Transportation Research Interdisciplinary Perspectives 13 (2022) 100569

Contents lists available at ScienceDirect

Transportation Research Interdisciplinary Perspectives

journal homepage: www.sciencedirect.com/journal/transportation-research-interdisciplinary-perspectives

Motorized travel mode choices of smallholder farmers in Akwa Ibom State, Nigeria

Uduak Akpan *, Risako Morimoto

Department of Economics, SOAS University of London, United Kingdom

ARTICLE INFO

Keywords:
Rural road infrastructure
Travel behavior
Transport mode choice
Rural mobility
Multinomial logit model
Nigeria

ABSTRACT

The poor quality of rural road infrastructure may limit the transport services available to rural dwellers. The objective of this study is to understand the travel choices made by rural smallholder farmers in Akwa Ibom State, Nigeria in the face of poor rural road infrastructure. The study uses an existing sampling frame of smallholder farmers obtained from the World Bank-supported Fadama III Project in Akwa Ibom State, and employs multistage sampling to generate data. According to the data, motorcycles are the most owned means of transportation in the study area, and also the most used – even by persons who do not own any means of transportation. Further, we employ the multinomial logit model to examine the factors that influence their choices of means of transportation, and we use motorcycle as the reference category. The result shows that the preference of respondents for the different means of transportation is influenced mainly by the attributes of the means of transportation. In addition, among the socio-economic variables included in the model, only the coefficient of income under saloon cars is significant. Given that motorcycles and tricycles are now dominating the rural transport landscape as an economical way to meet the transport needs of people, rural transport policy in Nigeria should be revised to reflect this reality. The operation of motorcycles and tricycles should be properly mainstreamed in rural transport policy to improve rural transport services.

Background

Good quality rural road infrastructure plays an important role in improving rural accessibility, and stimulating socio-economic development in different areas: enabling farmers to transport their produce to aggregation centers and markets (Njenga, et al., 2014, 2015); providing improved access to social services such as health and education (Asomani-Boateng et al., 2015); fostering a sense of political inclusion (Demenge, 2012; Dennis, 2017); among others. However, the quality of rural roads and connectivity in most countries in sub-Saharan Africa is poor and has hampered the ability of rural dwellers to access social infrastructure and services. World Bank (2017) estimated that over 450 million people or 70% of the rural population in sub-Saharan Africa have limited rural accessibility due to the poor quality of rural road infrastructure. Some rural roads are completely non-motorable during the rainy season (Oppong, 1996; Blanford et al., 2012). Other challenges facing rural transportation include the non-availability of public transport services, low institutional capacity to maintain existing infrastructure, etc. (Hine, 2014; Olawole, 2017). In the face of these challenges, and given the inherent mobility needs of people, rural dwellers are adapting their travel behaviors to fit their mobility needs, taking cognizance of available transport options and services. For example, motorcycles now play an increasing role in meeting the mobility needs of people in rural areas across sub-Saharan Africa (Bishop et al., 2018a,b; Divall et al., 2021). Motorcycles are popular due to several factors: they have a relatively low operating and maintenance cost; they are not significantly hampered by poor road conditions and can be ridden on tracks; and can operate door-to-door (Olubomehin, 2012; Bishop et al., 2018a,b).

The rural road quality in Nigeria is similar to that of most other countries in sub-Saharan Africa. A report by the World Bank estimated that in 2017 the total road network in Nigeria was between 193,000 km and 195,000 km. These are categorized as federal (32,000 km), state (31,000 km), while the remaining 130,000 km to 132,000 km are local government roads[1] (World Bank, 2019). Most of the roads are in poor condition: 40% of federal; 78% of state; and 87% of local government

* Corresponding author.
E-mail address: 674577@soas.ac.uk (U. Akpan).

[1] Nigeria is a federation that is made up of 36 states and a Federal Capital Territory. Each state is further divided into local government areas (LGAs). There is a total of 774 LGAs.

https://doi.org/10.1016/j.trip.2022.100569
Received 9 June 2021; Received in revised form 18 January 2022; Accepted 13 February 2022
Available online 17 February 2022

roads (World Bank, 2019). The local government roads and some of the state roads are regarded as rural roads.

Studies on rural transportation in sub-Saharan Africa have largely focused on the provision of rural infrastructure (Porter, 2014). Similarly, most government programs on rural road transport development focus on infrastructure improvement. For example, the Draft National Transport Policy of Nigeria developed in 2010 states the objective of rural transport as: "(i) Open up the rural areas for local and regional markets; (ii) Improve the institutional framework for rural road construction, maintenance and operation, for a more focused development; and (iii) Ensure sustainable funding for rural road construction and maintenance." (Federal Government of Nigeria, 2010, p. 33). However, other aspects of rural transportation, such as the provision of rural transport services that meet the needs of rural dwellers, are equally important (Porter, 2007, 2014). One aspect of rural transportation that has received very limited attention in the literature is the travel behavior of rural dwellers in developing countries. It will be difficult to make informed decisions on improving rural transportation without having a good understanding of the travel behavior of rural dwellers.

Agriculture plays a very important role in stimulating the rural economy. Over 80% of farmers in Nigeria are smallholder farmers[2] who reside in areas considered to be rural and are responsible for over 90% of agricultural output in Nigeria (Anderson et al., 2017; Sabo et al., 2017). These smallholder farmers contribute substantially to food security at local and national levels (Oluwatayo, 2019). Improvement in their incomes is contingent on selling produce in nearby markets or agro-collation centers that supply food to the expanding urban centers (Dennis & Pullen, 2017). However, the non-availability of an efficient transportation system and limited transport options poses a challenge to the transportation of inputs to farm and produce to markets (Berg et al., 2018). Consequently, understanding the travel behavior of rural smallholder farmers, based on the available transport options, is important because of the contribution of this category of rural dwellers to the economy, especially in terms of food security.

