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PREFACE

The Federal University of Technology, Minna, Niger State, Nigeria has currently among her objectives the promotion of excellence in multidisciplinary research and teaching in pure and applied science, science education, technical education, engineering technology, agricultural technology, health technology, information and communication technology and management technology. In pursuance of these objectives, the great need and significance of an academic Journal of Science and technology that will promote the development and sustenance of science and technological skills, ideas and techniques were recognized. Consequently, the university decided to resuscitate and sustain the former International Nigerian Journal of Technology Research (N.J.T.R). The idea of resuscitation of the journal is also to achieve the university's vision of being a model of efficient delivery of qualitative, functional and sustainable education for F.U.T., graduates, so that they can compete favourably with their mates in the global market economy or be world class or global standard workers, when they graduate.



In this volume, you will get a lot of information in various fields that will promote the teaching and learning of science and technology. I sincerely acknowledge and appreciate the effort of the Editorial Committee that worked hard to resuscitate the journal. It is sincerely hoped that the Nigerian and the world at large.

Professor M.S. Audu
Vice Chancellor

EDITORIAL

Universities especially university of technology are concerned with the teaching, research, discovering and developing new skills and techniques of manufacturing and fabricating equipments for teaching, learning and industrial development. It is very important the knowledge about these new skills, discoveries and techniques be shared among colleagues in other universities in Nigeria and in other universities all over the world.

This is the reason detre, the resuscitation of the Nigerian Journal of Technological Research was a very laudable venture that will act as a medium for achieving this laudable objective. In pursuance of these objectives the journal encourages scholarly articles that are empirical, practical, theoretical or clinically oriented in science, science education and technological disciplines to promote and sustain teaching and research skills in science education and technology by providing quality information in various areas of innovations in the teaching and learning of science and technology.

This issue covered these major areas in science education and technology such as:

- Land Resources Management
- Evaluation of Aquifer Characteristics
- Use of Advance Organizers for text visualization
- Mathematical Model for Human Standard of living determination

These articles will be of immense help to lecturers, students and the general reader. It will be a good inclusion to any institution library and private library.

The editorial committee remain immensely grateful to all scholars, who have contributed to this special resuscitation volume. We commend them for their contribution. We appeal to them to keep writing and contributing to the growing body of knowledge, so that their foot prints will be left in the sand of time, as they will still be speaking thousands of years after depature, like ShakeSpear, Einstein etc., Thank you very much, we are grateful and appreciate all of you.

Finally, it is important to note, however, that the views, findings and ideas in the articules remain the author's responsibility, while the editorial committee is responsible for the quality of the articles.

Prof. I. N. Mogbo
Editor-in-Chief

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Intra-City Passengers' Bus Stop Locations: Principles And Guidelines For Planning An Efficient Intra-City Mobility System In Minna, Niger State, Nigeria

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Abstract

The study focuses at planning for intra-city passengers' bus stops location points on the routes plying by the taxi in Minna Metropolis as to meet the rising intra-city transportation problems in the city. Related literatures were consulted as the secondary source of the data collection, to establish the need for organized bus-stops as being the usual practice in some cities in Nigeria; these scholarly views formed the platform for the necessity of this study in the city of Minna. So also, the primary data used in this study involves a detailed survey around the metropolitan area of Minna. Information was collected through the aid of questionnaire, oral interview and observations. Findings from this study revealed that the taxi - cab, government buses, and few private buses are the mode of commercial public transport system in the city and these transportation system have their designated routes of operations, also there were routes and areas in the metropolitan which are not served by these system of transportation, the study carried out shows that though there were designated locations for bus stops in the city, the commuters were left on taken decision on where to board vehicle and where to alight as they wishes. Due to the shortcomings in the arrangement and planning of transit facilities in MinnaP metropolitan area, this study however made provision for proper location and planning of bus stops along the routes servicing intra-city transit need in the city to adequately meet the expectations of the both the passengers and the drivers alike, and also be a source revenue to the government.

Keywords: transportation, planning, bus-stops, metropolis, intra-city and routes

Introduction

Transportation plays an important role in the development and growth of any settlement; it is the framework from which cities are built. Down the memory lane on the advent and breakthrough in the transportation technology, it is note worthy that the range and speed of available transportation modes had significant effects on urban form. The transit age produced denser, compact urban areas that still in common in most of the core of the cities. The use of automobile highways system has made provision for urban travelers to move without any range of constraint and this thus allows growing to occur with less restriction than before.

