

# GLOBAL SYSTEM FOR MOBILE COMMUNICATION (GSM) USAGE AND HOUSEHOLDS TRAVEL BEHAVIOUR IN MINNA, NIGERIA

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**Abstract-** the application of mobile phone usage on urban travel by households in developing countries particularly in Nigeria has revolutionized people's daily routine by reducing the time-space constraints thus giving virtual accessibility to activity areas. No wonder the effect of mobile phone usage on travel behaviour has been a main concern on whether it has complementary, substitutional, generating or trip-saving effects. This study explores the relationship between mobile phone usage and travel among households in Minna, Nigeria. Data were collected through questionnaire administration on randomly selected 1,303 respondents using open data kit (odk) package. In achieving this, a multistage sampling technique was adopted in which the city was divided into four cluster zones, from which 12 different residential neighbourhoods were selected in each zone. Findings reveal that 76% of respondents possess and use mobile phones as a means of communication. Furthermore, results show that 83.7% of trips were saved by mobile phone usage, 82.1% generated trips, 83.5% complemented trips while 96.4% substituted trips. The analysis of multiple regression shows that GSM variables were strong and quite adequate to assess its influence on households' travel in the study area with a coefficient of determination indicating 60% (i.e.  $R^2 = 60\%$ ). This result indicates that GSM usage relatively has high contributory effects on trips made by households in the study area. The result of factor analysis shows that 3 factors whose eigenvalues are greater than 1 accounted for 70% of the total variance. These factors are frequency of daily call, trip substituted by call and trip generated by call. It was therefore recommended that residents should be advised to make more phone calls to save trips, travel cost and time rather than commuting, except if necessary in order to reduce time-space constraints will invariably give virtual accessibility to activity areas.

**Keywords-** GSM, Travel behaviour, Call, Trip, Telecommunications

## 1. INTRODUCTION

The emergence and development of Information and Communication Technology (ICT) has influenced the pattern and behaviour of urban travels across the world. The introduction of GSM in particular has affected greatly the rate at which urban residents travel in the cities. The experimental studies of mobile phone usage and travels as telecommunications evolves arises due to the consequences of diverse challenges identified in the study group of Europe of 1982 and of Nigerian Communication Commission (NCC) in 1985. The identified challenges include among others concerns for environmental, ecological and economic transportation sustainability, in respect to the interaction and co-evolution of technology and human activity which were not thoroughly understood, Fadare & Salami [1].

There had been a lot of researches to support the influence of mobile phones' on households' travels although such studies evolved from the intra-urban forms of travels and these comprise Mokhtarian [2] who studied telecommunications and travel behaviour of passengers in Texas and concluded that, trip length increases due to use of telecoms; Fadare and Salami [1] investigated socio-economic attributes and telecoms and discovered that, household size, employed members of household and monthly income are contributors to trip rates and telecoms usage, in so doing producing longer trip length in

Ibadan. Also, Oyesiku [3] investigated inter-urban travel patterns of Ogun State Urban centres and discovered that, there were statistical variations between the commercial, transition and residential zones of the study area in relations to telecommunications usages.

Handy [4] studied travel choices in Berkeley and discovered that the road mode of transportation was mostly used due to its travel frequency; Fadare and Salami [1] empirically analyzed the impact of pre-GSM fixed land line telephone uses and travel behaviour of residents in Oshogbo and discovered that, there were statistical positive significant relationships between trip purpose, distance of calls and travel outcomes. Fujiwara et al. [5] examined the Urban travel behaviour characteristics of 13 cities based on household interview survey in East Asia and stated that there is statistical significant variations between and within the cities' 'phone calls usage and call distances, number of received calls, travel time, travel frequency, number of inter-urban calls, distance of received calls and callers' durations as telecommunications attributes; Obalowo [6] studied the impacts of telecommunication usages on households' travel demand in Yaba, Lagos and concluded that, there were lesser demands for households travels due to mobile phone usages.

