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SPATIAL VARIATION AND DETERMINANTS OF INTERACTION AMONG URBAN CENTRES IN AKWA IBOM STATE, NIGERIA

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ABSTRACT: *The aim of the study was to determine the volume of interaction among the urban centers in the study region and to assess the relationship between the observed volume of interaction and the expected volume of interaction in the study region.. Six urban centres were selected from the thirty-one urban centres in the study region using random number table. Data collection was by travel survey conducted from Monday – Saturday simultaneously in the six urban public motor parks between the hours of 7 – 9 am, 12 – 2 pm and 4 – 6 pm. The Chi-square technique 'goodness of fit' test was used to analyze the difference between the observed volume of interaction and the expected volume of interaction among the urban centers. The study revealed a significant difference between the observed volume of interaction and the expected volume of interaction in the region. The conclusion was that the determinants of inter – urban interaction in Akwa Ibom State, Nigeria are not just population and distance as postulated in the gravity model, other socio-economic variables such as number of industries, number of tertiary educational institutions, number of major markets, number of tourism sites and number of hospitals also contribute to inter-urban interaction in the region. This is a contribution to modifying gravity model for wider use. These findings will assist in the urban transportation planning of the region.*

KEYWORDS: Spatial Variation, Inter-Urban Interaction, Gravity Model, Akwa Ibom State, Nigeria

INTRODUCTION

In recent years, there has been noticeable increase in the demand for inter-city work, business and other trips stimulating interaction among the urban centers in the developing countries (Oyesiku, 1995). The current trend has brought to the fore the need for a better understanding of the travel pattern and behavior among urban centers and regions. The past one and half decades have witnessed a phenomenal increase in the demand for inter-city passenger travels, public and

private transport services in Nigeria (Daniel & Ituen, 2013). This has been due to increasing personal income, improved transport infrastructure and availability of vehicles for long distance travels in the market (Oyesiku, 1995). In Nigeria for example the demand for inter-city and regional trips in public transport rose from 41.5 % in 1986 to about 65% in 1990 (Daniel & Ituen, 2013). This increase poses additional challenges to the transport planners.

Basic to any planning is an understanding of materials (Crieghton, 1972). Materials are viewed here in a broad sense. The engineer for example, must understand not only the strength of the materials used in a bridge, but also the load that will be imposed on that bridge. The materials of an urban transportation planner include not only the physical ways and vehicles within which people and goods move about but also the trips themselves and activities which generate the trips (Daniel, 2002). Long-range plan for coordinated transportation systems to serve metropolitan areas cannot be developed based on intuition and judgment, but are based on rigorous processes, including computer tests, which demonstrate that the recommended plan maximizes performance in relation to an accepted goal

The Study Location

The study was conducted in Akwa Ibom State. Akwa Ibom State is one of the thirty-six States in Federal Republic of Nigeria. It was created on 23rd September, 1987 (Daniel and Akpan, 2006). There are 31 Local Government Areas including Uyo the State Capital. The State is strategically located at the Southeastern corner of Nigeria between latitudes $4^{o}30^{1}$ and 5^{o} 33^{1} North and longitudes 7^{o} 30^{1} and 8^{o} 25^{1}East (see Fig.1). By the 2001 census Akwa Ibom State recorded a total population of 3,920,208 persons (Inyang, 2010).