The influence of transportation system in urban planning is enormous with respect to location of residence, the provision of goods and services for consumption and even on the quality of life of the urban residence.

However, the development of any settlement is correlated with the introduction of new or improved transportation facilities and technology. Transportation system has been firmly agreed to be the lifeline of people and it connects both the urban and rural areas, while considering the effects on metropolitan cities, the practice of public transport caters for the need of all the sections of the society irrespective the social and economic status.

Intra- city transportation system in the developing countries is pre-occupied with different types mode and forms of systems and facilities, for instance; the development of fast railway system for intra-city movement, the use of commuter bus or taxi system, the introduction of bus lanes, bus priorities, putting in place bus stops, terminals and depots. All these lead to efficiency and effectiveness of intra-city

passengers' transportation systems. The reduction in the problems facing peoples' movement within their city had been made possible through an increase in the technological development which later improved the mode of transportation.

In Nigeria, there are different mode of transportation system in operation such as; water way system, railway system, airways system and road system. The most commonly pronounced mode for intra-city transportation system in Nigeria is road system. There are quite numbers of facility which could aid the smooth running of intra-city transport system, this include; provision for bus stop location and shelter, bus terminals bus deposits, garage and shops, rolling stocks (bus maintenance and emergency vehicles), road improvement for priority, bus lane and fare collection equipment office buildings.

Minna city is one among many cities in Nigeria witnessing rapid urbanization as a result or its proximity to the Federal Capital Territory. Minna benefitted from a well structured road that runs through the city diagonally, from the North to the South and East to the West. This road structure gives a unique pattern to the city in pattern of oval shape. However the road advantages of the city still lack some basic infrastructure to complement the user's value. The debating factor is on are towards the attitude of the road users in compliance to the rules in the use of these facilities.

This study is meant to prepare the spatial guidelines for locating bus-stop points in Minna with the view of developing an efficient intra-city mobility system for the city. The objectives of this study includes; to examine the major distributive routes plying by these public commercial transportation system in the city, to assess the factors responsible for these pattern of distributive routes, to identify and examine if there are certified intra-city bus-stops on these distributive routes, to prepare the framework on where bus stops will be located and plan for its development, if the need arises.

Study Area

Minna in the total expanse of land coverage lies in between the latitude $9^{\circ}92'$ - $9^{\circ}100'$ North and longitude $6^{\circ}30'$ - $6^{\circ}35'$ East. The area spans from Tundun- Fulani in the Northwest to Chanchaga in the South. In distance to other major towns and cities; it is about 135km away from the Federal Capital Territory, 86km to Bida, 110km away from Suleja and about 150 km to Kotangora. Minna is the administrative headquarters of Niger State and the State shared boundary with six different States of the Federation namely; Kebbi, Zamfara, Kaduna, the Federal Capital Territory (FCT) Abuja, Kogi, Kwara and international country with Republic of Benin toward the west. The city Minna derived it name from the traditional festival performed by the "Gbayi" who are the indigenous dwellers of the settlement. Now, Minna serves the purpose being the administrative headquarters to the State.

Intra-City Passengers' Bus Stop Locations: Principles And Guidelines For Planning An Efficient Intra-City Mobility System In Minna, Niger State, Nigeria

