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THE STRUCTURE OF INTRA-URBAN TRIP FLOWS IN YOLA METROPOLITAN AREA

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ABSTRACT

The study analyzes urban trips in Yola Metropolitan area. The objective was to examine the spatial structure of intra-urban trip flows in the city. Data for the study was mainly obtained through a travel questionnaire administered at household levels and to individuals to elicit their travel activities for a period of 10 days. The factor analytical method was employed in the analysis of the trip data. The results show that land use trip flows in Yola are organized hierarchically when the volume of flows is used as a measure of functional linkage. The residential land use tops the hierarchy of trip flows in the city. The implications of the findings on transport planning in the city are discussed.

KEYWORDS: Spatial, Structure, Intra-urban, Trip, Flows and Landuse.

INTRODUCTION

The structural analysis of intra-urban passenger trip flows has relatively received little or no attention particularly within the context of developing countries like Nigeria. Emphasis has been focused on the analysis of inter-regional or intra-regional structure of freight trip flows. This is typical of the studies conducted by Smith (1970), Onakomaiya (1968), Mabogunje (1974), Ogunsanya (1982), Galtima (2000), e.t.c. One possible explanation for this might be the low volume of passenger trip activities in most urban centers of the country. However, in recent times the increasing scale of urbanization, which has diversified the urban land use structures have resulted in more travel activities being undertaken by the people amidst some difficulties. Thus, the understanding of the structure of passenger trip flows holds significant implications for urban transportation planning. Therefore, the objective in this study is to examine the spatial structure of intra-urban passenger trip flows in Yola metropolitan area.

The Study Area and Methodology

Yola is located in the Northeastern axis of Nigeria (see figure 1). The city was founded in the 1840's during the Fulani Jihad movement into the Upper Benue region. Yola has wielded

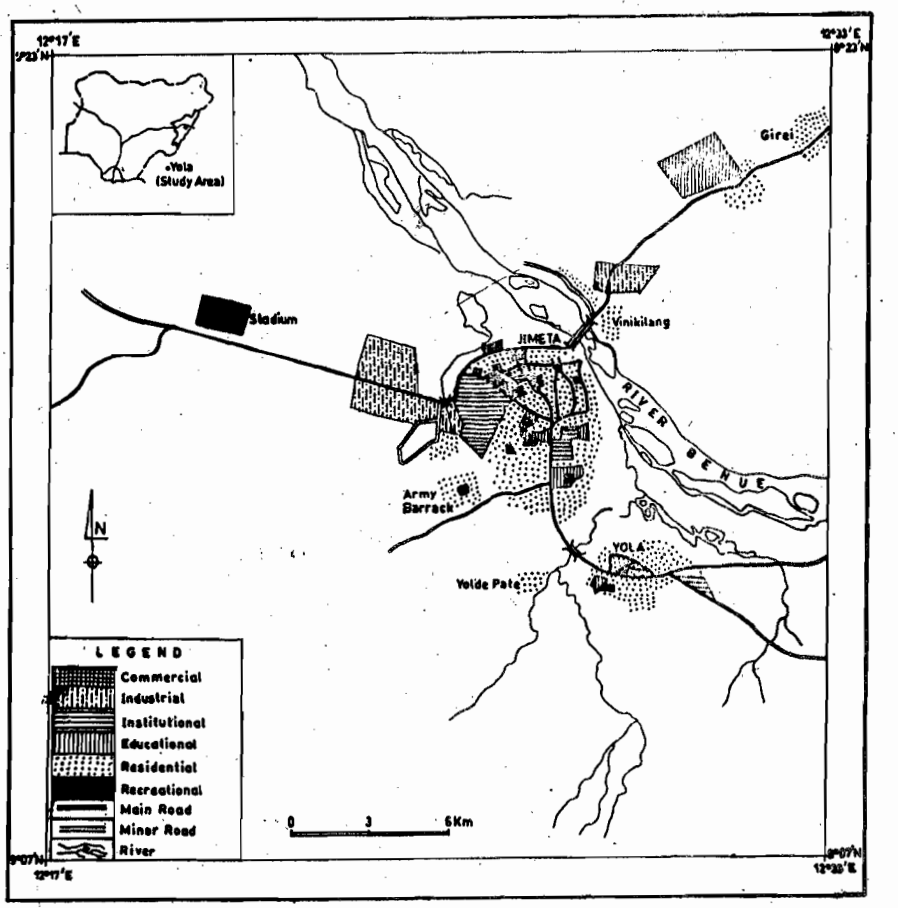

Fig. 1: - Land Use Map of Yola Metropolitan Area.

substantial power influence over many areas including parts of the Northern Cameroon Republic before the advent of the colonial administration in the area. During the British rule, the city served as the headquarters of the Adamawa province. Thereafter, it has played a capital city role to the defunct Gongola State and at present it is the headquarters of the Adamawa state.