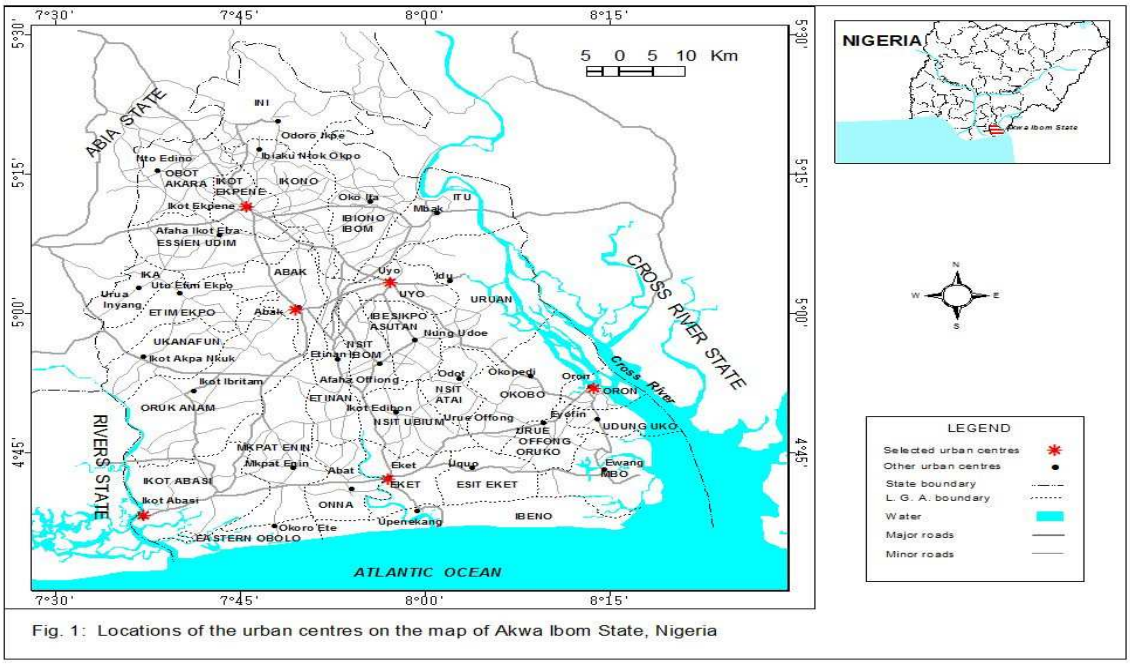

Fig. 1: Locations of the urban centres on the map of Akwa Ibom State, Nigeria

Research Problem

Daily, motorized movements of people and goods are observed on the major roads linking major urban centers in the study area. Questions arise as to what numbers of people are involved, why and where are they going? Every urban center in the region is involved in these movements. Each urban center generates and attracts certain types and number of trips daily to and from other urban centers. It is essential to investigate the volume of trips generated and attracted to the different sections of the region and the activities generating and attracting them. The result of the investigation will provides rational and scientific premise for decisions on the future adjustment in transportation practices and location of new socio-economic activity centres in the region rather than leaving matters to chance and relying on speculations.

Aim of the Study

The aim of the study was to determine the volume of interaction among the urban centres in the study region so as to establish any significant difference between the observed volume of interaction and the expected volume of interaction in the region. It study was also aimed at identifying the important determinants of interaction among the urban centres in the region.

REVIEW OF LITERATURE

The ability to analyze and forecast the inter-city travel demand depends on the determinants of inter-city trip generation behavior and information on the characteristics of the travelers. Oyesiku (1995) in his study, identified 12 determinants of inter-city trip generation to be sex, age, marital status, employment status, occupation status, level of education, level of income, house rent, vehicle ownership, mode of travel, household size and number of persons working in the household. Oyesiku used these determinants in explaining the volume of inter-city trips generation by the residents in those cities. Applying multiple linear regression analysis, the researcher was able to obtain a model for estimating future trip generation. Similar models are developed in this study, using SPSS Multiple Regression Analysis. Onakomaiya (1981) attributed the traffic congestion along some roads in Nigeria to lack of proper planning. According to him the design of low income class residential areas with narrow and winding street designs who were not thought of shift in class status to car owning group, have since rendered the planning foresight of professional untenable. Onakomaiya discovered that many low income residential areas have in less than two decades, more than doubled their population and many residents are now car owning families. Such areas according to him soon became centers of high trip generation and attraction, thus making traffic flow difficult. Oduola (1981) stated that out of the estimated 3.5 million people living in Lagos in 1977, 84 % constituted commuters to work and school. These trips involved an average time of one and half hours. Oduola suggested that improvement should be made through improved traffic management techniques and other measures in order to meet up with the rising demand for passenger trip in the city. In Maiduguri, Nigeria, the Dar Al-Handasah Consultants (1981) analysed the pattern of traffic flow in the city. The study recommended regular monitoring of traffic situation, because of the dynamic nature of the city. Ogunjumo (1982) based the study of Trip Generation in Ile-Ife on household survey and disaggregate trip generation techniques. Ogunjumo gathered ten socio-