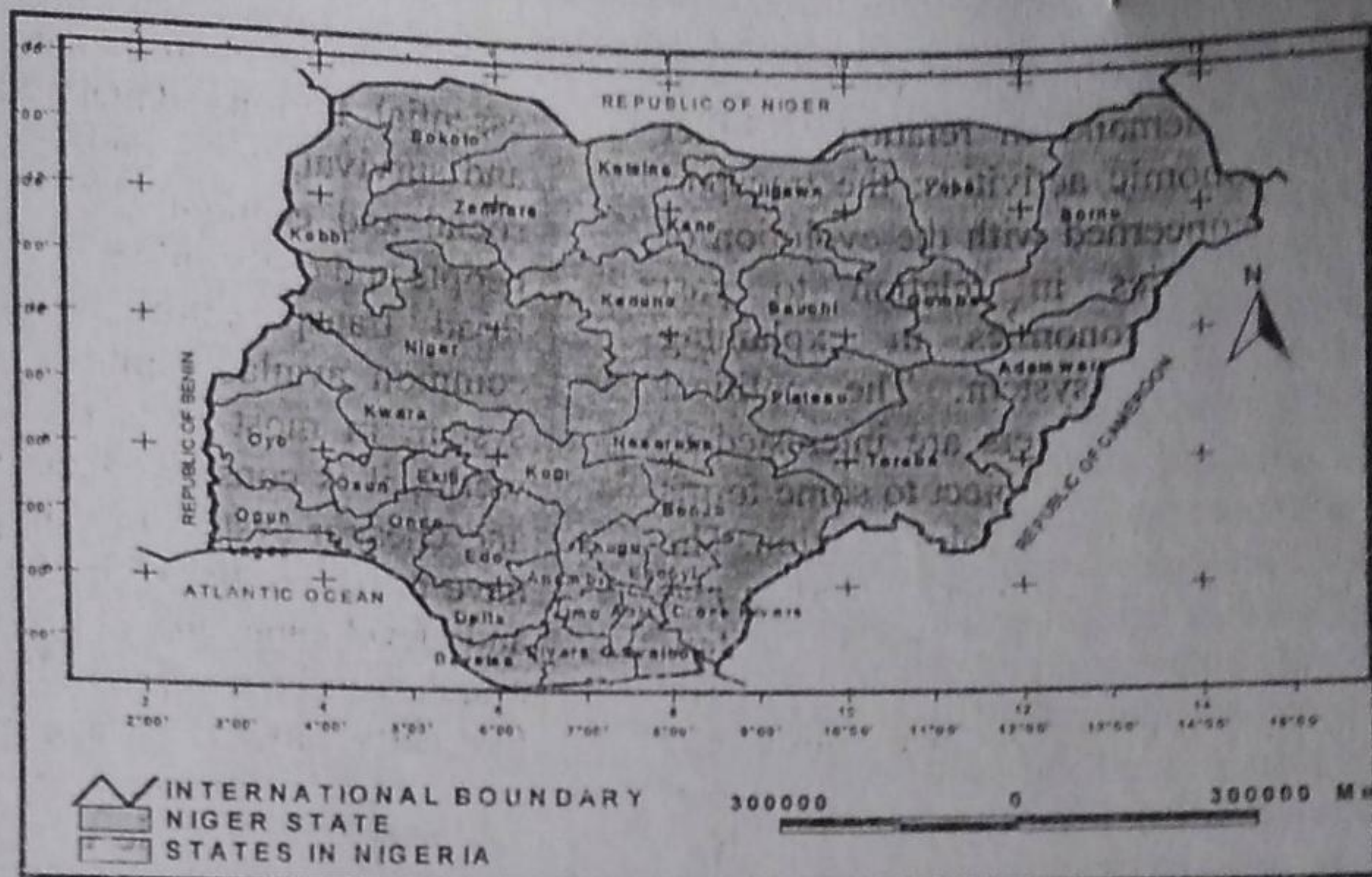


Fig. 1 Map of Nigeria Showing Niger State

The historical development of the city is traceable to the improved transportation system in Nigeria in the late 18th Century. Minna started developing during the era of railway construction in 1905; the town got expanded when the government inaugurated the judiciary body through the appointment of a chief judge (alkali), and later when the construction of prison took place. Due to these the economic and political strength, the focus shifted to the town and thereby gave birth to the movement of the indigenous settlers from the uphill in Paidia area along present Maitunbi to the central area of the city know as Mobil and the movement of non indigene to the city when the locomotive railway engine entered the city in 1910 and 1911. In 1924, the colonial governments choose Minna as district headquarters, and this action caused further expansion of the town. In 1957 as the colonial administrator created Minna emirate with an emir as its traditional head. After the independent of the country, in 1976 through the government declaration on local government reformed, Minna became the state capital and administrative headquarters of the newly created Niger State.

The expansion of the Minna was further enhanced when the seat of Federal Government was moved from Lagos to Abuja in 1992; this

action however changed the landscape of the town. Since then, there have been increases in residential buildings, viability and expansion of the commercial activities in the city and expansion of the city from the core to the suburb area. The network pattern of the city runs from Chanchaga and passes through the heart of the town to Tundun-Fulani the North-West of the city, the city also have a two banded network system known as the Western and Eastern Bye Pass and the regional road which runs from Bida axis through the heart of the town to Sarki-Power/Kaduna road axis. The intra-city and terminal system of transportation could be given in form of radial concept, with Mobil area serving as the focal point where commuters set out to other routes of operation.