Most studies on travel behavior in Nigeria have focused on urban areas (Olawole & Aloba, 2014; Olawole, 2015; Afolabi et al., 2017; Osoba, 2012; Idrisu & Osoba, 2015; Fadare & Salami, 2004; Ipingbemi, 2010). The travel behavior of rural dwellers in Nigeria seems to be an under-researched area (Olawole, 2017; Adetunji, 2020). We have not seen any study that has focused on rural smallholder farmers; hence, this study intends to address this knowledge gap. Specifically, the objective of this study is to examine the factors that influence the travel mode choices of rural smallholder farmers in the face of limited transport services caused by poor road quality.

The remaining part of this study is organized as follows: the second section will be a brief review of the literature, while the third section will be the methodology. In the fourth section, we will present and discuss our results; and we will make our conclusion in the fifth and final section.

Review of literature

Overview of travel behavior

There is a strong relationship between travel patterns and the needs of a population (Handy, 2005; Acker et al., 2010; Cui et al., 2017). Travel behavior examines how people move physically to meet their mobility needs; their purpose for moving; and the personal, social, and environmental conditions which influence their decisions to move (Acker et al., 2010). There are several factors that influence travel behavior: socio-economic and demographic characteristics of people such as age, sex, income, family size, etc. (Porter, 2011; Porter et al., 2013; Foley et al., 2021; Dėdelė et al., 2020); the travel options available to people (Porter et al., 2013); cost of travel (Porter et al., 2013; Foley et al., 2021); built environment and land use factors (Ramezani et al., 2021; Wee et al., 2019; Li et al., 2018); social affiliations and networks (Carrasco et al., 2008; Kim et al., 2018); ownership or access to technologies (Fadare & Salami, 2004; Porter, 2016; Gwaka, 2018); religious and cultural factors (Xu et al., 2009; Badawi & Farag, 2021); health conditions (Olawole, 2017; Porter et al., 2013), (Cochran, 2020; Dėdelė et al., 2020); and a combination of these factors. In recent times, the COVID-19 pandemic has affected the travel behavior of people (Brough et al., 2021; Irawan et al., 2021), (Brinkman & Mangum, 2021; Anwari et al., 2021). Due to the COVID-19 pandemic, several categories of workers regarded as non-essential workers were required to work from home which inadvertently influenced some changes in travel behavior (Balbontin et al., 2021). Travel behavior may manifest itself in terms of, for example, ownership of vehicles, the number of trips, length of trips, and travel mode choices.

Several studies have analyzed the travel behaviors of rural dwellers in developing countries. Bryceson & Howe (1993) examined rural household travel patterns and focused specifically on the gender perspective. Khayesi (1993) studied the rural household travel characteristics in the Kakamega district of Kenya using household surveys. The study sought to understand the purpose of trips, preferred routes and modes, length of trips, etc., and to establish whether there is a relationship between these factors. Airey & Cundill (1998) examined rural household travel behavior in a rural area in Kenya before and after the construction of a rural road. Oyeleye et al. (2013) categorized rural travel needs into "on-farm" (i.e. trips for meeting basic household needs such as water, firewood, etc.) and "off-farm" (trips for accessing markets or other social services). Porter et al. (2013) looked into the mobility constraints faced by elderly people in rural Tanzania and how this affected their health, income and livelihoods. Further, Porter et al. (2007) and Porter et al. (2010) examined how mobility challenges in rural areas affect the youths and their livelihood options.

Studies that focus on Nigeria are scarce. Olawole (2017) investigated how the limited availability of travel services and options affected the quality of life of elderly people in a rural area in Nigeria. The study observed that elderly people had unmet travel needs due to poor conditions of roads, unreliable and irregular transport services, among others and these unmet travel needs affected their opportunities to meet their health needs. Adetunji (2020) studied the travel behavior of women to markets in rural communities in South-Western Nigeria.

Travel mode choice is a subset of travel behavior that seeks to understand the factors that influence people's preferences for different modes of transportation at any given time. There are numerous studies in the literature that have been carried out to examine travel mode choices and these studies focus on diverse travel-related themes including gender (Scheiner & Holz-Rau, 2012; Salon & Gulyani, 2010); work (Bhat, 1997; Amoh-Gyimah & Aidoo, 2013); school (Mitra et al., 2010; Mitra & Buliung, 2015; Zhang et al., 2017). Most of these studies are either in developed countries or urban areas in developing countries.

A good number of literature on travel choices in rural areas in sub-Saharan Africa are part of the DFID[3]-funded Research for Community Access Partnership (ReCAP) or the World Bank-funded sub-Sahara African Transport Project (SSATP)[4]. Willilo et al. (2015) carried out a baseline study on rural transport service indicators using Kidabaga-Boma La-Ng'ombe Road in Kilolo District of Tanzania which is a 20 km road with parts being an earth road and other parts being a gravel road. The result showed that the dominant mode of transportation was motorcycles while trucks were used for evacuating agricultural produce.

[2] Farmers who own less than 2 ha of land

[3] United Kingdom's Department for International Development , which closed on 2 September 2020 and merged with the Foreign and Commonwealth Office (FCO) to create the Foreign, Commonwealth and Development Office

[4] http://www.ruraltransport.info/RTSi/resources/project_outputs.php (Accessed on 29th October 2020)