Ogunkoya [7] studied the cybernetics of travel and telecommunications relationships in metropolitan areas of Nigeria and concluded that, there had been a drastic surge in mobile phone ownership and the respondents affirm that accessibility to mobile phone

reduces the number of intended trips by them; Fadare [8] stated that the use of telecommunications is a natural substitute for transportation, it is a substance of consequential outcome rather than initial intent that telecommunications often substitute for transportation. Agunloye [9] examined the influence of mobile phone calls on travel pattern of air passengers in Murtala Mohammed Airport Two (MMA2) Lagos, Nigeria using survey research method and concluded that, there was a positive significant relationship between mobile phone calls and travel frequency in the study area.

Lastly, the application of telecommunication to travel has altered most especially urban resident's ways of life by reducing the time-space constraints and encouraging virtual accessibility to activity centres in which Minna is not an exception. Thus necessitate this study in order to provide insight to the intricate influences GSM usage has on the travel behaviour of households in Minna, an emerging urban centre in North-Central Nigeria.

## II. LITERATURE REVIEW

### II.1 Conceptual Framework

There is an existence of intricate relationship between telecommunication and travel Kvan et al. [10] and they can assume different forms. Communication was categorised into three major modes to give insight into the conceptual relationship between telecommunication and travel Mokhtarian, [11]. These include; face-to-face communications which entail the transportation of passengers; the transfer of an object containing information e.g. letter or books which entail freight transportation; and telecommunications which involve the movement of electrons over cables or radio wave via the air. Moreover, there have been established relationship between information and communication technologies and people travel behaviour. The possible relationship between telecommunication and physical travel as acknowledged by scholars can be described as substitution, complementarity, modification, generating, and neutrality (Salomon, [12]; Mokhtarian[13]; Mokhtarian & Salomon, [14]; and Nobis and Lenz, [15]).

Substitution takes place when the use of a mode reduces or eliminates the use of other modes Wojade, [16]. However, Yuan et al., [17] and Mokhtarian, [11] stressed that transportation problems are becoming worse in spite of the substitution of telecommunication due to the following reasons: (i) not all activities has an Information and Communication Technology (ICT) counterpart; (ii) ICT is not always a sufficient alternative to physical travel e.g. the limitation of cyber-infrastructure; (iii) ICT is not always a desirable substitute e.g. hanging out with friends in a bar; (iv) travel carries some positive utility; (v) not all ICT can replace travel.

Complementary arises when the use of one mode of communication increases the use of another mode. It can also be clustered into "enhancement" and "efficiency". Wojade [16] emphasised that enhancement occurs when the use one mode directly facilitates the use of another mode, while, efficiency takes place when the use of one mode increases the performance or effectiveness of the other mode.

Modification takes place when the use of one mode of communication alters or change the use of another mode. For example Wojade [16] asserted that a telephone call can alter or change the departure time or destination with respect to a trip or communication that would occurred. Consequently, the trip is neither substituted nor generated but rather modified.

Neutrality occurs when the use of one mode has no impact on the other modes. For example a routine trip to grocery store may not create any need for telephone calls.

James [18] looked into the problematic use of mobile phones: measuring the behaviour, its motivational mechanism and negative consequences using self-report questionnaire to administer the item pool to a developmental sample and found a distinction between actual behaviour, its outcome and motivations.

Zenkeller [19] make use of empirical platform and modelling to study the impact of telecommunications and transport on spatial behavior and found a combined platform of physical and virtual off-home activities. Handy [4] observed travel choices in Berkeley and found that, the road mode of transportation was mostly used because of its travel frequency; Fadare and Salami [1] empirically analyzed the impact of pre GSM fixed land line telephone uses and travel behaviour of residents in Oshogbo city, Nigeria and found that, there were statistical positive significant relationships between trip purpose, distance of calls and travel outcomes. Fujiwara [5] examined the Urban travel behaviour characteristics of 13 cities based on household interview survey in East Asia and found statistical significant variations between and within the cities' phone calls usage and call distances, number of received calls, travel time, travel frequency, number of inter-urban calls, distance of received calls and callers' durations as telecommunications attributes; Obalowo [6] studied the impacts of telecommunication usages on households' travel demands in Yaba, Lagos and found that, there were lesser demands for households travels due to mobile phones usages. The above review shows that GSM usage influence on urban travel behaviours is not a conclusive issue, more research efforts need to be done to validate previous studies and or provide us a better understanding of the empirical relationship between GSM usage and urban travel behaviours in cities of developing countries.



