THE ROLE, EFFICIENCY AND QUALITY OF SERVICE OF THE MATATU MODE OF PUBLIC TRANSPORT IN NAIROBI, KENYA: A GEOGRAPHICAL ANALYSIS.

By

ISAIAH GIBSON ADUWO

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DECLARATION.

This Thesis is my original work and has not been presented for a degree in any other university.

Isaiah Gibson Aduwo.

This Thesis has been presented for examination with my approval as the appointed University Supervisor.

Dr. R. A. OBUDHO.

DEDICATION.

This work is dedicated to my parents, Mr.and Mrs. U. B. ADUWO from whom I am indebted for having provided both the moral and financial support during the course of my studies.

ACKNOWLEDGEMENT.

This is to acknowledge the assistance I received from various sources during the course of my Post-Graduate studies. First and foremost, I am indepted to the Department of Geography, University of Nairobi for having granted me the chance to pursue this course together with my sponsors, the German Academic Exchange Centre (DAAD). I also wish to aknowledge the assistance which I got from my Supervisor Dr. R. A. Obudho through whose guidance I was able to grasp all the theoritical concepts in Urban Geography. His guidance in the process of writting this thesis is also appreciated as well as those of all my colleagues with whom we shared lively academic discussions relevant to this research as well as all the respondents who were a source of most of the data used in this study. I need not forget to mention and thank those who assisted me in the process of data collection, especially my Research Assistants, Mr. G. Opondo and Mr. P. Apindi as well as Mr. Kinyanjui of the Matatu Vehicle Owners Association who provided me with data on various aspects of the matatu operations. Last but not least I am also indebted to my wife Kevin and son Bob for their encouragement and patience during the time I was pursuing the M.A. course

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LIST OF ABBREVIATIONS.

CBD	Central Business District.
CBS	Central Bureau of Statistics.
DFPRD	District Focus Policy for Rural Development.
GOK	Government of Kenya.
GDP	Gross Domestic Product.
HMSO	His Majesty Stationery Office.
JKIA	Jomo Kenyatta International Airport.
KANU	Kenya African National Union.
KBSL	Kenya Bus Service Limited.
KUTP	Kenya Urban Transport Project.
LDCs	Less Developed Countries.
LSHS	Labh Singh Harnam Singh.
MAK	Matatu Association of Kenya.
MDCs	More Developed Countries.
MCN	Municipality of Nairobi.
MVOA	Matatu Vehicle Owners Association.
NBS	Nyayo Bus Service.
NCC	Nairobi City Commission/Council.
NCTU	Nairobi City Transportation Unit.
NNP	Nairobi National Park.
NTB	Nairobi Town Bus.
NUSG	Nairobi Urban Study Group.
NYS	National Youth Services.
PSV	Public Service Vehicle.

RCS	Railway Commuter Services.
UNCHS	United Nations Centre for Human Settlements.(Habitat)
UNEP	United Nations Environmental Programme.
WBMAS	World Bank Matatu Assistance Scheme.

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ABSTRACT.

This study is specifically concerned with an intermediate mode of public transport (or para-transit), a phenomenon which is prevalent not only in the form of the matatus in Nairobi but also in other urban centres of Less Developed Countries (LDC's) in slightly different forms. These have emerged basically in response to the generally low standards of living and the high population densities prevailing in most of these urban centres. They play a significant role in providing a much needed service to a wide cross-section of the population. Past and present experience concerning these forms of transport have shown that if they are properly regulated, they can play an even more important role in meeting the mobility needs of the urban population, reducing the need for unprofitable conventional public transport services, increasing the options available for the travelling public, and increasing income and employment generating activities for the low income in urban areas. This study looks at the matatu mode of public transport in Nairobi within the same context.