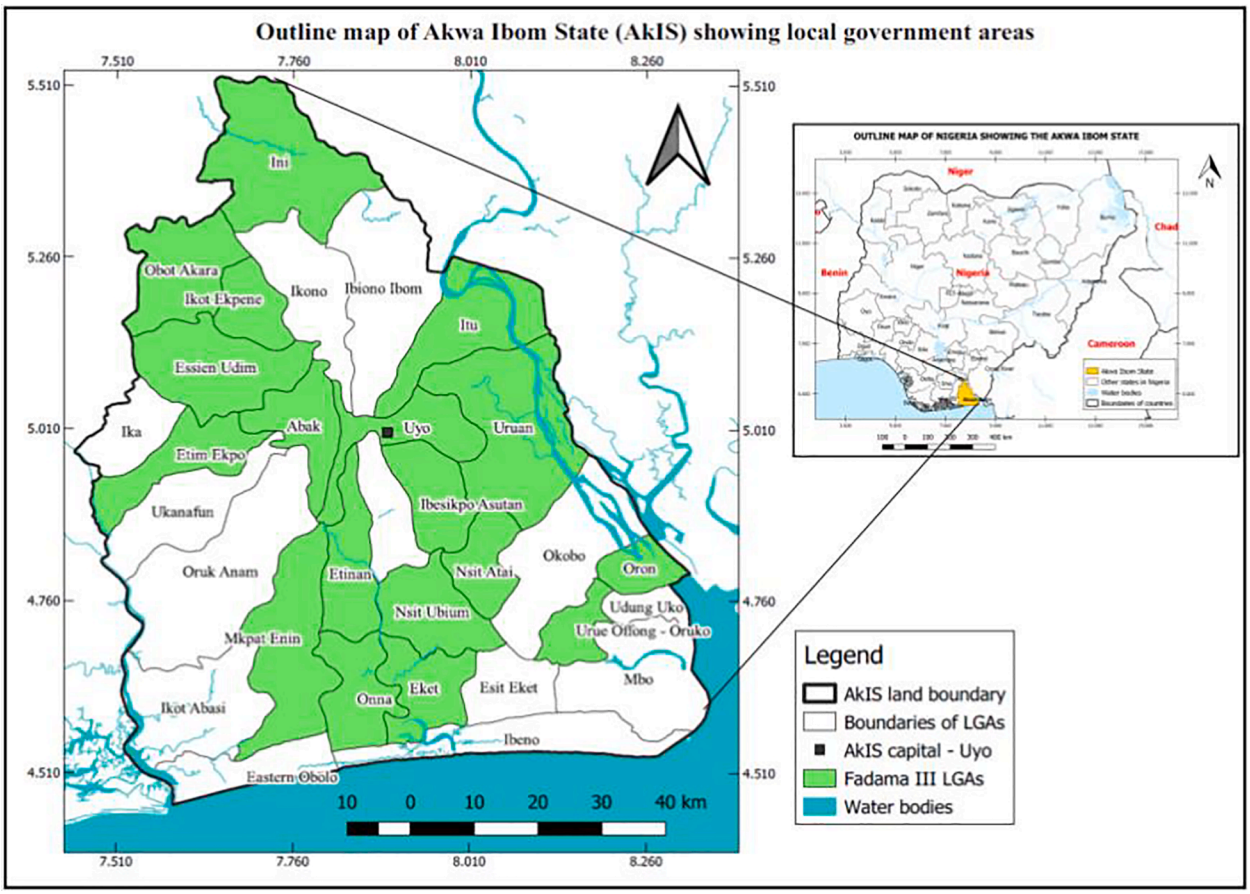

Fig. 1. Map of Nigeria showing Akwa Ibom State Source: Authors.

Table 1
Characteristics of informal transport services in the study area.

Type of vehicle	Routes	Schedules	Passenger capacity	Pricing (fares)	Service coverage
Motorcycle	Variable	Variable	1–2	Variable (always negotiated)	Rural/ Urban
tricycle (keke)	Variable	Variable	3–4	Semi-fixed	Rural/ Urban
Mini-bus/bus	Fixed	Semi-fixed	10–16	Semi-fixed	Mainly urban / inter-LGA transportation
Saloon car taxis	Fixed	Semi-fixed	4–6	Semi-fixed	Mainly urban / inter-LGA transportation

Source: Field observation conducted from 3rd to 28th December 2020.

Some medium-distance travels were done by walking. The survey also revealed that the average commute time on regular days was about 45 min by bus and motorcycle, and 1 h by truck, yielding an average speed of 25 km/hour and 20 km/hour respectively. Other indicators related to cost of travel, reliability of travel modes, etc. were also reported. Starkey et al. (2019) presents a summary of a similar survey in Ethiopia covering four regions (Amhara, Tigray, SNNP and Benishangul-Gumuz). The survey showed that the highest number of trips were to markets, religious centers, and farmlands; 99% of trips to farmland was by walking, 98% of trips to school was by walking; while 67% of trips to hospital was through bus/minibus. Further, the study reported a reduction in the time taken to access social amenities in areas where there was an improvement in road quality. Similarly, Bishop et al. (2018a,b) found that motorcycle was the dominant means of transportation in the rural areas of four countries (Ghana, Kenya, Tanzania, and Uganda). Motorcycles were used mainly because they are readily available even in emergencies, provided employment opportunities, and can easily navigate bad roads and tracks.

This overview of literature clearly shows that there is a knowledge gap on travel mode choices of rural dwellers in sub-Saharan Africa, hence the need for this study to contribute to filling this knowledge gap in Nigeria.

Discrete choice model

The discrete choice model has been used extensively to examine travel mode choice problems (Ben-Akiva & Lerman, 1985; Ben-Akiva & Bierlaire, 1999). The model assumes that the travel choice made by a