Literature Review

Transportation, because of its multi-disciplinary nature defies any rigid definition. It is a subject of interest to the engineer, the economist, the sociologist, the political scientist, the historian, the geographer, and the urban and regional planner, each of them with there own perspective. Transport engineers are concerned with the design, construction and maintenance of vehicles, infrastructure and facilities; transport economists deal with the

analysis of transport demand and the cost of meeting this demand in relation to other forms of economic activities; the transport historian is concerned with the evolution of transport facilities in relation to past societies and economies in explaining modern transport system. The political scientists and the lawyers are interested in transport because it is subject to some forms of political control and legal regulation. The viewpoint of the geographer and urban and regional planner in transport is spatial. Distance and location are basic to the understanding of spatial distribution and interrelationship of phenomena. Transport is a measure of the relations between these spatially located phenomena (Ogunsanya 2002).

Simply on Ogunsanya view, transportation was defined as a process that involves the movement of people, goods and services from one giving point of origin to specific destination. It is considered as an integral part of urban centre, it is the medium for spatial interaction within which all the parts of the city is linked. Due to the growth of the cities, the effectiveness of transportation system is subject to the proper planning and provision of necessary facility to meet the expected purpose, transportation however involve planning.

Of a truth, transportation plays vital roles in both social and economic aspect of the city as well as the people. The derived importance is what many considered beyond the singular purpose as a medium for movement and spatial interaction; in such that it benefits is seen to influences the development of economic, industrial and cultural growth of any country at large. This submission is what Ogunsanya 2002, tagged as the maker and breakers of cities. With respect to the impact on the development of the early cities and the intending force for the future expansion of our cities, it has the tendency of divergence of linkages to different parts of the cities. This simply

implies that, a good transportation system is essential for city development, sustenance and survival, with significant effects on the social and economic characteristics of the people and of the urban in general.

Road transportation as been the most common available intra-city transportation system in most parts of the cities of the world; it is considered the most affordable and cheaper system of transportation which have the capability of linking the developed and developing areas. Road transportation system can be used by all such of vehicles like carts cartage, cycles, motor cars, bus, trucks, lorries, at the same time they are being used by the pedestrians. This system is the pattern that offers itself for the service of the whole community and the system of its operations within the city is referred to as intra-city transportation system.

The need for bus stop for intra-city mobility cannot be underestimated, with the sense of orderliness it gives to the movement of people and freight on the road, social benefits to the people, the aesthetics value on the city, and its immense contributions to revenue generation, to mention but a few. A bus stop is a designated point or place where buses or taxi used for commercial transportation stops for passengers to board or alight. Planning and design of bus stoop at any location is a crucial element as the drive improves the quality of service delivery by these buses and any other mode of transportation.

The idea of bus stop in the city creates convenience and comfort to all the commuters; therefore, it is a necessity to be properly plan to meet its optimum benefits. Bus stops should be seen as busy locations that require proper planning and guidelines for development, starting from identification of suitable locations along metropolitan routes and construction of shelters on these points. The shelter for bus stop vary in sizes depends on some notable factors such like type of land use in the area where the bus

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stop is located and the available space at the corridor of the road.

The envisaging problems regarding planning, design and development of bus stop is in relation bus stop spacing. Bus stop though simple in concept, but has generated a quite number of controversy which has to do with the numbers of allowable bus stops along a particular length of route. The basis of the argument is subjected to the inherent trade-off that exist between bus stop location, in such that the fewer the bus stop along any routes, the higher the average access cost to the commuters, as the transporters will bear the shortage in their monetary returns. Also it is applicable to the route with longer distance which will yield returns to the operators of the buses. The standard adopted varies from country to country, the formulated range of some developed countries prescribed the minimum and the maximum spacing; Germany: 250m -600m; Britain: 300m - 500m and USA: 120m-800m.

Methodology

The sources of data for this research work involve both the secondary and primary data. The sets of secondary data used include the records and reports from the Ministry of Transport Minna and the information from the National Union of Road Transport Workers (NURTW), the texts, articles from journals and internet materials. The primary source of data includes the data collected direct from the field; this was done through the survey, oral interview and the administration of

questionnaire to both the drivers and the passengers. In this study, 100 questionnaires were randomly distributed to the taxi drivers that were registered with the unions and plying in Minna.