economic variables namely; number of work trips per day by household, annual income, level of education, household size, distance from home to workplace and vehicle ownership. Ogunjumo correlated these socio-economic parameters with work trips, using multiple regression analysis and discovered a relatively high level of correlation between trip frequencies and three independent variables – household size, workers per household and number of vehicles owned by households. Ogunjumo also discovered a low level of association between trip frequencies and income reduction, distance and travel time but nevertheless acknowledged that the effect of education on household trips which was negatively correlated was not conclusive and recommended further investigation. Though this study was intra – city study, it emphasizes the efficiency of multiple regression analysis method in transport studies. The use of multiple regression analysis method was also chosen for this work. In a related study conducted still in Ile-Ife, Nigeria, Ogunjumo (1986) reported that frequency of urban travel were influenced by the size of household, number of workers in a household and vehicle ownership. The author observed using regression analysis that people with one or more cars had higher rates of travel than non-car owning group. The author submitted that the transport problem in Ile-Ife was that of peak hour problem which required some planning in order to address inadequate network capacity, narrow roads and improved traffic management free of any bottleneck. The pattern of urban trip making in Nigeria was identified by Ogunsanya (1993) to show work, and recreational trips as dominant types of trips undertaken in sub-regions within Nigeria. They accounted for seventy-five percent of total urban trips; ninety-five percent by road using public transport. This explained why congestion and other difficulties of movement were experienced during working days but were absent during holidays and weekends. Daniel (2005) conducted a study on trip generation in Uyo, Capital City of Akwa Ibom State, Nigeria. He generated data from 480 household in 25 randomly selected communities in five demarcated zones within Uyo city. Using multiple regression analysis, the researcher developed models for calculation of future work trips, market trips, health trips, funeral trips, wedding trips and religious trips. Based on the projections, the researcher recommended the dualization of three roads considered to be future major carriage ways for trip makers to various sections of the city. The researcher also recommended decentralization of certain specialized functions from the city center to other zones of the capital city, development of satellite towns at the periphery of the inner city and provision of recreational facilities around the city as control measures to trip generation in the inner city.

This study will contribute to the understanding of the inter-urban interaction in this region of Nigeria. The study will ensure efficiency in providing the needed transport services on the part of the transport operators and also provides a sound basis for transportation related policy decisions on the part of the policy makers. Furthermore, the study will provide an empirical basis for comparing spatial the inter-urban interaction patterns in this part of the world with others.

The Gravity Concept

The gravity model is the basis for understanding inter-urban interaction. The concept says that the expected interaction between any two cities i and j will increase as the product of the population of the two cities (P_i P_j) increases, and it will decrease as the distance between i and j (dij) increases. This is expressed mathematically as follows:

$$IAB = \frac{\text{Population of A x Population of B}}{(\text{Distance between A \& B})^2}$$

This may be expressed as a ratio as follows:

$$Iij = \frac{P_i P_j}{dij^2}$$

where P_i = Population of town a

P_j = Population of town b

dij = Distance between town a & b

Source: Taaffe and Gauthier (1973)