### III. THE STUDY AREA

Minna, is a rapidly growing urban centre in North-Central Nigeria which is located between Latitudes 9°42' N and between Longitude 8°55' N. It lies wholly with the physical and cultural zone of transition described as the "middle belt of Nigeria". Kaduna and Federal Capital Territory border the State to both North-East and South-East respectively. Minna has a total land area of 74,344 km<sup>2</sup> wide and it is approximately 8% of the land area of the country. Minna is a town comprising majority Gbogi, Nupe and Yoruba and Hausa speaking people. The population of Minna has grown 176,756 (NPC 2016) at 3.2% growth rate. There are twenty-four neighbourhoods in Minna. The main modes of transportation in the City include Cars/taxis, Mini-buses and motorcycle popularly known as 'okada' and tricycles known as 'keke napep'.



Figure 1 Map of Niger State showing Minna City  
Source: Department of Transport Management, FUT Minna

### IV. METHODOLOGY

A cross-sectional survey approach was used to examine the influence of GSM usage on household's travel in the city. A multistage sampling technique was adopted for this study. The study area was first divided into four clusters using major traffic corridors as boundaries. In each cluster, three neighbourhoods of low, medium and high densities were selected. Figure 3 shows the neighbourhood selected for questionnaire administration.



Figure 2 Selected 12 Neighbourhoods in Minna.  
Source: Author's field work (2018)

In determining the suitable sample size, the recent population of Minna was obtained from National Population Commission (NPC). From which the current estimated population of 176,753 was gotten. Since the target population is the household according to Nigerian Bureau of Statistics (NBS, [20]), an average number of 6 persons live in a household. The estimated population is hereby divided by 6 which gave rise 29,459 households. However, due to the large population, a Dillman [21] sample size formula was adopted to determine that suitable sample size. The formula is given as:

$$N_s = \frac{N_p(p)(1-p) + (B/C)^2 + (p)(1-p)}{1}$$

Where;

N<sub>s</sub> = completed sample size needed (notation often used is n)

N<sub>p</sub> = Size of Population (notation often used is N)

P = Proportion expected to answer a certain way (50% or 0.5 is most conservative)

B = Acceptable level of sampling error (0.03) = (3%)

C = Z statistic associated with confidence interval (2.17) = 97% Confidence level

$$N_s = \frac{(286,838)(0.5)(1-0.5) + (286,838-1)(0.03/2.17)^2 + (0.5)(1-0.5)}{1}$$

$$N_s = \frac{(71,709.5) + (286,837)(0.000191) + (0.25)}{1}$$

$$N_s = \frac{(71,709.5) + (55.04)}{1}$$

$$N_s = 1,302.86$$

Hence, a total number of 1,303 sample size was arrived at only 888 were correctly administered and returned valid which is 68.2% of the questionnaires administered. Questionnaires were administered on this population using Open Data Kit (ODK) within 12 residential neighbourhoods in the study area. Data on GSM usage and travel behaviour of households were majorly sourced through questionnaire administration. The questionnaire tried to provide basic answers to key variables identified like, trip generated by call, frequency of call, trip saved by call, trip complement call, GSM ownership, cost of call, duration of call, number of daily and weekly trips made, trip purposes. The variables/data captured were analyzed using multiple regressions, factor analysis and correlation statistical tools, SPSS packages were used to run the analyses.

### V. RESULTS AND DISCUSSION

#### 5.1 Use of ICT by Households in Minna

Information Communication Technology (ICT) comprises of GSM, WhatsApp, Facebook and social media applications that are used for information dissemination are considered as various options for communications. From the findings, a very high percentage of respondents possess and use GSM (76.0%) this is followed by WhatsApp (15.2%) while other communication applications seem insignificant

as shown in Table 1. The popularity of GSM and WhatsApp could be due to their ease of setting up and fast SMS, voice, picture, video sharing facilities.