Discussion of Results

The Major Distributive Routes

The public commercial transportation mode for intra-city movement in Minna comprises of the taxi cab which are commonly available in all the routes within the city, the government owned public bus popularly called "the Talba Bus" only frequent on the major arterial road (Chanchaga - Mobil - Maikunkele) in the city and quite number of buses who majorly confined toward a route (Mobil - Dusken Kura Gwari). The distributives routes for these public transportation systems are limited to the road network which passes through the city and the few that link the neighbourhood areas. Some notable routes and the approximate distance from the city centre (Mobil) the heart of the city are given as follows; Mobil - Chanchaga: 13.5km, Mobil - Kpakungun: 5.3km, Mobil (Sabon gari) - Maitunbi: 6.5km, Mobil - Bosso Estate: 8.3km, Mobil - Suaka Kahuta: 4.2km, Mobil - Bosso/Maikunkele: 6.7km/21km and Mobil - Duksen Kura Gwari: 4.7km. From these findings, Mobil is the central and nodal point that distributes to other parts of the city; this implies that the concept of the city shows that it is radial, with Mobil terminal as the focus and other roads as tributaries. Fig.2 however, shows the distributive routes for the commercial taxis and other few buses servicing the city.



Fig. 2; Minna Street Guide Map Showing the Taxi Routes.

Factors Responsible for the Distributive Pattern

Concerning the factors responsible for this distributive pattern of intra city mobility, the finding from the study has attributed the factors to the land form and the land use pattern in relation to system for development as allowed by the government.

The response from the driver plying these routes on why they neglect some routes was subject to the low number of passengers along the routes, which may not be in favour of the expected monetary delivery for the day; this was the subscription of 95% of the respondents. The implication of this system on intra-city movement is that some parts of the city may not be connected with public commercial transportation be it the private or government own vehicles and the area or the neighbourhood become a subject to the

mercy of the motor-cycle rider known as "Okada operators".

Availability of Bus Stops along the Distributive Routes and Level of Compliance

The study to ascertain the concerted effort of the government on the provision of the bus stop location and facilities was carried out, the finding revealed the provision and steps taken by the government demarcating points and placing a sign posts as bus stop. These locations also follow the same routes pattern plying by the commercial vehicles, implies that the routes that were not served initially are still left out in provision of where the passengers will board or alight from a vehicle. Regarding the bus stop infrastructure (shelter) at these location points; the finding shows that nothing was found to serve as shelter at all the locations earmarked as bus stop.