The size and the population of Yola have increased tremendously over the years. In 1963, there were about 17,372 people living in the city, and by 1973 this has risen to 46,670 people (Maxlock, 1975). The estimated population of about 200,000 people in 1990 has increased to 230,000 by 1991 (NPC, 1991). Today, the projected population stands at about 320,000 people. Similarly the size of the city has also expanded. It grew from 80sq.km in 1960 to about 200sq.km by 1990. At present the size of the city is about 300sq.km. Thus, Yola can be classified as a medium-size urban centre. Metropolitan Yola has a dual structure - Yola town, which is the traditional seat housing the founders of the Jihad and Jimeta the modern sector, as centre of the European sphere of influence. The State secretariat complex, the central market, the airport, the industrial area and the numerous educational establishments are found in the Jimeta area. The location of the city on the banks of the river Benue has contributed to its growth. The river enabled the city to function as a gateway for inland water transport between Nigeria and the neighbouring Cameroon Republic. The river port at Yola was prominent in the exchange of commodities in the Adamawa region.

These developments hold significant implications in understanding the demand for mobility in the area. The first public transport (the mini-bus service) was introduced into the city by the late 1970's. Today, the public vehicle fleet comprising the motorcycle, the taxi and the bus transit type predominantly account for the intra-urban trip travels in the city.

A comprehensive field survey was conducted to source data on the travel pattern of the people. A travel questionnaire was administered to households and individuals to elicit their tr vel activities for a period of ten days. The details of the type of data required and the collection procedure are similar to that reported in Galtima, (1999). The city was divided into thirty micro-land use areas for the purpose of data collection. In each of the 30 identified land use zones about 20 people were interviewed making a total of 603 people as the sampled population. The first building unit was selected at random and thereafter the others were sampled systematically, 1 in every 50 units as suggested by Bruton, (1985). This approach ensures a wider coverage of trip activities from all parts of the city. However, the thirty land use zones were grouped into six major land use areas for the analysis of the trip data. This was to achieve a macro-land use based transport planning approach, which is consistent with modern practices in metropolitan areas. The principal methods of data analysis employed were the factor analytical technique and the 'principle of dominant association' of Nystuen and Dacey, (1961), which explained the pattern and hierarchy of the inter-relationships between the land use areas in terms of trip flows. The detailed applications of these techniques are found in the text.

Intra-urban Trips in Yola

The pattern of urban travel varies from one city to another. This variation is influenced by the differences in land use activities, the transport system and also the socio-demographic characteristic of the people. The influence of these factors creates the demand for urban mobility. The land use factor has been playing a very crucial role in the travel decision process. Urban travels or trips can be classified into types either on the basis of the purpose of the journey or as a result of the characteristics of the land use origin and destination of the trips. In Yola Metropolitan Area the trips are defined according to Work, Business, Market, Religious, Recreational, School, Shopping, Health Care, Social Visits and 'Others' (trip types, see table I). A broad based categorization like this is done to enable a sufficient understanding of the pattern of travel demand in the city

Table I: Trip Type Categorization in Metropolitan Yola.

TYPE OF TRIP	TOTAL TRIPS	PERCENTAGE %
Work	1007	21.30
Business	574	12.14
Market	466	9.86
Religious	550	11.64
Recreational	192	4.06
School	765	16.18
Shopping	168	3.55
Health-care	126	2.67
Social visits	595	12.59
Others	284	6.01
TOTAL	4727	100.00

Source: Fieldwork, 2000.

In table I, the commuter trips (work and school trips) appeared as the dominant type of trips, which account for 1,772 or 37.48% of the total trips in the city. They imposed a tremendous demand on transport infrastructure facilities in urban areas. The least undertaken trips are the Shopping and Health-care trips, which together accounted for 5.21% of the trips.

The Spatial Pattern of Intra-urban Trip Flows in Yola

Urban trips are found to exhibit some form of regularity in their spatio-temporal dimension. An examination of the structure of urban land use zone trip flows in Yola, as in table II, reveals that the Residential land use zone generates and attracts more trips of all types than any other zone in the city. This is not unexpected as most daily trips in any city begin and end in the residential areas. The Recreational land use has the least number of trip flows accounting for only 53 and 245 trips generated and attracted respectively. The low trip activity for this area is due to the location of minor recreation centers such as school playgrounds that are immersed in the other land use zones. Thus the city's designated recreational area as in the land use map is less patronized. The commercial land use areas

Table II: Intra-Urban Trip Flows (O – D) by Land use Type

	Residential	Recreational	Educational	Institutional	Commercial	Industrial
Residential	2450	160	250	200	300	86
Recreational	53	00	00	00	00	00
Educational	87	31	402	69	90	10
Institutional	300	37	40	705	55	05
Commercial	320	11	30	75	1121	25
Industrial	60	06	10	05	15	144

Source: Fieldwork Data.

especially the Jimeta-Yola market zone is another heavy trip activity center. It serves as the commercial nerve center of the city where large-scale whole and retail sales occur daily.

