because they examine individual travel choices and the degree of uncertainty. These tools have mostly been applied to advanced market economies because of the importance of infrastructure in promoting trade and commerce (infrastructure-led growth). In developing economies, however, most literature has been concerned with the lack of performance, growth and other inhibitions resulting from lack of adequate infrastructure to support industries and the real sector. These conditions have also affected the growth and entrepreneurship.

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The study recommends government action in three areas: Growing insecurity in the country generally, specifically some Northern Nigerian roads, secondly the need for growth in the public-private-partnership (PPP) in road, building and maintenance of existing roads.

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And thirdly, increase public policy actions towards meeting the goals of the millennium development goals (MDGs) due to the importance of infrastructure for growth and empowerments of individuals towards entrepreneurial growth in Nigeria.

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This study is a springboard or a pointer to the fact that “A good public transport system must be easy and convenient to use, fast, safe, clean and affordable” according to Kyle [42], that the conditions of roads are kind of empowerment tools for the populace – access educational, trade and social environments, these are important parameters for achieving the goals of millennium development goals (MDGs).

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References

1. Ben-Akiva, M., & Bierlaire, M. (1999). Discrete choice methods and their applications to short term travel decisions *Handbook of transportation science Springer*, (pp. 5-33).
2. Luce, R. D. (1959). Luce's choice axiom. *Scholarpedia*, 3(12), 8077.
3. Werndl, C. (2011). On choosing between deterministic and indeterministic models: underdetermination and indirect evidence. *Synthese*, 1-23.
4. Pavlyuk, D., & Gromule, V. (2010). Discrete Choice for a Preferred Transportation Mode Reliability and statistics in transportation and Communication, 22
5. Alaba Adetola, J. G., Champika Lyannage. (2011). A Critical Appraisal of Road Transport infrastructure :Management in Nigeria. *DOCTORAL RESEARCH WORKSHOP, Wednesday, 12th October 2011 University of Central Lancashire, United Kingdom*, 77-94.
6. Campbell, A. (2009). Federal road management for sub-Saharan African nations: A Nigerian case study.
7. Campbell, D. (2012). Arrested development: growth theory has come a long way. How much further can it go? *Region Focus*(Fall), 36-40.
8. Okojie, G. (2012). Nigerian roads have challenges of poor design, materials, and supervision, *Leadership*, 30/02/2012, pp. 5-8.
9. Hashim, Y., & Meagher, K. (1999). *Cross-Border Trade and the Parallel Currency Market-Trade and Finance in the Context of Structural Adjustment: A Case Study from Kano, Nigeria, Research Report 113* (Vol. 113): Nordic Africa Inst.
10. Pickett, Joseph P., and others, eds. The American Heritage Dictionary of the English Language: Fourth Edition. Boston: 399 Houghton Mifflin, 2000
11. Bierlaire, M. (1997). Intelligent Transportation System Programm. *Massachusetts Institute of Technology*, 1-30.
12. Manski, C. F., & Lerman, S. R. (1977). The estimation of choice probabilities from choice based samples. *Econometrica: Journal of the Econometric Society*, 1977-1988.
13. Kahneman, D., & Tversky, A. (1996). On the reality of cognitive illusions. *Psychological review*, 103(3), 582-591
14. Tversky, A. & Kahneman, D. (1973). Availability: A heuristic model for judging frequency and probability. *Cognitive psychology*, 5(2), 207-232. On the reality of cognitive illusions. *Psychological review*, 103(3), 582-591
15. Christopher F Baum, Yingying Dong, Arthur Lewbel, & Yang, T. (2012). A simple alternative to the linear probability model for binary choice models with endogenous regressors. [This presentation is based on the work of Lewbel, Dong & Yang]Comparing features of Convenient Estimators for Binary Choice Models Economics Working Paper No. 789, *Boston College, Boston College, This presentation is based on the work of Lewbel, Dong & Yang*, 1-82.
16. Iliyasu, Z., Abubakar, I. S., Galadanci, H. S., & Aliyu, M. H. (2010). Birth preparedness, complication readiness and fathers' participation in maternity care in a northern Nigerian community. *African Journal of Reproductive Health*, 14(1).
17. Kawuwa, M., Mairiga, A., & Usman, H. (2007). Community perspective of maternal mortality: Experience from Konduga local government area, Borno state, Nigeria. *Annals of African medicine*, 6(3), 109.
18. Ouro-Bang'na, M., Kabore, R. A. F., Zoumenou, E. E. N., Gnassingbe, K., & Chobli, M. (2008). Anesthesia for children in Sub-Saharan Africa—a description of settings, common presenting conditions, techniques and outcomes. *Pediatric Anesthesia*, 19(1), 5-11.
19. Tukur, B. M., Bawa, U., Odogwu, K., Adaji, S., Passano, P., & Suleiman, I. (2010). Praying for Divine, *African journal for reproductive health*, 1(14), 113-119