It is based on the notion that there is no single answer to the most appropriate mode of public transport in Nairobi. Instead, due to the limits of available financial resources and the limited executing capability of the government and city authorities, the best option available for urban public transport

in Nairobi should be that of conservation of the existing systems and their improvement through incremental changes. Hence the matatu mode of transport in Nairobi should not be banned in view of its current role. This study attempts to measure the matatu system's general role, its efficiency and quality of service especially as relates to their generation of employment and incomes for the low income, the proportion of commuters who use them and the reasons why they do so despite the inherent dangers associated with their operations. In doing this the study first identifies the factors which influence the distribution of their services in Nairobi area and notes that there is a strong functional relationship between the distribution of their services and that of population distribution. The strength of this relationship is measured using correlation and regression techniques which are also used to show the nature and strength of the relationship between the distribution of matatu services and other factors such as the distances covered per trip, the profitability levels, and the income levels of the population. The strength of the relationship between the distribution of matatu services and population distribution provides a strong indication of the important role which they play in offering a complimentary service especially in areas of high public transport demand. They have continuously emerged and offer their services mainly in the predominantly densely populated low income zones in Nairobi. They could play an even more important role in increasing the future accessibility and mobility needs of the

city's low income residents who are continuously acquiring residence in the suburbs.

The study then looks at some of the factors which influence public transport modal choice in Nairobi with a view to identifying the positive quality attributes of the matatus. On the basis of a Stated Preference (SP) study of a sample of commuters it is noted that due to the excessively high demand for public transport services in Nairobi, the commuters tend to choose and use the mode of public transport that is most frequently available. It is because of this that matatus are mostly used. However, a closer analysis of the stated preference using Thurstone's Law of Comparative Judgement Case V procedures reveals that the factors comfort and speed or time taken are also highly valued while there is little concern for factors such as cost, reliability and safety. But it is possible to discern differences in the respondents' ranking of the choice factors which is attributed to general socio-economic factors such as the level of income, the distances covered per trip, and the level of public transport demand. The factor cost, for example has a relatively higher preference ratings amongst the predominantly low income residents, while the importance of the factor speed or time taken depends on the distances covered per trip.

On the basis of these findings, this study makes various suggestions concerning the future of Nairobi's public transport

system and the future role of matatus. It notes that some of the positive quality attributes of matatus such as their flexibility, speed and frequency of service should be taken into consideration in planning for their future role. The past planning responses are also analyzed with a view to showing how they have been implemented and the practical difficulties.

CHAPTER ONE.

INTRODUCTION.

This study concerns itself with an intermediate form of public transport or paratransit; a phenomenon which is prevalent not only in form of the matatus in Nairobi but also in other urban centres LDCs in slightly different forms. Past and present experience concerning such forms of public transport show that if they are properly promoted and sensibly regulated, they can play an even more important role in meeting mobility needs by reducing the need for unprofitable conventional public transport services, increasing the options available to the travelling public, and increasing income and employment generating activities for the low income (Kirby,1976). This study looks at the matatu mode of public transport in Nairobi in more or less the same context.

It is based on the notion that there is no single answer to the question of the most appropriate mode of public transport in urban areas. Instead due to the limits of available financial resources, the best options available for urban public transport in the LDCs may often be that of conservation of the existing systems and their improvements through incremental changes. Hence the matatu system in Nairobi should not be banned in view of its productivity, efficiency, and quality of services.

This chapter begins by giving a brief description of the study area, its historical and geographical background, and the present land use and population growth patterns. The city's current public transport system is seen as one which has emerged and has been shaped by the population pressures, urban structures, and the general transport system prevailing in the city. The second section looks at the research problems stating it briefly before stating the study objectives and the hypotheses to be tested. The third section reviews existing literature and the practical measures which have been taken to solve the city's public transport problems. It first reviews existing literature on public transport systems showing how irrelevant western perceptions and notions have been used in the LDCs before looking at the existing literature on Nairobi's public transport system and matatus in particular. This is followed by an explanation of the theoretical framework which this study uses, the operational concepts and definitions of the terms used. The chapter ends by an outline of the subsequent chapters.

1.1: BACKGROUND TO THE STUDY AREA.