However, the land use Origin-Destination (O-D) trip table II, does not show easily a clear structural arrangement of trip flows. The similarities and the inter-relationships that exist among the land

uses in terms of trip generation and attraction are heavily embedded. A number of studies have shown how to unravel the orderliness that exists in trip flows, for example Goddard, 1970, Smith, 1970, Kanno, 1976, Ogunsanya, 1982, Galtima, 2001. The factor analytical technique has been extensively used and the results obtained were more reliable than other pattern discerning methods. In this study the factor analysis method is applied to the matrix table II, which contains land use trip Origin and Destination data. The matrix is in the form of 6 x 6 indicating the basic structure of trip flows between the various land use zones.

The R-mode factor analysis that involves an analysis of the column vectors of the matrix was used in identifying the land use areas in terms of trip destination and origin. Thus, the application of the R-mode factor analysis resulted in the extraction of four factors. However, only those relevant factors that have Eigen values of greater than or equal to one are considered as suggested by Kaiser, (1974). Thus, a total of four factors were found to be relevant for the analysis. The four factors together account for 93.10% of the total explained variance. This was obtained through the rotation of the initially extracted factors by the Varimax rotation method. The objective was to refine the loading by assessing the effect of each of the variables on the four factors identified. Hence, new factor loadings and factor scores are obtained from the rotated results, see table III.

The four factors represent the dimensions on which intra-urban trip flow data in Yola may be classified. The factor loadings indicate group of destinations while the derived factor scores show the most prominent source of origin to each group. Each dimension of the factor solution could be interpreted as a trip flow sub-region wherein a group of land use zones exhibit a high degree or similarities in their character of trips. The character of the four factor dimensions is here described.

The first dimension accounts for 32.30% of the total variance with an Eigen value of 1.939. This dimension is characterized by high factor loadings on the Residential, Recreational and Educational land uses. This dimension can be labeled as 'Commuter' zone. An examination of the factor scores also indicated these land uses as the principal source of trip origins. Thus, a strong functional relationship exists within these identified land use areas as major region of trip generation and attraction. The second dimension accounts for 23.2% of the total percentage variance. High factor loading is found on the Residential and Industrial land uses. In addition to these two the Recreational land use serves as zone of trip origin. The three zones exhibit a high degree of intra-zonal trip flows

Table III: Factor Loadings & Scores by Type of Land use

Land Use	FACTOR 1		FACTOR 2		FACTOR 3		FACTOR 4	
	Factor Loadings	Factor scores	Factor Loadings	Factor scores	Factor Loadings	Factor scores	Factor Loadings	Factor scores
Residential	0.685	0.221	0.533	0.249	0.318	0.146	0.238	0.128
Recreational	0.778	0.301	0.457	0.169	0.373	0.177	0.125	0.016
Educational	0.927	0.684	-0.118	-0.358	-0.114	-0.306	-0.071	-0.132
Institutional	0.061	-0.139	-0.091	-0.081	0.960	0.869	-0.038	-0.050
Commercial	0.031	-0.053	0.005	-0.088	-0.030	-0.050	0.990	0.963
Industrial	0.047	-0.200	0.935	0.792	-0.136	-0.124	-0.028	-0.107
Eigen Value	1.939		1.390		1.193		1.059	
Percentage Variance	0.323		0.232		0.199		0.177	

Source: Data Analysis.

In table III, the third (factor) dimension accounts for 19.9% of the total variance and an Eigen value of 1.193. It is characterized by high factor loading (0.960) on the Institutional land use as trip destination zone. Most of the trips come from within the zone and from the Residential, and Recreational land uses whose factor scores are more than 0.1 in value. This dimension could be classified as 'Non-based' trip zone. The fourth dimension explains for 17.7% of the total variance. It has a very high factor loading and scores on the Commercial land use, which indicates that the area is a major zone of trip generation and attraction.

The factor method employed has been useful in grouping the land use areas on the basis of their similarities in the way they generate and attract passenger trips. The method revealed the functionally linked land use zones of trip flows in the city. However, in order to obtain a hierarchical pattern of intra-urban trip flows among the land uses the principle of dominant association by Nystuen and Dacey (1961), as in Ogunsanya, (1982), is applied. The principle is used to identify the underlying pattern in the land use trip flow matrix in Table, IV. This table also indicates the rankings of the city's land use areas, which is determined from the column totals. In order to account for the hierarchical structure from the matrix Table IV, the maximum element in each row area to the column area is determined and underlined. This maximum flow represents the nodal flow.