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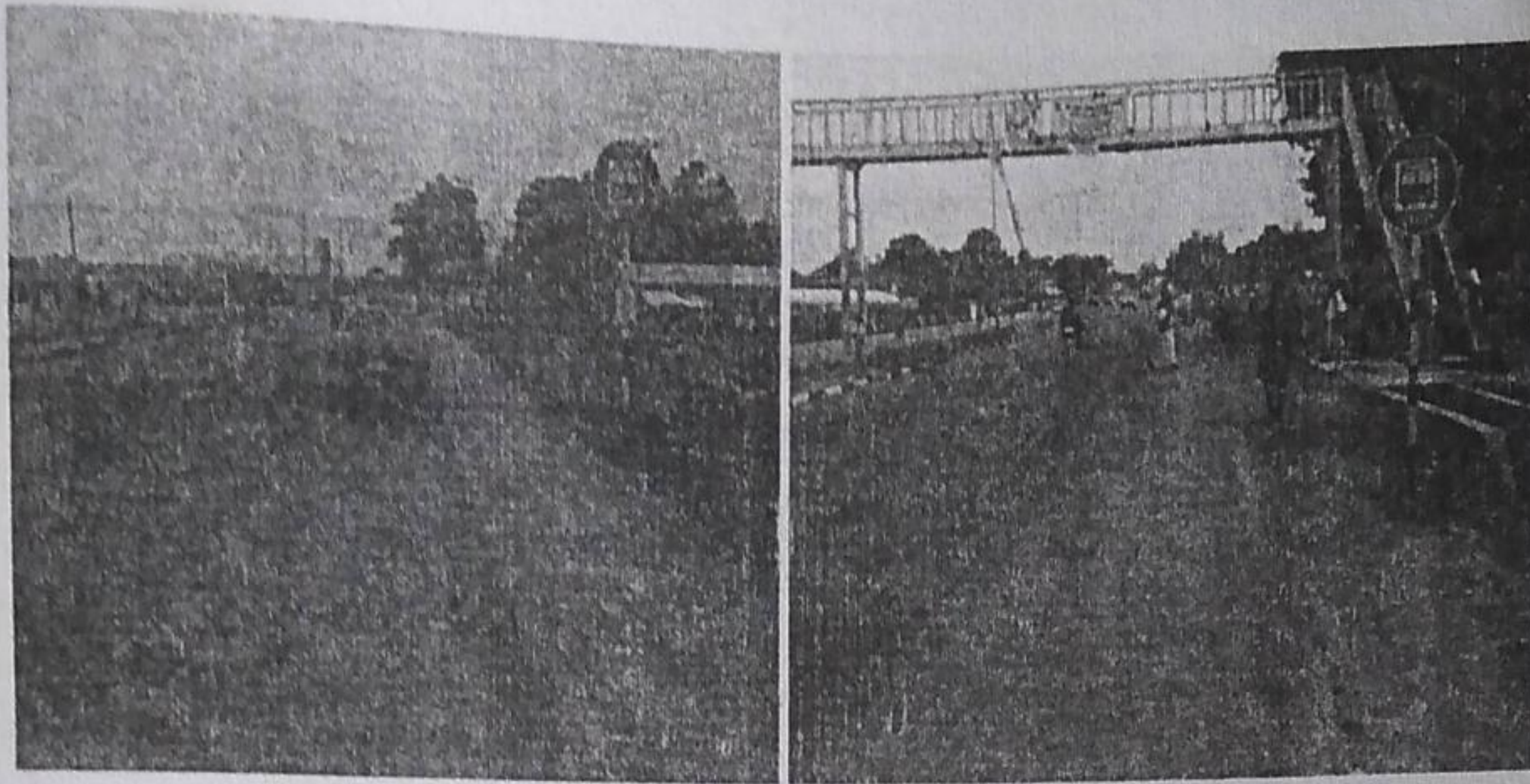


Plate 1. The bus stops location demarcation and Sign Post for bus stop.

This study also notified a dilapidated bus stop shelter along government road which formally was being used as a sample for what government is intending doing, the one located at Niger State College of Education

gate built by a rotary organization but poor in aesthetic and form and the two shelters located at Mobil the city centre, built by government and still in a good condition



Plate 2. The bus stop located at Mobil Central Area.

The survey carried out on level of compliance by the taxi drivers, 100% of the respondents acknowledged the presence while 80% of them agreed not to be in compliance with the use except the one

located at Mobil central area. 100% of the drivers for the government owned buses fully complied with the use of the bus stops for passengers to board and alight.



Plate.3 Mobil Central Area Bus stop with the Government Public Bus

Strategy for Sitting Bus Stop Locations

Planning for bus stops system in urban intra-city transit requires the understanding of the framework and guidelines in bus stop planning, taken into consideration the information relevant to bus stop placing, that is the place where the bus stops are to be located, the design of bus stops and development. All these require different stages and the contents are given as follows:

Development of Bus Stop Policies and Procedures:

Policy development establishes a systematic process for the purpose of sitting of bus stops. The policy specifies the processes for making these decisions, and sets the process for developing transit plans and for the review of projects that may affect transit operations. This policy and procedure also ensures that the bus stops receive the proper assessment and technical review before they are established.

Placement of Bus Stops: The proper location of stops is critical to the safety of passengers and motorists, and to the proper operation of the transit system. It is important to consider the unique circumstances at each intersection when selecting bus stop locations, bus stop location should take into consideration a

number of factors including: spacing along the route, location of the expected passenger traffic generator, either based on population density and/or specific use (i.e. major employment centers, regional shopping centers, hospitals, etc.), for the stop, traffic safety, pedestrian safety and access to stop, pathways leading to and from bus stop areas should be level, have a firm surface, and be free of obstacles, availability of adequate right-of-way to ensure that the bus stop meets the accessibility standards for the disables, curb clearance – adequate space for buses to stop, and return to the traffic flow, operational effectiveness issues (including relation to the nearest intersection, bus turning requirements, and re-entering the travel lane).

Minimum Bus Stop Elements: - this is to give the minimum characteristics needed in order for a bus stop to be functional for buses and for taxi cabs use to meet the purpose of the people especially those that are disables. The considerable elements include:

- a. The landing area where the bus stop sites shall be chosen to meet the maximum extent practicable, lifts or ramps deployed on a firm, stable surface as to permit a wheelchair or

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mobility aid user to maneuver safely onto or off the bus and bus stop.