The gravity model, although useful in identifying forces affecting traffic flows has been flawed as ineffective theory of traffic flow (Daniel. 2012). One major reason is that there is seldom a clear behavioral basis for the weights used or the functions fitted. Also, the gravity equation is cross-sectional in nature that is, based on data for a single point in time and therefore has limited predictive utility. A change in transport costs, for example a reduction in the friction of distance will not necessarily have impact on traffic that one would expect from a given equation since the equation was based on cross-sectional comparisons among linkages between cities of different sizes and distances apart. Equations based on previous effects of changes in the friction of distance on traffic over the same route through time would provide a better predictive base, but they would introduce difficulties in separating distance effects from the region wide trends in traffic. For example, a region wide increase in traffic over the same time period might cause traffic increase over a single route, which could then be erroneously attributed to the effects of lowered transport costs over that route (Isard, 1989). Thus, this empirical work would make meaningful contributions towards modifying the model for wider use.

RESEARCH METHODOLOGY

Trip data used in this study were obtained from travel survey conducted in six randomly selected urban centers in the region. Thirty (30) field assistants were trained and used for the survey exercise. The survey was conducted simultaneously in the six urban centers for a week (Mondays to Saturdays), during the hours of 7am – 9am; 12-2pm and 4-6pm each day. These hours were determined as peak hours during the pilot survey conducted prior to the survey proper. It was ensured that the period of the survey was devoid of any local or national festivals and holidays. A total of 1856 copies of pre-coded questionnaire that were properly completed were used in the analysis. The questionnaire was designed such that the needed pieces of information were quickly obtained from all willing travelers as they individually boarded buses and taxis at the motor parks. At each park, there were five field assistants, each targeting buses and taxis loading to the targeted urban centers. Data on socio-economic development factors in the six selected urban centers were obtained from government annual reports, year books, journals, diaries, manuals and maps. Multiple regression analysis technique and chi-square technique as a goodness of fit test were used in the analysis.

FINDINGS AND DISCUSSION

Spatial Variation of Interaction

Table 1 presents the origin and destination matrix obtained from the field survey. It shows the weekly average of all the trips observed in the region during the study. The rows indicate the number of trips generated by the six urban centers, whereas the columns indicate the number of trips attracted to the urban centers. Uyo for example generated the highest number of trip with a total of 564 weekly trips to other urban centers. Ikot Abasi generated the least with 57 trips weekly. On the other hand, a total of 644 weekly trips were attracted by Uyo from other urban centers. This was also the highest regional trip attraction. Oron attracted least with a total of 129 weekly trips from other urban centers. A combination of the total trips generated and attracted by a set of two urban centers became the volume of interaction between them. Fifteen interaction links were established among the six urban centers (see Fig. 2). The volume of interaction between Uyo and Abak for instance was 150 which was the total number of trips generated by Uyo to Abak plus 155 which was the total number of trips attracted by Uyo from Abak. The total volume of interaction between Uyo and Abak was therefore 150 + 155 = 305 (see Table 2). Among the fifteen interaction links, Uyo - Eket link was observed to record the highest volume of trips (325). This represented 17.5% of the total regional volume. Abak - Oron link produced the least volume of trips (08), representing 0.4% of total regional volume. No interaction was observed between Ikot Abasi - Ikot Ekpene and Ikot Abasi - Oron.

Table 1: Spatial variation of interaction

Origin	Destination							
		Uyo	Abak	Ikot Ekpene	Oron	Eket	Ikot Abasi	Weekly Total
	Uyo	-	150	143	60	155	56	364
	Abak	155	-	52	8	72	32	319
	Ikot Ekpene	141	29	-	35	50	28	283
	Oron	143	0	34	-	88	23	288
	Eket	170	53	64	26	-	32	345
	Ikot Abasi	35	2	0	0	20	-	57
	Total	644	234	293	129	385	171	1856

Author's field work (2010)