Nairobi is situated at the southern end of the agricultural heartland of Kenya, 1°19' degrees south of the equator and 36°59' degrees east of the prime meridian. This study is concerned with the built-up parts of Nairobi area which occupies 690sq. km. (268sq.miles) with a population of about 1.8 million people according to estimates (NUSG,1973). It is by far the smallest

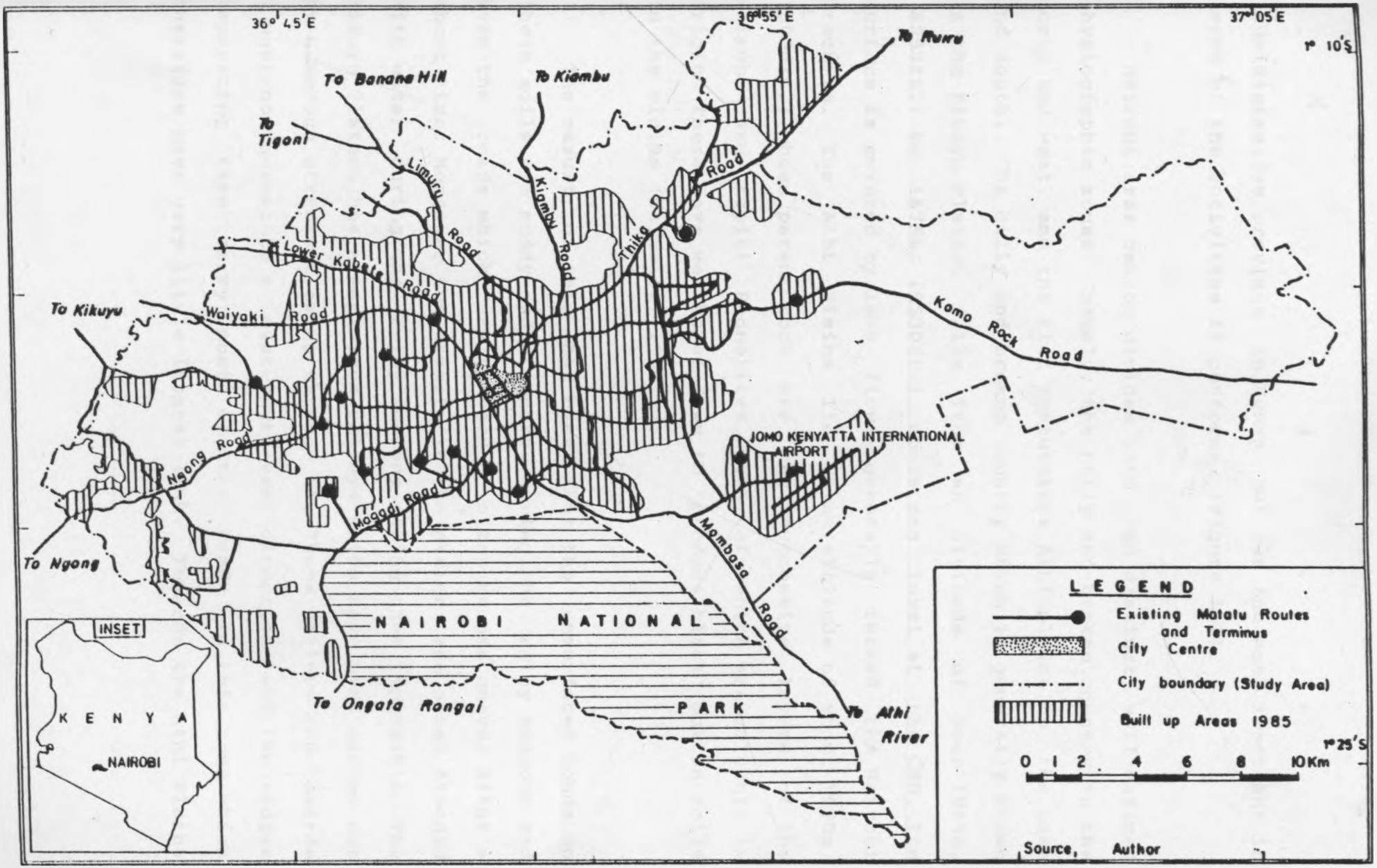

FIG. 1.1: THE STUDY AREA

administrative province in Kenya but yet the most important in terms of the activities it performs. (Figure 1.1).