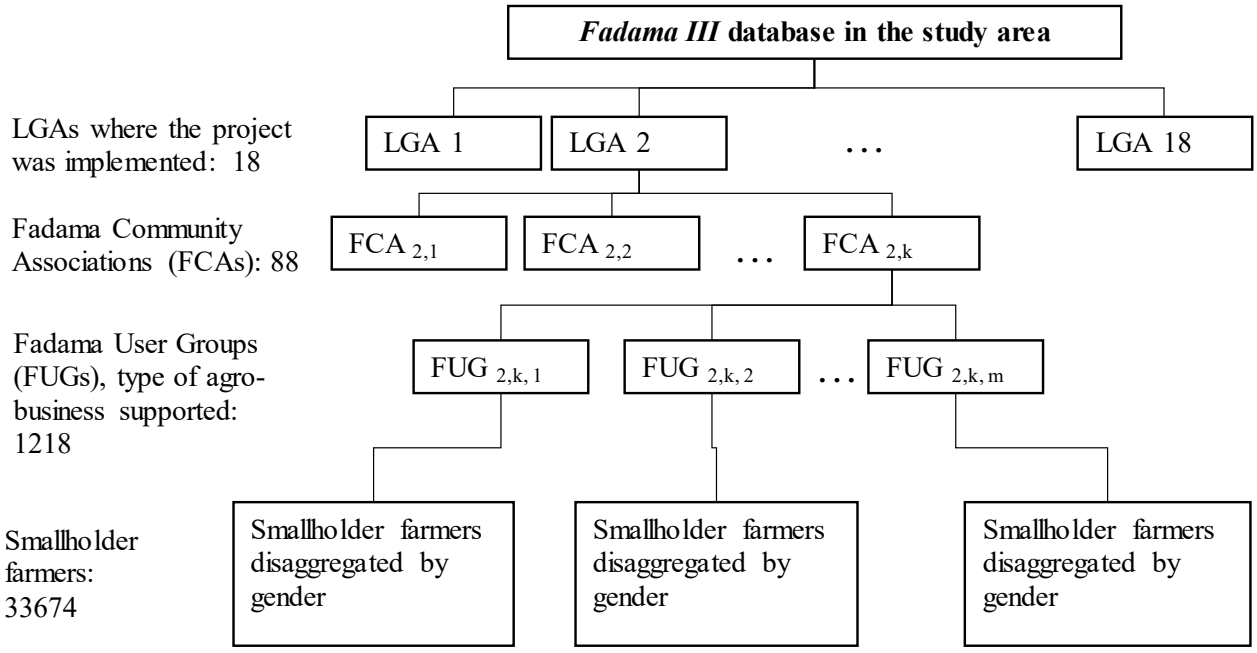

Fig. 2. Structure of Fadama III database used as the sampling frame.

person is dependent on the attribute of the person (e.g. socio-economic characteristics) as well as the attributes of the different means of transportation available to the person at a particular time. Since travel mode choices are discrete and qualitative, statistical models for estimating categorical dependent variables are commonly used to analyze travel choice problems. Specifically, multinomial logit model (MNL) is commonly used due to its simplicity and ease of estimation and interpretation (Ben-Akiva & Lerman, 1985; Müller et al., 2008; Thrane, 2015). However, Forinash & Koppelman (1993) highlights a major weakness in using the MNL which is that it reduces the relative probabilities of alternatives if a new mode of transportation that is similar to one of the existing modes is introduced (i.e. the condition of independence of irrelevant alternatives). To overcome this challenge, other advanced models such as nested logit (Dissanayake & Morikawa, 2002), multinomial probit (Can, 2013) are used. In addition to discrete choice modeling, machine learning tools such as random forest (Cheng et al., 2019; Sekhar et al., 2016), decision tree (Lindner et al., 2017), and Neural Networks (Golshani et al., 2018) have been applied to address travel choice problems within the last decade.

Methodology

Case Study: Akwa Ibom State, Nigeria

This study is carried out in Akwa Ibom State, Nigeria. Akwa Ibom State is one of the 36 states in Nigeria located in the Niger Delta region of the country, and lies between latitudes 4° 32.1′ and 5° 33.1′ North, and longitudes 7° 25.1′ and 8° 25.1′ East. The state has a landmass of 7249 km2 and is made up of 31 local government areas (LGAs) of which six (6) adjoin the Atlantic Ocean. Each LGA is made up of several communities/villages. The state had an estimated population of 5.27 million in 2015 (Government of Akwa Ibom State, 2014) and falls within the tropical rain forest and mangrove swamp agro-ecological zones in Nigeria. Its vegetation is mainly green foliage of trees and shrubs. Farming and fishing are the predominant economic activity in the rural areas in the hinterland and coastal areas respectively. There are several other non-agro micro-scale enterprises like raffia/mat/broom making, carpentry, grocery retailing, which also thrive in rural areas (Amos et al., 2015). We present the map of Akwa Ibom Showing LGAs in Fig. 1. The state capital, Uyo, is considered to be one the fastest growing cities in Nigeria (Ukpong & Udofia, 2011; Essien & Cyrus, 2019; Usanga et al., 2020).

The public transportation system in the study area is generally non-functional. Transport services consist mainly of private individuals operating buses, mini-buses, saloon car taxis, tricycles, or motorcycles depending on the coverage area or distance to be covered. Bicycles are mostly privately owned and used. Buses and saloon car taxis operate mainly for inter-LGA transportation which are generally longer; mini-buses and tricycles (*keke*) operate along the major roads in the state capital while motorcycles operate along minor streets; and tricycles and motorcycles operate in other urban areas. In rural areas, the common transport services are motorcycles and tricycles, even though bicycles are owned and used by individuals. The entry requirement for operating any commercial transport service involves registration of the means of transportation, paying acceptable fees to be allowed to ply certain routes, and paying for daily tickets. In terms of fares, there is no fixed fare for motorcycles: fares are negotiated for every journey and may depend on different factors such as the distance to be covered, road quality, time of the day, whether or not the passenger has luggage, etc. The fares for tricycles, mini-buses and taxis are relatively fixed for any defined route but may fluctuate in response to an increase in the price of petrol or the time of the year (for example, the fares in December are usually higher). In terms of departure and destination points, tricycles,

Table 2
Summary of the sampling frame and sample size.

Summary of Sampling frame				LGA selected from simple random sampling	Expected number of respondents (using systematic sampling with 10% sample size)	Actual number of respondents
LGA	Female	Male	Total			
Abak	515	277	792	Selected	79	73
Eket	431	474	905			
Essien Udim	902	788	1680	Selected	168	102
Etim Ekpo	2489	1384	3873			
Etinan	1742	1329	3071			
Ibesikpo Asutan	1314	858	2172	Selected	217	110
Ikot Ekpene	1163	992	2155			
Ini	427	463	890			
Itu	1025	1136	2142	Selected	214	113
Mkpat Enin	707	640	1347	Selected	135	93
Nsit Atai	1053	713	1766			
Nsit Ubium	1563	1332	2895	Selected	290	105
Obot Akara	893	667	1560			
Onna	1016	1049	2065			
Oron	1273	1123	2396			
Uruan	359	171	530	Selected	53	24
Urue Offong/ Oruko	438	385	808			
Uyo	1319	1308	2627			
Grand Total	**18,629**	**15,089**	**33,674**		**1156**	**620**

Source of sampling frame data: Akwa Ibom State Fadama III Coordination Office

mini-buses/buses, and saloon car taxis have specific departure and final destination points. However, passengers are usually at liberty to drop off at any point before the final destination but will be required to pay the full fare. A summary of the characteristics of transport services in the study area is presented in Table 1.