- b. Slope: The slope of the landing area must be parallel to the slope of the roadway in order for the bus wheelchair lift or ramp to be effectively deployed. The slope should not exceed 1 foot vertical over 20 feet horizontal (5%), and the cross slope should not exceed 1 foot vertical over 50 feet horizontal (2%).

Passengers' Amenities at Bus Stops: This is the features that enhance the attractiveness in the city. The design of bus stop waiting areas and provision of amenities that enhance security and comfort plays a significant role in a person's decision to use transit. Passenger amenities are installed at selected bus stops to improve passenger comfort and the relative attractiveness of transit as a transportation alternative. Selection of bus stops at which to install amenities takes into account a number of factors, including: average daily boarding, proximity to major trip generators, passenger transfer activity, planned neighborhood improvements, transit corridor marketing efforts, equity among communities in the County, proximity of other nearby sheltered areas, and customer and community requests. Other important amenities needed includes; installation of transit shelter at some selected bus stops, the provision of benches at these shelters and placing of lighting facilities at the bus top shelter.

The Design Parameters: - this is the detail geometric guidelines for design of bus stop which ranges from the bus turnout in respect to placing of signal at the appropriate place. Signals are place at intersections will allows the buses to have access of re-entering into the roads. Apart from this, the criteria for bus shelter is given in regards to the points where the bus stop are to be, necessary precaution includes to avoid block sight

distances and provision of accessories. The importance of bus stop sign is to provide specific information along the routes as well for the general public.

Planning for bus stop in Minna has become a necessity for efficient intra-city transit operation taken into considerations the findings from the survey carried out in the city regarding the condition of the city road network; 12.3% of the respondents admitted the road to be in good condition, 64% agreed that the condition of the road is fair, while 23.7% admitted to be poor. In lieu of need for provision of bus stop in around the major roads in the city, 90% of the respondents embraced the introduction of bus stops in the intra-city transit system in Minna, as these respondents agreed with the fact that there were various alighting points despites the non designation or declaration of any point as bus stop, therefore lead to on-street parking during the boarding and alighting of passengers.

For bus stop location and spacing in Minna, the land use of the area is the major factor combine with the spacing. In this city with regards to the structure of the city and the pattern of land use with could be expressed as dispersed in nature, 300m – 500m is adequately better for the space in between two bus stop location. So also, the common areas for passengers alighting were observed and incorporated into the spacing plan.

However, using GPS for spacing interval and acknowledging the frequent points where people board and alight from commercial vehicles, total numbers of 208 bus stops are require in all, for these identified routes to be use by all the mode of transportation in Minna. The number of bus stops per each routes are given as follows: Mobil – Bosso/ TundunFulani (36), Mobil – Maitunbi (20), Mobil – Kpakungun (26), Mobil – Sauke Kahuta (34), Mobil – Okada Road/ Bosso Estate (34), Mobil – Duksen Kura Gwari (12), Mobil - Chanchaga (50).