Nairobi area can be divided into two distinct well defined physiographic zones, namely, the hilly and broken country to the north and west, and the flat featureless Athi plains to the east and south. The hilly and broken country which is generally known as the Kikuyu Plateau falls from an altitude of over 1905m. (6250ft.) to 1675m. (5500ft.) above sea level at the CBD. Its surface is covered by lava flows generally termed the Nairobi Trachyte. The Athi Plains lie in an altitude of about 1500m. (5000ft.) whose parent rock are the successive layers of the Nairobi and Kapiti Phonolites both of which are volcanic in origin. These have weathered down to produce black cotton soils in the plains (Walmsley, 1957).

The result of this has been that the unsurfaced roads on these soils are muddy and slippery during the rainy seasons and even the roads which are tarmacked often become uneven after a short time. Moreover the streets in the plains are often flooded with water during the rainy seasons making them impassable. The Kikuyu Plateau has steep sided valleys which have been carved out by numerous streams flowing through it. These valleys run towards a west-north-west to a east-south-east direction and the ridges separating them carry most of the roads in this zone which therefore have very little lateral link. Towards the Athi Plains

these valleys flatten out hence the development of irregular and seasonal swampy river courses on the Athi Plains. Generally, the Athi Plains receive low rainfall of about 500mm. (20 inches) per year and is mainly covered by natural grasslands and a few thorny bushes. The Kikuyu Plateau which has a much higher rainfall of approximately over 1000mm. (40 inches) was originally a thickly forested area but with the clearing of land for settlement, only Ngong and Karura Forest Reserves remain.

1.1.1: Historical Background.

Nairobi was first established as a transportation centre on a railway station which later grew up to become an administrative centre. The site was chosen by the railway constructors in 1899 because it offered many advantages. It was midway between Mombasa and Kisumu hence a suitable stopping place before continuing the railway construction over the difficult terrain which lay ahead in form of the steep slopes of the eastern rift valley. Other advantages which the site offered included, the availability of an adequate water supply from the nearby Nairobi River and the Mbagathi streams in the south, ample level land for railway sidings and other impediments of a railway, an elevated cooler ground to the west suitable for residential purposes, and an apparently deserted land offering freedom for land appropriation (Hake,1977).

The new settlement was named after the Maasai word "enkare

nairobi" which means "a place of cool water". The railhead reached the site in June 1899 and by July it had become the railway headquarters which was moved from Mombasa (Halliman and Morgan, 1977). In August the provincial administration was transferred here from Machakos and this marked the beginning of the town's growth into an administrative and transportation centre. A noticeable feature then was the physical disparity between the apparatus of the government and those of the railway administration with the railway administration having its own doctors, magistrates, Police and a highly developed technical and administrative staff (White and Thornton, 1943).

In 1900, the Nairobi Municipal Regulations were published by the government administration and these defined the town as an area within the radius of 1.5 miles from the centre. (section A Figure 1.2). An outbreak of plague in 1901 and 1902, followed by another in 1904 threatened the existence of the settlement but by 1906 it was realized that the town's removal could not be possible. Instead such environmental problems only served in encouraging and stimulating racial segregation of land uses (Hake, 1977). By 1906 definite land use zones had appeared though not planned with the Europeans in Westlands, the Asians in the North and the African workers predominantly in the East. (Figure 1.3). By 1907, Nairobi was accepted as the official capital of Kenya. Its position became firmly established during the First World War when it was used as a military base. Afterwards