**Table 1: ICT Usage Among Respondents**

ICT	Frequency	Percentage
E-mail	13	1.7
Instagram	6	0.7
GSM	675	76
Facebook	50	5.6
WhatsApp	135	15.2
Twitter	6	0.7
Total	888	100

Source: Author's field survey (2017)

The use of ICT has been known to influence trip making as stated by Fadare [22] [23]. In the study area, attempt was made to establish the extent to which ICT influence trip-making. The result shows that telephone helped them in saving or reducing their weekly trips, while about 82.1% still believe that GSM usage also generate many of its own. The results in Table 2 further shows that 83.5% of respondents also believe that the GSM also complement many of trips they make weekly while 96.4% believe that GSM calls substituted many trips they would have made. The number of trips saved, generated, complemented and substituted weekly varies from 1 to 5 as shown in Table 2.

**Table 2: Frequency of Trip Saved/Generated/Complement and Substituted by call**

No. of Trip	Trip saved by call		Trip generated by call		Trip complemented by call		Trip substituted by call	
	n	%	n	%	n	%	n	%
0	145	16.3	158	17.8	147	16.6	152	17.2
1	112	12.6	177	20.0	147	16.6	98	11.1
2	111	12.5	234	26.4	111	12.5	187	21.2
3	118	13.3	182	20.6	115	13.0	228	25.7
4	117	13.2	87	9.8	88	9.9	123	14.0
5	115	12.9	88	9.9	118	13.3	155	17.5
	888	100	888	100	888	100	888	100

Source: Author's field survey (2017)

In order to quantitatively analyse the level at which GSM usage influence urban travel behaviour in Mirra, the researcher made use of the regression model. The regression model can be conceptualized as:

$$Y = F(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8) + e \dots \dots \dots (2)$$

**Table 4 Regression Model Analysis for GSM Influence on Travel Behaviour**

Adjusted R Square	Adjusted R Square	Adjusted R Square	Adjusted R Square	Adjusted R Square	Adjusted R Square	Adjusted R Square	Adjusted R Square	Adjusted R Square	Adjusted R Square
0.774	0.620	0.490	0.377	0.280	0.200	0.140	0.090	0.060	0.040

n = Predictors: (Constant), Duration of daily call, Frequency of daily call, Cost of daily call, Trips saved by call, Trips generated by call, Call complementing trip, Trips substituted by call, Number of GSM ownership

Where Y represents the number of trips made by respondents;

- X<sub>1</sub> = Duration of call
- X<sub>2</sub> = Frequency of daily call
- X<sub>3</sub> = Cost of daily call
- X<sub>4</sub> = Trips saved by call
- X<sub>5</sub> = Trips generated by call
- X<sub>6</sub> = Call complementing trip
- X<sub>7</sub> = Trip substituted by call
- X<sub>8</sub> = Number GSM Ownership

e = Error term of prediction  
Equation (3) above is now made operational in the form of a regression

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + e \dots \dots \dots (3)$$

Where X<sub>1</sub>.....X<sub>8</sub> represented independent variables and b<sub>0</sub>, b<sub>1</sub>, b<sub>2</sub>, b<sub>3</sub>, b<sub>4</sub>, b<sub>5</sub>, b<sub>6</sub>, b<sub>7</sub>, b<sub>8</sub> represent the regression constants. Using the equation (4) above, the data was subjected to multiple regression analysis. A multiple regression analysis was performed using 8 variables namely; Frequency of daily call, Trips generated by call, Call complemented trip, Trip saved by calls, Cost of daily calls, Number of GSM owned and Duration of call.

The first level of analysis is to show the correlation analysis of each of the variables with the total weekly trips generated.