Table IV: Ranked Origin-Destination (O – D) Trip Flow Matrix by Land use Type

	Residential	Recreational	Educational	Institutional	Commercial	Industrial
Residential	2450	160	250	200	300	86
Recreational	53	00	00	00	00	00
Educational	87	31	402	69	90	10
Institutional	300	37	40	705	55	05
Commercial	320	11	30	75	1121	25
Industrial	60	06	10	05	15	144
Total	3,270	245	732	1,054	1,581	270
Rank	1st	6th	4th	3rd	2nd	5th

Source: Fieldwork Data.

The results show that the Recreational land use is the only zone that send its' largest flow to a larger zone, the Residential land use, while the other five land uses have their largest flows within their zonal areas. Therefore, using the concept of 'independent' and 'sub-ordinate' classification of the principle of dominant association, the Recreational land use area, which sends its' largest flow to a larger area (determined by the rank size) can be regarded as sub-ordinate zone. The land use areas that send their largest flows unto themselves such as the Educational, Institutional, Commercial and Industrial can be regarded as 'independent' areas.

By the transivity and acyclic properties of the principle of dominant association the pattern of intra-urban flows in Yola metropolis as depicted by this matrix Table IV, contains hierarchies. Therefore, it can be stated that the Residential land use is the most dominant in terms of functional links. The second order areas are the Institutional, Educational, Commercial and the Industrial land uses, while the Recreational land use can be classified as minor or satellite center.

Planning Implications

The study has revealed some significant findings that hold strong implications for urban transportation planning in Yola Metropolitan Area. The Residential land use that tops the hierarchical structure of the trip flow zones will require enhanced transport facilities because of its' domineering character. This land use area, which is segregated into high, medium and low class is not adequately served with roads in spite of the high trip volumes associated with it. A number of roads in the city are either not motorable and/or appear like pedestrian thoroughfare, thus making the transport system inefficient. The second order land use zones, will similarly require travel facilities that are commensurate to their trip generation and attraction abilities. Each of the land uses in this category should have specific transport plans that can be integrated into the city's master plan.

CONCLUSION

This work has examined the structure of intra-urban trip flows in Yola metropolitan area. The results indicate that land use trip flows in Yola are organized hierarchically when the volume of flows are used as a measure of functional linkage. On the basis of this it is therefore possible to evolve a land use wise transport plan that is capable of being integrated into the city's overall plan. The Urban planning authorities should prioritize the provision of transport facilities in the form of roads to effectively link the various parts of each land use area as immediate solution to improve intra-zonal mobility. The long-term objectives of the plan should cater for efficient intra-urban trip flows between the diverse areas of the city.

REFERENCES

Goddard, J. B., 1970. Functional Regions within the city center: A study by Factor analysis of taxi flows in central London. Institute of British Geographers 49: 231-242.

Galtima, M., 1999, Disaggregate Trip Pattern in Maiduguri Metropolis. Un-published Ph.D. Thesis, Department of Geography, University of Ilorin, Ilorin-Nigeria.

Galtima, M., 2001, The Structure of Commodity Flows in Northwestern Adamawa Region. Yolde: A Multi-Disciplinary Journal, 3 (1): 4

Hay, A. M. and Smith, R.H.T., 1970. Inter-regional trade and money flows in Nigeria 1964. Oxford University Press, London.

Kaiser, H. F., 1974, Little Jiffy, mark IV Educational and Psychological Measurement, 34: 33-47.

Kanno M., 1976. Canonical analysis of commodity flows and socio-economic structure in major U.S. metropolitan areas. Geographical Review of Japan 49: 146-157.

Mabogunje, A. L., 1974. Interstate state commodity Flow in Nigeria. Planning studies unit, Department of Geography, University of Ibadan.

Montes, C., 1995. Transport and Land-use Planning :the case of British and French Conubations. Journal of Transport Studies , 3(2): 127-141.

Nystuen J. D. and Dacey, M. F., 1961. A graph-theory interpretation of Nodal Regions. Papers of the Regional Science Association 7.(pp84)

Ogunsanya, A. A., 1982. Spatial Pattern of Urban Freight Transport in Lagos Metropolis. Transport Research-A, 16A,(4): 67-79.

Onakomaiya, S. O., 1968. The spatial structure of internal trade in delicacy foodstuffs in Nigeria. Unpublished Ph.D. Thesis, University of Wisconsin, U.S.A.

Smith,R.H.T.,1970, Concepts and methods in commodity analysis. Economic Geography, 46: 57-71.