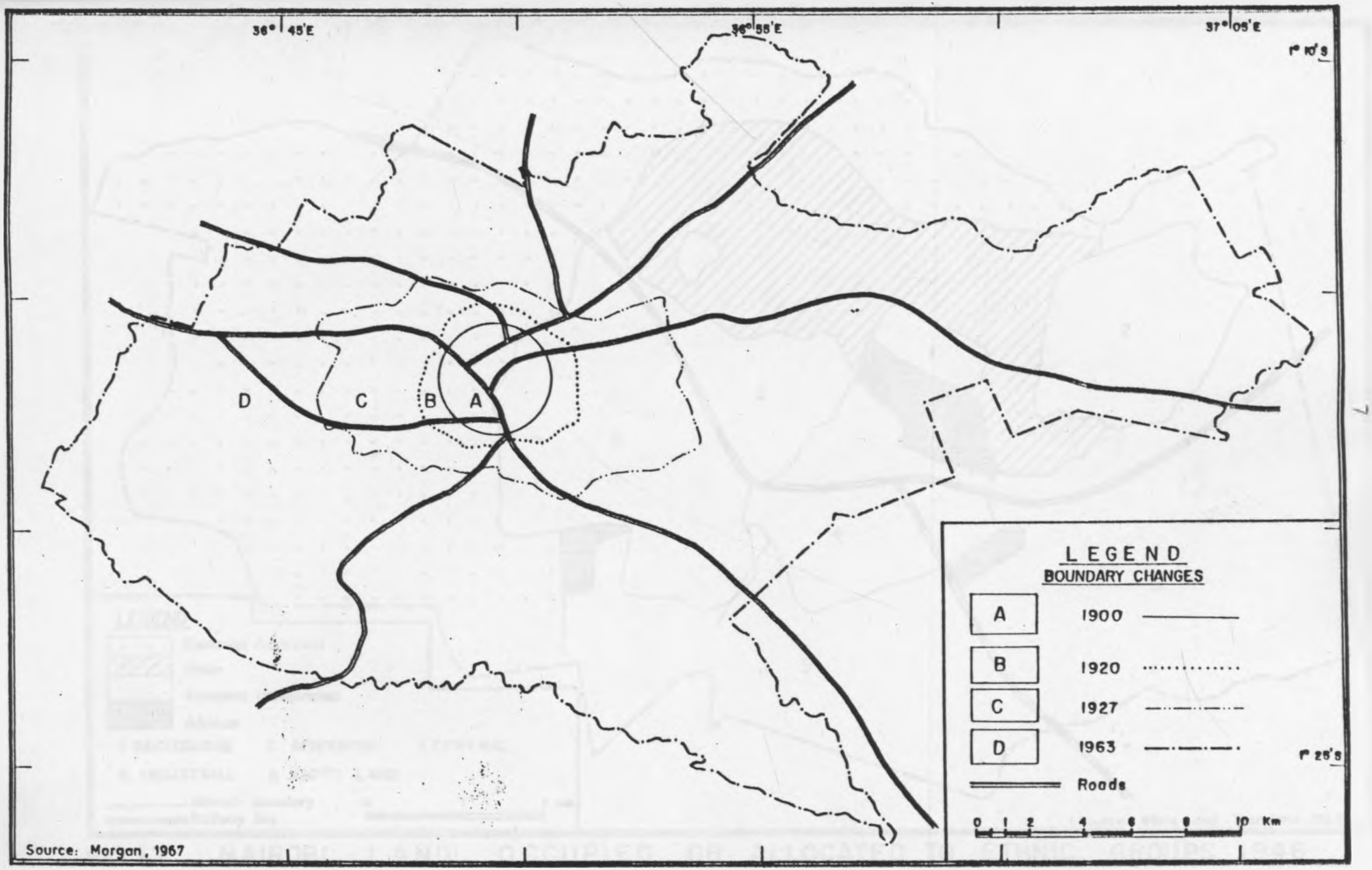

FIG. 1.2: NAIROBI: BOUNDARY CHANGES SINCE 1900.