**Table 3 Correlation Analysis**

	Call duration of daily call	Frequency of daily call	Cost of daily call	Trip saved by call	Trip generated by call	Call complementing trip	Trip substituted by call	No. of GSM ownership
Call duration of daily call	1.00	0.20*	0.12*	0.19*	0.20*	0.20*	0.17*	0.20*
Frequency of daily call	0.20*	1.00	0.14*	0.18*	0.18*	0.18*	0.18*	0.18*
Cost of daily call	0.12*	0.14*	1.00	0.18*	0.18*	0.18*	0.18*	0.18*
Trip saved by call	0.19*	0.18*	0.18*	1.00	0.18*	0.18*	0.18*	0.18*
Trip generated by call	0.20*	0.18*	0.18*	0.18*	1.00	0.18*	0.18*	0.18*
Call complementing trip	0.20*	0.18*	0.18*	0.18*	0.18*	1.00	0.18*	0.18*
Trip substituted by call	0.17*	0.18*	0.18*	0.18*	0.18*	0.18*	1.00	0.18*
No. of GSM ownership	0.20*	0.18*	0.18*	0.18*	0.18*	0.18*	0.18*	1.00

\*. Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

Source: Author's Computer Analysis (2018)

The result of correlation analysis in Table 3 shows that majority of the variables are highly correlated with the total weekly trips made by households at 0.01significant level. For instance, frequency of call (X<sub>2</sub>), has the highest correlation of 67%. This is not surprising because, the frequency of calls is a by-product of total weekly trip generated. This is followed by the cost of call (X<sub>3</sub>) with 52%. The variable with the least correlation is the duration of call (X<sub>1</sub>) which is just about 10%.

Source: Author's Computer Analysis (2018)

Table 5: Testing Variance in Respondents GSM Usage influence on Travel

ANOVA <sup>a</sup>						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1527.799	8	190.975	164.544	.000 <sup>b</sup>
	Residual	1020.197	879	1.161		
	Total	2547.995	887			

a. Dependent Variable: Total no of wkly trip

b. Predictors: (Constant), Number of GSM ownership, Duration of Call, Trip save call, Trip substituted by call, Trip generated by call, Call complimenting trip, Cost of call, Frequency of daily call

Source: Author's Computer Analysis (2018)

The result of the regression analysis as shown in Table 4 shows that the model yielded an appreciable  $R^2$  as it gives a value of 0.600 (60%). Moreover, the model is statistically significant with p-value of <.001 at 0.05 alpha level. The model coefficient of eight variables is:

$$Y = -.136 + (-.039)x_1 + (0.886)x_2 + (-.001)x_3 + (0.073)x_4 + (0.226)x_5 + (0.157)x_6 + (-.284)x_7 + (0.152)x_8 \quad (4)$$

The analysis of multiple regression shows that GSM variables were strong and quite adequate to assess its influence on households travel in the study area. The whole of the eight variables explain a total variation of 60%. This adequately explains the various trips made by household under the study. This result indicates that GSM usage relatively has high contributory effects on trips made by households to various activities centres in the study area. While, the remaining 40% is accounted for by the other factors which have not investigated. The ANOVA result indicates that the model is significant at 0.000 level while  $F = 164.544$ .

## 5.2 Factors Influencing Travel Behaviour in Mirna

In order to identify the most significant factors among GSM usage variables influencing travel behaviour of households in Mirna, a principal component analysis with varimax rotation was used as shown in Table 7 six variables were considered these include; frequency of daily call, cost of daily call, trip saved by call, trip generated by call, trip complimented by call and trip substituted by call. The principal components technique used seeks to maximize the sum of squared loadings of each factor extracted in turn.

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.778
Approx. Chi-Square	3707.852
Bartlett's Test of Sphericity	18
Sig.	.000

Source: Author's Computer Analysis (2017)

The KMO and Bartlett's Test in table 6 was used to test the adequacy and validity of the data used for study, which indicate that it is significantly adequate.

Table 7: Factor Analysis Communalities

	Initial	Extraction
Duration of Call	1.000	.563
Frequency of daily call	1.000	.914
Cost of call	1.000	.651
Trip save call	1.000	.592
Trip generated by call	1.000	.711
Call complimenting trip	1.000	.665
Trip substituted by call	1.000	.843
Number of GSM ownership	1.000	.675
Total no of wkly trip	1.000	.660

Extraction Method: Principal Component Analysis.