Survey design and data collection

Sampling frame

We used an existing sampling frame from *Fadama III* project in Akwa Ibom State. *Fadama III* was a project of the Federal Government of Nigeria that benefited from financial and technical support from the World Bank. The objective of the project was to improve the income and agricultural productivity of rural smallholder farmers and was implemented using a community-driven approach (World Bank, 2016a). The project was to be implemented in 20 of the 31 LGAs in the study location but the actual implementation was in 18 LGAs (see Fig. 1). The smallholder farmers in *Fadama III* were selected from each participating LGA following laid down guidelines. The beneficiaries included farmers in crop production, animal production, agro-processing, agro-marketing, among others (FMAWR Nigeria, 2009, p. 19; World Bank, 2016a). There was no restriction in terms of gender or age, and farmers were grouped into cooperative societies of between 10 and 25 persons called "Fadama User Groups" (FUGs). The FUGs were further grouped into "Fadama Community Associations" (FCAs). In all, the total number of FCAs was 88, the total number of FUGs was 1218, and the total number of beneficiaries (i.e. smallholder farmers) was 33,674 (18,629 females and 15,089 males) (Akwa Ibom State FCO, 2016). The structure of the database where the sampling frame is obtained is presented in Fig. 2.

We elected to use this sampling frame because: (i) the beneficiaries are a good reflection of rural smallholder farmers; (ii) the geographic spread of the smallholder farmers across rural areas in the study location is considered to be fairly even as a result of the due diligence put in place during the process of implementing the project; (iii) the smallholder farmers therein are generally literate; (iv) it is easier to locate them for data collection. The sampling frame contains the names of smallholder farmers and the agricultural value chain each farmer operates in. The addresses of most of the farmers are also included.

It is important to mention that the use of this sampling frame introduces some sampling biases. First, the sampling frame is only a proportion of smallholder farmers in the study area because not all LGAs were included; (ii) the sampling frame may not cover all smallholder farmers even in those LGAs where the project was implemented; (iii) the smallholder farmers of *Fadama III* project had benefitted from technical support from the project in terms of training on methods to improve agricultural productivity and in agro-business development, as well as financial support. The technical and financial supports had led to improvement in their incomes (World Bank, 2016b). Therefore, they may not be in the same socio-economic status as those not represented in the sampling frame. It was not possible to ascertain the proportion of smallholder farmers covered by the sampling frame in any LGA. Consequently, the findings from this study may not be generalized to cover all smallholder farmers in the study area but may cover only those smallholder farmers in the sampling frame.

Data collection

The study adopted a multi-stage sampling procedure. In the first stage, we selected 7 LGAs randomly from the 18 LGAs where the *Fadama III* project was implemented as shown in Table 2. Thereafter, we adopted systematic sampling and our target was to obtain data from 10% of smallholder farmers in each selected LGA. We followed the list of smallholder farmers by FCAs and FUGs as they appear in the database. However, we were unable to get data from all the smallholder farmers for several reasons: contact details of beneficially was not included in the database; some of the smallholder farmers had died, were ill, changed address, were not reachable, declined the questionnaire, etc. In all, we were able to get data from 620 smallholder farmers as shown in Table 2.

Table 3
Summary of questionnaire.

Segment	Question	Description
Socioeconomic characteristics of respondents	Age	Age of respondent. Data type = numeric.
	Sex	Sex of respondent. Data type = dummy (1 = male, 0 = female).
	Income	(i) Monthly income of respondent (from "less than ₦20,000" to "above ₦100,000.00"[5]. Data type = ordinal (ii) Primary source of income (options are "farming", "trading", "agro-marketing and sales", "public servant", and "others". Data type = categorical
	household size	Household size. Data type = numeric
Ownership of means of transportation, preference, and rationale	Number and type of the various means of transportation owned	A lists of the means of transportation is provided and respondents are requested to fill in the number of each means of transportation owned. Data type = numeric.
	Frequency of using different means of transportation	A table that lists the means of transportation is provided and respondents are requested to select the frequency of using each means of transportation. The options range from "Never" to "Very often". Data type = categorical.
	Most used means of transportation	A list of all the means of transportation is provided and the respondent is required to select only one option. Data type = categorical.
	Rationale for using the means of transportation most used	A table which lists the means of transportation is provided and respondents are requested to select the rationale for using the different means of transportation. The options are: "it is safe", "it is affordable", "It is comfortable", "It is readily available", "It is suitable for the type of road available in the area", and "It is fast and reduces the travel time". Data type = categorical
	Most frequent travel days: weekdays or weekends	Between weekdays and weekends, when do you travel more often? Data type = categorical
	Why do you travel out of your home most?	Options are: "To farm (If farming is the main source of income)", "To market", "To work (if farming is not the main source of income), "To church", and "To drop or pick children from school", and "Others". Data type = categorical.

Primary data were generated from the respondents using a questionnaire configured in a mobile data collection application called *kobocollect*. The only mode of transportation available in the study area is road. The transportation options (excluding walking) are bicycle, motorcycle, auto-rickshaw or tricycle (popularly called *keke*), bus/mini-bus, and saloon car. A summary of the questionnaire is presented in Table 3.

Previous studies on travel mode choice collected data on several other variables. For example, travel time for different means of transportation (Can, 2013; Aloulou, 2018); travel cost (Can, 2013; Aloulou, 2018); and questions related to the built environment (Masoumi, 2019; Ding et al., 2017; Ye & Titheridge, 2017; Munshi, 2016). Even though these variables are very important in understanding travel mode choice, we were unable to generate data on them. This is because the pre-test indicated that respondents may find it difficult to provide reliable answers to these questions. The survey was conducted between 8th January and 6th February 2021.