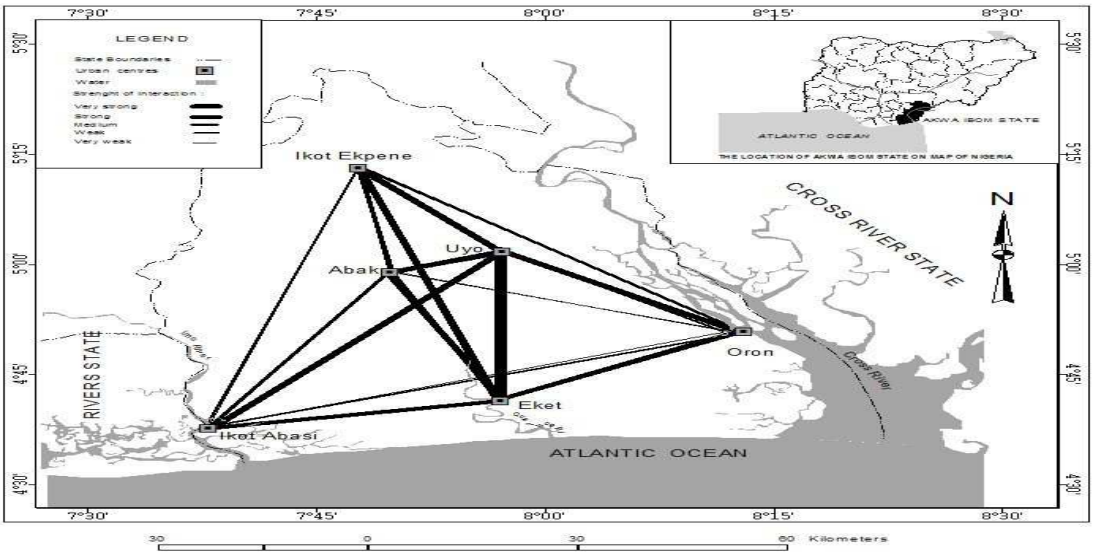

Fig. 2: The Interaction Links and volume among the urban centres

Difference between Observed and Expected Interaction Volumes

Table 2 lists in the fifth column the observed volume of movement among the six selected urban centers in the State. In the sixth column, gravity-model expectations that use a simple (P_i P_j/dij) formula are listed. In order to control the largeness of the gravity model figure, a constant; k = 1/100 was added to the basic model as follows:

$$Iij = \frac{k\ P_i\ P_j}{Dij}$$

where P_i = Population of town a,
P_j = Population of town b, and
dij = Distance between town a and b.

Table 2: Observed interaction volume and gravity concept predicted estimate of the study area

S/N	Urban centers	Distance $(Km)^2$	Popula-tion (AxB)	Y Observed volume (Trip attracted + trip generated)	X Predicted volume $\frac{PiPj}{dij^2}$
1	Uyo – Abak	306.25	2478.00	305	800
2	Uyo – Ikot Ekpene	900.00	6944.30	279	770
3	Uyo – Oron	2,025.00	6596.20	203	325
4	Uyo – Ikot Abasi	10,000.00	2265.60	91	022
5	Uyo - Eket	3,306.25	4956.00	325	150
6	Abak – Ikot Ekpene	756.25	1235.85	82	163
7	Abak – Oron	2,143.69	1173.90	8	055
8	Abak – Ikot Abasi	6,806.25	403.20	34	006
9	Abak – Eket	1,600.00	882.00	125	055
10	Ikot Ekpene – Oron	5,439.06	3289.72	69	060
11	Ikot Ekpene – Ikot Abasi	12,106.00	1129.92	28	010
12	Ikot Ekpene – Eket	4,556.25	2471.70	114	054
13	Oron – Eket	1,806.25	2347.80	114	130
14	Oron – Ikot Abasi	7,225.00	1073.28	23	015
15	Ikot Abasi – Eket	1,806.25	806.40	56	045

Compiled from author's field record (2010)

To determine the difference between the observed volume of interaction and the expected volume of interaction among the urban centers, the Chi-square 'goodness of fit' test was carried out. The formula is as follows: $$X^2 = \frac{\sum (O - E)2}{E}$$

X^2 = 1495.29 was the calculated value, DF = N-1 = 15-1 = 14, the table value of X^2 distribution at v = 14 at 0.05 level of significance was 23. 685. Therefore the calculated value was higher than the table value, this confirmed that there is a significant difference between the observed volume of interaction and the predicted volume of interaction in the region.