Source: Author's Computer Analysis (2017)



Table 8 Results of Analysis of Variance

Component	Total Variance Explained			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
	FDC	3.973	44.140	44.140	3.973	44.140	44.140	2.755	30.606
TSUBC	1.264	14.042	58.182	1.264	14.042	58.182	2.470	27.443	58.050
TOC	1.038	11.534	69.716	1.038	11.534	69.716	1.050	11.666	69.716
NGO	.932	10.351	80.068						
CCT	.462	5.123	85.201						
TNWT	.444	4.931	90.131						
COC	.422	4.692	94.823						
TSC	.369	4.100	98.923						
DOC	.097	1.077	100.000						

Extraction Method: Principal Component Analysis.

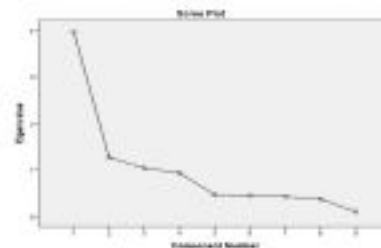
Source: Author's Computer Analysis (2018)

\*Note: FDC: Frequency of Daily Call; TSUBC: Trip Substituted by Call; TGC: Trip Generated by Call; NGO: Number of GSM Ownership; CCT: Call Complementing Trip; TNWT: Total Number of Weekly Trip; COC: Cost of Call; Trip Saved Call; DOC: Duration of Call

Using the eigenvalue-one criteria (i.e. Kaiser 1960 criterion) Table 8 explains the result of total variance of GSM factors influencing travel behaviour of households. The result reveals that 3 factors whose eigenvalues are greater than 1 accounted for 70% of the total variance. The cumulative value of the first three factors is 70% with factor 1 accounting for 44.14%.

The result confirmed that frequency of daily call explained 44.14% of the total variance influencing travel behaviour while trip substituted by call and trip generated by call explains 14.04% and 11.53% respectively. The implication of this outcome on households travel behaviour is that telecommunication (mobile phone usage) i.e. rate of phone calls and trip saved by calls has significant influence on household's travel which invariably diminished the time-space constraints and provide virtual accessibility to activities centres in the study area.

A cursory look at the screen plot in Figure 3 shows that 3 factors were extracted (point of sharp and sudden change in slope) of which factor 1-3 account for more than 70% of the changes in variance which is relative to the remaining 6 factors (i.e. 4-9). These variables according to their order of ranking from 1-9 include; frequency of daily call, trip substituted by call, trip generated by call, number of GSM ownership, cost of daily call, total number of weekly trip, cost of call, trip saved by call and duration of call.

Figure 3 Screen Plot  
Source: Author's Computer Analysis (2018)

The result of the extraction method in Table 7 after ranking the output reveals that the factors with the highest output were frequency of daily call (0.914), trip substituted by call (0.843) and trip generated by call (0.711) while the least factor is duration of call (0.563).

## CONCLUSION AND RECOMMENDATION

This study hitherto has revealed the significant role mobile phone usage plays in household's mobility in Minna. The study revealed that 76% of respondents possess and make use of mobile phones as a means of ICT communication in the study area. Results also shows the extent to which GSM usage influence trip making by indicating that telephone calls saved respondents from making trip (83.7%), generated trips (82.1%), trip substituted by call (94.6%) and complement trip-making (83.5%). This result corroborates the findings by Fadare in 2007 and 2010. The analysis of multiple regression shows that GSM variables were strong and quite adequate to assess its influence on households travel in the study area with coefficient of determination (i.e.  $R^2 = 60\%$ ). This indicates that GSM usage relatively has high contributory effects on trips made by households in the study area.

### 6.1 Recommendations

In order to meet travel demands and mobility needs of the society particularly in urban centres residents are advised to make phone calls to reduce personal trip frequency, travel cost and time instead of commuting, except if so necessary. Secondly, cost of making calls should be considered by households as an option in relation to trip making. Lastly, there should be service efficiency by various network providers in order to create a conducive atmosphere for interconnectivity among various subscribers, this will help to improve performance and effectiveness of GSM calls, which invariably reduce the rate of personal travels

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