Analytical technique

This study aims to examine the travel mode choices of rural smallholder farmers. We focus on a single mode of transportation, i.e. road transport. The available means of road transportation within the study area (excluding walking) are bicycle, motorcycle, auto-rickshaw (popularly called *keke*), mini-buses/buses, and saloon cars. Consequently, we adopt multinomial logit (MNL). We note that the nested logit model is preferred to the MNL if any of the discrete options is considered a close substitute of another. In our case, none of the options is a close substitute of another, therefore we assume that the condition of independence of irrelevant alternatives will not be violated. The travel mode choice model is described as follows:

Let U_{ik} represent the utility derived by an individual i if s/he chooses an alternative k from a set S of possible discrete alternatives, where $k = 1, \ldots, K$; $i = 1, \ldots, n$. Then,

$$U_{ik} = F\left(Y_{ij}, Z_{ikm}\right) + \varepsilon_{ik}$$

Table 4
Summary of socio-economic characteristics of respondents.

	Category	**Number of respondents**	**% of respondents**
Age of respondents	0–20	2	0.32%
	21–30	68	10.97%
	31–40	248	40.00%
	41–50	172	27.74%
	51–60	87	14.03%
	61–70	39	6.29%
	71–80	4	0.65%
	Total	**620**	**100.00%**
Gender of respondent	Male	317	51.13%
	Female	303	48.87%
	Total	**620**	**100.00%**
Household size	Less than 4	98	15.81%
	5 or 6	288	46.45%
	7 or 8	190	30.65%
	9 or 10	34	5.48%
	11 or 12	5	0.81%
	Greater than 12	5	0.81%
	Total	**620**	**100.00%**
Average Monthly income	Less than ₦20,000	55	8.87%
	₦20,001-₦40,000	340	54.84%
	₦40,001-₦60,000	137	22.10%
	₦60,000-₦80,000	56	9.03%
	₦80,000-₦100,000	27	4.35%
	Above ₦100000	5	0.81%
	Total	**620**	**100.00%**
Primary Source of income	farming	292	47.10%
	Trading	122	19.68%
	Agro-marketing and sales	97	15.65%
	Public/civil servant	59	9.52%
	Others	50	8.06%
	Total	**620**	**100.00%**

[5] At the time of carrying out this study, the monthly minimum wage in Nigeria is ₦30,000.00 while the exchange rate is US$1 = ₦ 379.5

where:

$Y_{ij}, j = 1,\ldots,J$ represents j th socio-economic characteristics of the i th individual ($i = 1,\ldots$, n) which influences the choice of the k th means of transportation as the most used means of transportation; Z_{ikm}, $i = 1, \ldots$, n, $k = 1,\ldots$, K, $m = 1,\ldots$, M, represents the value of the m th characteristic of the k th means of transportation most used by the i th individual; ε_{ik} is the random error term. If an individual i uses means of transportation k most frequently, it implies that the utility that i derives from that means of transportation is generally higher than the utility from other means of transportation. Therefore, the probability that individual i uses means of transportation k most frequently is the probability that the utility of k is higher than the utility of other available means of transportation.

$$p_{ik} = P\left(U_{ij} > U_{i1}, U_{ij} > U_{i2}, U_{ij} > U_{im}\right), \quad j \neq m$$

The probability that an individual will choose any of the k th alternative is given as:

$p(k) = \frac{\exp(\beta_{0k}+\beta_{1k}X_{1i}+\beta_{2k}X_{2i}+\beta_{3k}X_{3i}+\cdots+\beta_{jk}X_{ji}+\varepsilon_{ik})}{1+\sum_{l=1}^{L-1}\exp(\beta_{0l}+\beta_{1l}X_{1i}+\beta_{2l}X_{2i}+\beta_{3l}X_{3i}+\cdots+\beta_{jl}X_{ji}+\varepsilon_{il})}$; $k, l \in$ S, where S is the set of categorical dependent variables with K elements.

Results and discussions

The results will be presented in two parts. In the first part, we will present the summary of the data collected to show the characteristics of the respondents as well as the ownership and frequency of the different means of transportation available in the study area. In the second part, we will present the result of the discrete choice model.

Summary of data collected

Socio-economic characteristics

The socio-economic characteristics of the respondents are presented in Table 4. We observe from Table 4 that the modal age of the respondents was 31–40 years accounting for 40% of the responses while the extremes (i.e. 0–20 years and 71–80 years) accounted for the least. The gender distribution of respondents was fairly even. The household sizes of about 77% of the respondents were between 5 and 8. The modal income range was ₦20,001 – ₦40,000 (US$52.79 – US$105.40) per month and the income of about 77% of the respondents was between ₦20,000 and ₦60,000 (US$52.79 – US$158.10) per month. Farming was the primary source of income for 47% of the respondents which is not surprising because the respondents are sampled from a sampling frame of smallholder farmers.

Ownership and use of means of transportation

On ownership of means of transportation, respondents were asked to state the number of means of transportation they own. The result is presented in Table 5. Our observation in Table 5 (column a) shows that motorcycle is the means of transportation mostly owned by respondents which is in line with the findings of (National Population Commission, 2019).

The next question was to know the means of transportation mostly used by the respondents. We observe from Table 5 (column b) that the means of transportation used most often is motorcycle, followed by tricycle. The observation that motorcycle is the means of transportation mostly used by smallholder farmers is a reflection of the rapid increase in the reliance on motorcycles in most rural areas in sub-Saharan Africa as a market-driven response to the inefficiencies in the transport systems, especially the non-availability of quality all-weather roads and public transportation. The fact that motorcycle can navigate bad roads, coupled with the availability of relatively cheap and fuel-efficient Indian and Chinese-made motorcycles, makes it an appealing alternative for meeting the transportation needs of people (Jenkins et al., 2020). This finding agrees with previous studies in several other countries in sub-Saharan Africa (Jenkins et al., 2020; Ehebrecht, et al., 2018; Porter, 2014; Mustapha, et al., 2017; Bishop et al., 2018a,b). Next, we sought to understand whether the preference for any means of transportation is due to ownership of that means of transportation. In other words, do respondents who use motorcycles most frequently do so because they actually own a motorcycle? This information is included in Table 5 (column c). The result shows that a large number of people who selected bicycle, motorcycle, and saloon cars as their most used means of transportation actually do own the means of transportation. For example, out of the 14 persons that selected saloon car as their most used means of transportation, 13 actually own a saloon car. Interestingly, 27 respondents had indicated that they own at least one saloon car. This means that some respondents own saloon cars in addition to another means of transportation but they use other means of transportation more often than their saloon cars. This may also be a consequence of poor road quality. Tricycle is a major exception because out of the 101 respondents who selected tricycle as their most used means of transportation, only 9 actually own a tricycle. This suggests that tricycle is preferred by a sizeable number of people whether they own it or not. We move on to get insights on the means of transportation most used by people who do not own any means of transportation. This result is presented in Table 5 (column d). We observe that motorcycles and tricycles are still the most used means of transportation for respondents in this category.