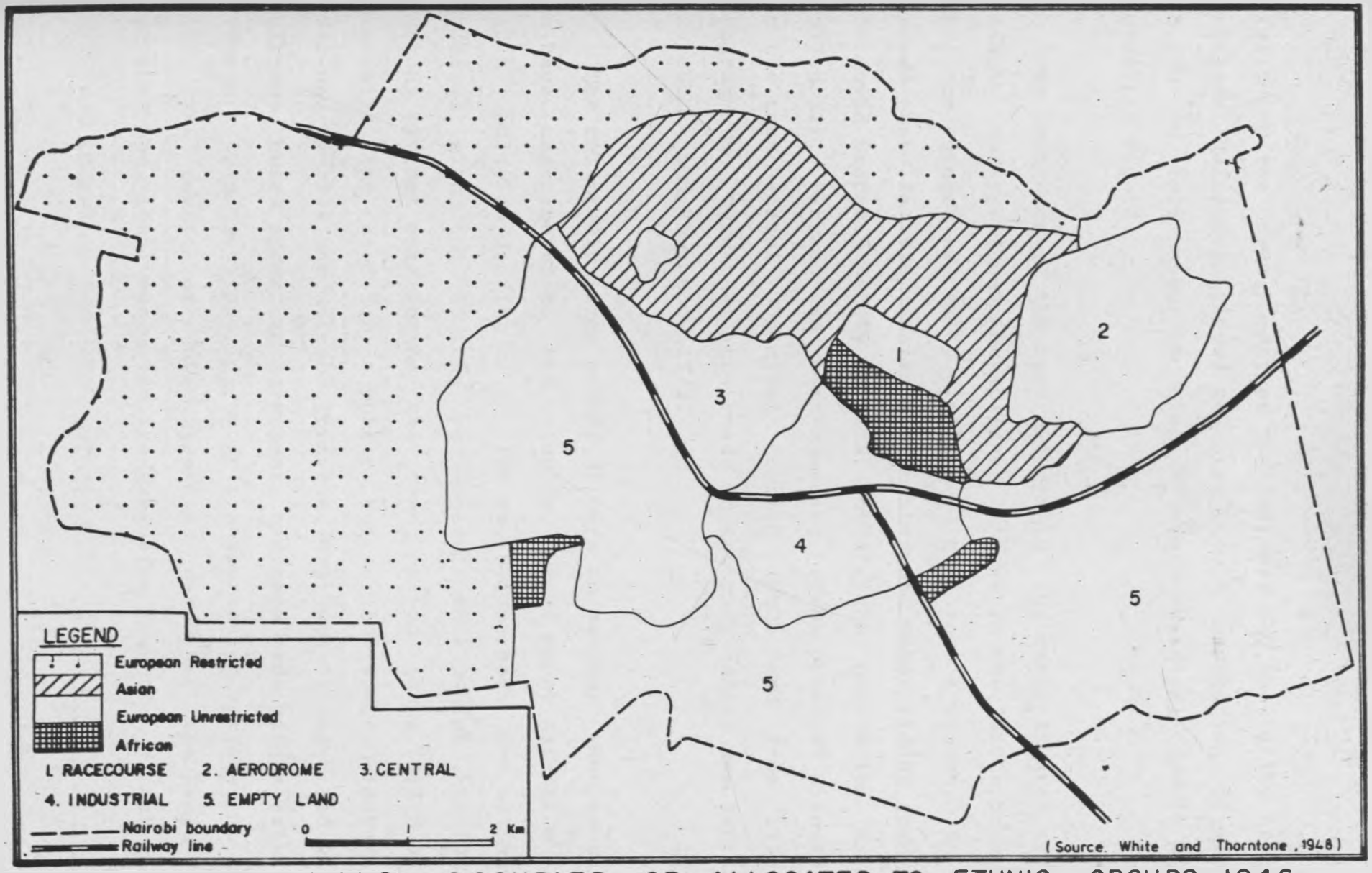

FIG. 1.3: NAIROBI: LAND OCCUPIED OR ALLOCATED TO ETHNIC GROUPS, 1946.

following the development of the railways and the influx of the settlers, Nairobi continued to grow to a population of about 15,000 in 1919 when it also became a Municipal Council with corporate rights.