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- 543 20. Omofonmwan, S. I., & Odia, L. O. (2009). Oil exploitation and conflict in the Niger-
544 Delta region of Nigeria. *J Hum Ecol*, 26(1), 25-30.
- 545 21. Flynn, D. K. (1997). "We are the border": identity, exchange, and the state along the
546 Bénin-Nigeria border. *American Ethnologist*, 24(2), 311-330.
- 547 22. Reporters, S. (2013, May 24, 2013). 1,497 Illegal Routes Into Nigeria news page,
548 *Sahara Journal*, pp. 1-10. Retrieved from <http://saharareporters.com>
- 549 23. Nieta-Parra, S., Olivera, M., & Tibocha, A. (2011). The politics of transport
550 infrastructure policies in Colombia: OECD Publishing, 1-58
- 551 24. IRF(International Road Federation). (2008). Building the better road. *Special Buletin*
552 *for Africa, November*, (International Road Federation), 1-20.
- 553 25. Fernandes, A. C. (2009). Explaining Government Spending: a Cointegration
554 Approach: Universidade do Porto, 366 Faculdade de Economia do Porto.
- 555 26. Bose, N., Haque, M. E., & Osborn, D. R. (2007). Public Expenditure and Economic
556 growth: A disaggregated analysis for developing countries*. *The Manchester School*,
557 75(5), 533-556.
- 558 27. Fakayode, B. S., Omotesho, O., Tsoho, A. B., & Ajayi, P. D. (2008). An Economic
559 Survey of Rural Infrastructures and Agricultural Productivity Profiles in Nigeria.
560 *European Journal of Social Sciences*, 364 7(2).
- 561 28. Estache, A., Speciale, B., & Veredas, D. (2005). How much does infrastructure
562 matter to growth in Sub-Saharan Africa? *unpublished, World Bank (June 2005)*.
- 563 29. Sunil Sinha, I. F. (2011). Literature on the constraints to investment in Developing
564 Countries. *Department for International Development., Final Report 2011*, 1-34.
- 565 30. Bank, W. (1994). World Development Report 1994: Infrastructure for Development.
566 *World Bank: Washington, DC, USA*.
- 567 31. Adesanya, A. (2010). Bringing the Nigerian Railways back on track: Challenges and
568 options., 1-21.
- 569 32. Osuji, O. (2013, March 21, 2013). Once upon a Nigerian Railway Corporation,
570 *National Mirror*, pp. 1-10. Retrieved from <http://nationalmirroronline.net>
- 571 33. De, P. (2006). Empirical Estimated of Trade Costs for Asia. *ADB institute and Inter-*
572 *American Development, Third LAEBA Annual Meeting Seoul, South Korea (LAEBA*
573 *16/11/2006)*, 1-15.
- 574 34. Clarke, D., et al., 2004, "In-depth study of motorcycle accidents", D.f. Transport,
575 Editor.London
- 576 35. Wilson J.S., Mann, C.L. and Otsuki, T. (2003), "Trade Facilitation and Capacity
577 Building: Global Perspective" 410 unpublished manuscript, World Bank: Washington
578 DC.
- 579 36. Limao, N., & Venables, A. J. (2001). Infrastructure, geographical disadvantage,
580 transport costs, and trade. *The World Bank Economic Review*, 15(3), 451-479.
- 581 37. Mokhtarian, P. L., & Salomon, I. (2001). How derived is the demand for travel?
582 Some conceptual and measurement considerations. *Transportation Research Part*
583 *A: Policy and Practice*, 35(8), 695-719.
- 584 38. Awoyemi, J. R. (2011). A Study of the factors militating against Public transport
585 operation in Nigria. *Department of Management Science, Ladoke Akintola*
586 *University of Technology, Ogbomoso(Web Directory)*, 1-5.
- 587 39. Filani, M. O. and Abumere, S. I. (1993). *Operational Efficiency in the Provision of*
588 *Mass Transit Services by State-owned Transit Companies in Nigeria. Urban*
589 *Passenger Transportation in Nigeria*, Edited by S. G. Ikya, Ibadan. Heinemann
590 Educational Books (Nig.) Plc
- 591 40. F.G.N. (2010). Draft National Transport Policy. *Federal Government Press, Abuja,*
592 *Nigeria*.
- 593 41. Foster, V., & Briceño-Garmendia, C. (2009). Africa infrastructure country
594 diagnostics. *Overhauling the Engine of Growth: Infrastructure in Africa. September.*
595 *Washington, DC: World Bank*.

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42. Kyle, R. (2011). How important are good public transport systems to urban and social development? [Sustainable Development Department]. *World Bank Online*(Global: International Briefing), 1-5