Determinants of Inter-urban Interaction

School trips, work trips, trips to visit friends and relations, personal business trips, recreational trips, medical trips, religious trips, burial trips, market trips and wedding trips were observed to be the categories of trips undertaken in the study region. The determinants of interaction in the region were identified to include the following:

(i) number of industries;
(ii) number of tertiary educational institutions;
(iii) number of major markets;
(iv) number of tourism sites;
(v) number of hospitals;
(vi) population size; and

(vii) distance.

Multiple regression analysis was used to measure the separate influence of the individual determinants acting in conjunction with other determinants on the volume of each category. The results are shown in Table 3. The important determinants of the respective trips and their regression coefficients were as follows: **School trips**; Number of institutions (-.880)* and number of tourism sites (-.600) **Work trips**; Number of institutions (.726) and Distance (-.556); **Trips to friends and Relatives**; Number of institutions, No. of markets (.775) and number of tourism sites (-.720) ; **Personal business trips:** Number of markets (.556); Recreation trips = No. of Markets (.714) and No. of tourist sites (-.753); **Medical trips:** Distance (-.508) and Number of tertiary institution (.767); **Religious trips:** No. of markets (.785); **Burial trips**: Number of markets (.723) and number of tourism sites (-.708) ; **Market trips:** Number of tertiary institutions (.848) **Wedding trips:** Number of markets (.857) and Number of tourism sites (.857); **Other trips:** number of markets (.721).

Table 3: Coefficient matrix of trips and socio-economic development factors of urban centers in the region

Trips	Distance	Population	No. of institutions	No. of market	No. of hospital	No. of indus-tries	No. of tourism sites
School trip	-.518	-.179	*-.880	.174	-.245	-.178	* -.600
Work trip	*-.556	-.324	*.726	.081	.161	.347	-.205
Visit to friends	-.112	-.013	*.781	*.775	-.260	-.213	*-.720
Personal bus. trip	-.497	-.148	-.181	*.556	.264	.244	-.316
Recreation trip	.224	-.176	-.167	*.714	.153	.383	*-.753
Medical trip	*-.508	-.356	*.767	-.125	.151	.078	-.390
Religious trip	-.268	-.026	.066	*.785	.209	.059	-.515
Burial trip	-.053	.209	.164	*.723	-.066	-.377	*-.708
Market trip	-.463	-.081	*.848	.358	.014	.245	-.210
Wedding trip	.339	.143	.166	*.857	.024	-.123	*-.454
Other trip	-.039	.090	.013	*.721	.152	-.006	.016
Total trip							

* Significant at 0.05 level of Significance
Compiled from author's field record (2010)

Therefore the determinants of inter – urban interaction in Akwa Ibom State are not just population and distance as postulated by the gravity model, other socio-economic variables such as number of industries, number of tertiary educational institutions, number of major markets, number of tourism sites and number of hospitals also contribute to inter-urban interaction in the region.

CONCLUSION

The study has actually revealed the volume of interaction among the urban centres in Akwa Ibom State and has established that there is a significant difference between the observed volume of interaction and the expected volume of interaction in the region. It has also identified the important determinants of interaction among the urban centres in the region. The study has therefore laid a framework for rational and scientific premise for decisions on the future adjustment and location of new socio-economic activity centres in the region. Policy makers would no longer base their inter-urban transportation decisions on speculations for no decision based on speculations could be considered sound and useful. This study has also provided the basis for comparing the spatial patterns of interaction among urban centers in this part of the world with other regions of the world. However, the continuing transportation planning process requires adequate monitoring and updating the interaction patterns and trips generation relations when sufficient change warrants. Since the interaction patterns provide the linkage between socio-economic development factors and trip, it is important that the relationships established be evaluated periodically for stability and applicability.

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