Furthermore, we observe that some respondents own more than one means of transportation while some did not own any. Specifically, 236 (38.06%) of respondents did not own any means of transportation; 286 (46.13%) owned only one; 82 (13.23%) owned two; 11 (1.77%) owned three; and 5 (0.81%) owned four or more. For some respondents that owned more than one means of transportation, the vehicle types owned included the different means of transportation.

While motorcycles provide an important means of mobility for the respondents (and indeed rural dwellers in general), studies have shown that the high reliance on motorcycles by rural dwellers also has negative consequences. For example, Jones et al. (2016) reported that motorcycles had the highest risks of danger among other means of transportation used in rural areas. This is mainly due to the poor safety practices of the riders who are often young males (Oginni et al., 2007; Olumide & Owoaje, 2015). Motorcycles contribute significantly to the number of road traffic accidents in Nigeria (Oluwadiya et al., 2009), and these accidents result in injuries, traumas, or permanent disability (Oluwadiya

Table 5
Number of respondents who own different means of transport.

Means of transportation	(a) No. of respondents who indicated that they owned each means of transportation*.	(b) Number and % of respondents who selected means of transportation as the most used.	(c) Number of respondents who own a means of transportation and selected that means of transportation as most used.	(d) No. of respondents who do not own any means of transportation and selected means of transportation as most used.
Bicycle	109	69 (11.1%)	61	8
Motorcycle	290	388 (62.6%)	253	131
Tricycle (keke)	47	101 (16.3%)	9	72
Minibus/Bus	31	48 (7.7%)	20	24
Saloon car	27	14 (2.3%)	13	1
Total		**620 (100%)**		**236**

N/B: Some people own more than one means of transportation

Table 6
Frequency and rationale for using different means of transportation.

Means of transportation	Number of respondents who selected means of transportation as the most used.	Rationale for using different means of transportation (Number who selected the option, %)					
		It is affordable	It is safe	It is comfortable	It is fast/reduces travel time	It is readily available	It is suitable for the type of road
Bicycle	61	33 (54.1%)	60 (98.36%)	42 (68.85%)	14 (22.95%)	55 (90.16%)	42 (68.85%)
Motorcycle	388	159 (40.98%)	362 (93.3%)	324 (83.51%)	304 (78.35%)	329 (84.79%)	277 (71.39%)
Tricycle	101	21 (20.79%)	101 (100%)	97 (96.04%)	93 (92.08%)	91 (90.1%)	81 (80.2%)
Mini-bus/Bus	48	18 (37.5%)	47 (97.92%)	46 (95.83%)	46 (95.83%)	45 (93.75%)	44 (91.67%)
Saloon Car	14	5 (35.71%)	14 (100%)	14 (100%)	14 (100%)	10 (71.43%)	8 (57.14%)

et al., 2009; Nwadiaro et al., 2011) with attendant economic costs. Tricycles (auto-rickshaws or *keke*) are the second most used means of transportation. Incidentally, reports of road crash with tricycles are not common.

Rationale for preferring the most used means of transportation

We now examine the rationale for using the different means of transportation. For the rationale, the options provided were: "it is affordable", "it is safe", "it is comfortable", "it is fast/reduces travel time", "it is readily available", and "it is suitable for the type of road". Respondents were allowed to select more than one option. The result is presented in Table 6.

We may observe from Table 6 that out of the 61 respondents who selected bicycle as their most preferred means of transportation, 60 (98.36%) prefer it because they considered it safe while 55 (90.16%) preferred it because it is readily available. Also, out of the 388 respondents who selected motorcycle as their most preferred means of transportation, 362 (93.3%) preferred it because they considered it safe while 329 (84.79%) preferred it because it is readily available. Similarly, all the respondents who selected saloon car as their most preferred means of transportation did so because they considered saloon car to be safe, comfortable and fast.

Travel days and cost of trips

Our result also shows that almost all the respondents travel more on weekdays than weekends and also travel most to work or farm. Further, respondents spend between ₦100 (US$0.26) and ₦500 (US$1.32) per trip depending on distance, destination, the quality of the road, and whether or not they have luggage. While the expenditure on transportation looks small if compared internationally, it actually constitutes a substantial proportion of income given that the minimum wage in Nigeria is ₦30,000.00 (US$79.05) per month which amounts to ₦1000 (US$2.64) per day.

Logistic regression result

The means of transportation mostly used by the respondent is selected as the dependent variable. The options are: bicycle, motorcycle, tricycle (*keke*), mini-bus/bus, and saloon car. We use motorcycle as the reference category because it is the modal category. The socioeconomic characteristics of the respondents included as explanatory variables are: age (numeric), sex (dummy), income (ordinal) and household size (numeric). We include a dummy variable to show whether or not the means of transportation mostly used by a respondent is owned by the respondent. The rationale for preferring to use a means of transportation may be viewed as a respondent's perception of the attributes of the means of transportation. The attributes were: "it is safe", "Fare/Cost (it is affordable)", "It is comfortable", "It is readily available", "It is suitable for the type of road available in the area", "It is fast and reduces the travel time". We include additional 30 dummy variables to represent the rationale for using the different means of transportation (i.e. six attributes X five means of transportation). The names of the attribute are

Table 7
Result of multinomial logistics regression.[b]