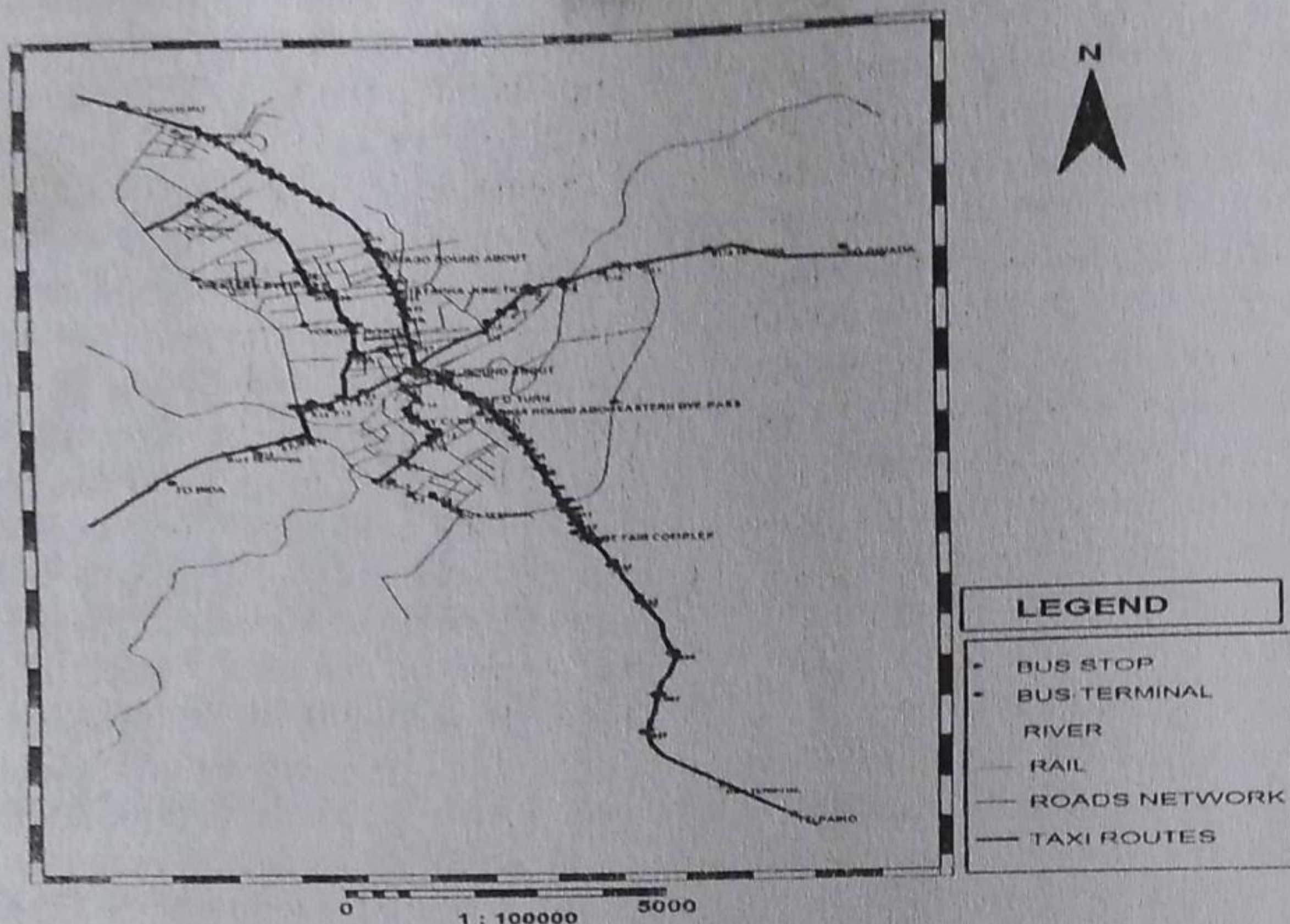


Fig3. The Proposed Designated Location for Bus stop in Minna.

Fig.3 showing the referenced points for the bus stops location along the routes for commercial intra-city transit system in Minna. To develop the shelter for these bus stops, a lay bye of 2m-12m may be required by the road side, to some places that the space or set back or reserves road. The shelter may have the dimension of 2m by 3m by 2.8m, to consist of sitting area with and outside the shelter. Alternatively, where development of shelter seems not possible, bus stops can still be located using the sign post and with notification sign be erected as approaching the bus stop at about 30m.

Recommendations and Conclusion

The planning for bus stops location in the city like Minna provides not only beauty to the city but free movement of people and goods, with therefore makes life easy for the people. The following recommendations are important for the development of bus stops in Minna.

- i. The transportation plans and policies are to be developed for

- ii. Government to be more committed to provision of transportation infrastructure in the State capital.
- iii. Public enlightenment programmes be organized by the government on the need and compliance in Minna.
- iv. The public commercial transportation organizations and unions are to be carried along in all facet of planning for bus stops in the city of Minna.
- v. The developed shelters should accommodate advertisement for revenue generation
- vi. Enforcement of traffic regulations by taken serious by the government agencies.

As transportation is essential to functioning of any city, being the maker and breaker of cities, the planning is a serious task for all stakeholders; the government, the transport

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experts, private sector and entire masses to see to the development of it not only on inter-city relationship but on the relevance in developing intra-city transit. As much as the intra-city bus transit is important to the nation, the provision of necessary facilities should be taken lightly. A great deal of emphases of Niger State Government and the State Ministry of Transportation should place on location of bus stops points, placing of traffic signs and construction of bus shelters for efficient and aesthetic pleasing environment.

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