Parameter Estimates									
Which_means_of_trans_do_you_use_most_often?[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
bicycle	Ownership	1.271	0.544	5.459	1	0.019	3.563	1.227	10.343
	Bicycle_comfortable	1.515	0.609	6.190	1	0.013	4.551	1.379	15.016
	Bicycle_readily_available	1.919	0.628	9.347	1	0.002	6.811	1.991	23.301
	Bicycle_roadtype	2.496	0.997	6.274	1	0.012	12.136	1.721	85.576
	Motorcycle_readily_available	−1.671	0.709	5.560	1	0.018	0.188	0.047	0.754
mini_bus	bus_affordable	4.377	2.064	4.496	1	0.034	79.623	1.392	4553.027
	bus_roadtype	3.408	0.775	19.321	1	0.000	30.219	6.610	138.139
saloon_car	Income	1.547	0.522	8.772	1	0.003	4.698	1.688	13.077
	car_travel_time	2.146	0.939	5.225	1	0.022	8.554	1.358	53.884
	car_readily_available	4.186	1.560	7.201	1	0.007	65.739	3.091	1397.961
tricycle	Ownership	−1.012	0.507	3.991	1	0.046	0.363	0.135	0.981
	tricycle_safe	1.428	0.718	3.956	1	0.047	4.169	1.021	17.025
	tricycle_travel_time	1.184	0.470	6.339	1	0.012	3.267	1.300	8.213
	tricycle_readily_available	1.203	0.484	6.184	1	0.013	3.331	1.290	8.600
	tricycle_roadtype	1.891	0.551	11.786	1	0.001	6.627	2.251	19.510

[a]The reference category is: motorcycle.
[b]Running the model threw up a warning: "Unexpected singularities in the Hessian matrix are encountered. This indicates that either some predictor variables should be excluded or some categories should be merged. The NOMREG procedure continues despite the above warning(s). Subsequent results shown are based on the last iteration. Validity of the model fit is uncertain". Also, floating point overflow occurred while computing some statistic and the values of such statistics were set to system missing

appended to the means of transportation for ease of reference. The model is estimated using SPSS V25. The result is presented in Table 7 and shows only explanatory variables that are significant. We also exclude variables where "floating point overflow" occurred while computing some statistics because the values of such statistics were set to blank.

From our result, the coefficient of *Ownership* under bicycle shows that smallholder farmers in the sampling frame who own bicycles are more likely to use them than motorcycles. Also, smallholder farmers who perceive bicycles as comfortable, readily available, and suitable for the type of road respectively are more likely to use bicycles than motorcycles. The negative coefficient of *Motorcycle_readily_available* under bicycle show smallholder farmers in the sampling frame who consider motorcycles as being readily available are less likely to use bicycles than motorcycles. For the coefficients of variables under mini-bus, only two explanatory variables (*bus_affordable* and *bus_roadtype*) were significant. The result shows that smallholder farmers in the sampling frame who consider mini-bus/bus as affordable and suitable for the type of road they use respectively are more likely to use mini-buses/buses than motorcycles. For saloon car, *Income*, *car_travel_time*, and *car_readily_available* are significant. Finally, the negative coefficient of *Ownership* under tricycle suggests that smallholder farmers who own tricycles are less likely to use tricycles more often than motorcycles. Also, smallholder farmers are more likely to use tricycles than motorcycles if they consider tricycles as being safe, reduces travel time, readily available, and appropriate for the roads in their areas.

With the exception of the coefficient of *Ownership* under tricycles, every other coefficient presented in Table 7 seems intuitive. For example, it can be expected that a smallholder farmer will be more likely to use a saloon car rather than motorcycle if s/he has higher income or if s/he perceives that saloon cars will reduce his/her travel times and is readily available. On the other hand, the negative coefficient of *Ownership* when comparing tricycles with motorcycles seems to be counter-intuitive. This is because it is expected that a smallholder farmer who owns a tricycle will be more likely to use the tricycle than motorcycle. Furthermore, our result shows that almost all socio-economic variables included in the model (age, sex, household size) do not contribute significantly to the preference of smallholder farmers for different means of transportation. The only socio-economic variable that contributes significantly to the preference of a means of transportation is income which contributes to the preference of smallholder farmers for saloon cars.

Conclusion

The objective of this study is to understand the travel choices made by smallholder farmers in the face of limited transport options, with a view of integrating this knowledge into rural transport policy. The result of this study shows that the means of transportation mostly owned by smallholder farmers in the sampling frame is motorcycle. Motorcycle is also the most used – even by smallholder farmers who do not own any means of transportation. The other means of transportation mostly used by the respondents is tricycle. The result of the MNL shows that the preference of the respondents for the different means of transportation is influenced mainly by the attributes of the means of transportation. Given that motorcycles and tricycles have now dominated the rural transport landscape as an economic response to meeting the transport needs of people, rural transport policy needs to be revised to reflect this reality. The operation of motorcycles and tricycles should be properly mainstreamed into rural transport policy in a manner that is directed at improving rural accessibility. Our result shows that safety is a primary consideration for preferring each means of transportation. Given the propensity of motorcycles to road crashes, it is important to improve safety through consistent public awareness. Since tricycles are less susceptible to road crashes, the use of tricycles for rural transportation should be promoted.

This study used a sampling frame which limits the generalizability of the research to cover all smallholder farmers in the study area. In addition, the study was unable to obtain numeric data on some of the variables that could influence travel choices such as cost of transportation and travel time. Therefore, future studies may be designed to overcome these limitations by conducting more detailed surveys.

Ethics and Consent

This data collected in this study were collected with the support of a number of subjects who accepted to complete our questionnaire after agreeing to the Informed Consent statement included at the top of the questionnaire.

Funding information

This research is part of the doctoral research of the Corresponding Author. The doctoral research is funded by the Commonwealth Scholarship Commission, United Kingdom.

CRediT authorship contribution statement

Uduak Akpan: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Writing – original draft. **Risako Morimoto:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

We gratefully acknowledge Mr. Archibong Usen of *Fadama III* in Akwa Ibom State, Nigeria for the immense assistance and support during the data collection process. We also thank the anonymous reviewers who reviewed this paper. Their comments and suggestions have helped to improve the paper.

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