By then much of the road network in the central area as we know it today had been established. It was in the 1920's however that the automobile really influenced the town's growth. It is argued that in 1928, Nairobi was the most motor-ridden town in the world proportionately to its non-African population (Hake, 1977 p.22). Parking and over-speeding became problems discussed in the then Nairobi Municipal Council (NMC) and from 1929 a programme to tarmac all the roads in the city centre was carried out (White and Thornton, 1943).

The relatively large number of cars in Nairobi then is said to have contributed to the thinning out of upper Nairobi which had a population density of as low as 6.1 persons per net acre compared with the African residential zone which had 125.9 persons per net acre during the same period (Hake,1977 p.34). Meanwhile, the need for a public bus service was considered in 1932 and by 1934 the Nairobi Town Bus (NTB) was inaugurated with only two buses after an agreement had been made with a British Transport Company to provide urban transportation services in the city. The result of this agreement was that the Kenya Bus Services Ltd. (KBS) was given the exclusive franchise of carrying

fare paying passengers in and around the then Municipality of Nairobi. However, during this time the demand for public transport was low mainly consisting of Europeans, Asians and a small but growing number of Africans. Even the buses were designed similarly to those double-deckers serving British urban centres.

Matatus emerged spontaneously in the 1950's when they were mainly used by the residents of the African residential zone to move goods, and people to and from the nearby rural areas to their residences in the city. They grew in numbers with the influx of migrants into the city upon independence in 1963 when colonial restrictions on the movement of Africans was removed (Kapila et al,1982). The word matatu is derived from a local term mang'otore matatu which means "thirty cents" which was the standard fare which they used to charge during those days.

In 1950 Nairobi became the first town in East Africa to be granted the status of a city. From its early growth, the city's functions have developed and expanded so that today it has achieved an overwhelming dominance in the political, social, and economic life of the people of Kenya and the whole region. Apart from being the centre of most national activities, it has also developed an international status as a major centre for international conferences and as a headquarters of international bodies such as the United Nations Environmental Programme (UNEP)

and the United Nation Centre for Human Settlements (UNCHS-Habitat) among others.

1.1.2: Land Use Pattern.

The above natural set up and historical background of Nairobi has had an impact on the human land-use pattern and population distribution of Nairobi. The city has a clearly differentiated central commercial and cultural CBD accommodating business offices and commercial facilities plus government and civic authority offices. In the south east of the CBD is the railway station which has prevented the development of a direct link between the CBD and main industrial area. These two zones are not only the major activity zones but are also the zones with the highest road network density.

The city's population is catered for mainly in three main types of residential areas primarily located in the North-West, South, and East of the CBD. The majority of the residents occupy the high density residential wards to the east and north-east of the CBD. To the north and south are medium density residential areas, while the low density residential areas (Upper Nairobi) are concentrated in the north and west (Figure 1.4). Today each of these residential areas is distinguishable by its density, the quality of the environment, and the economic level of its population. Upper Nairobi remains an expensive area occupied mainly by transient European expatriates and also by some wealthy

Africans and Indians plus a large African domestic servant population. Muthaiga and Lavington remain the most exclusive and are favoured by officials of foreign embassies and international organizations (Obudho and Aduwo,1988).

Housing for the Indian community has separated into more clearly defined income groups with Parklands being at the upper end whereas many plots and houses in Eastleigh formerly occupied by poorer Asians now belong to Africans. Nairobi South and West were built before independence for prosperous Indian artisans living close to the industrial area but today a high proportion of Africans live there. Most of them are of a middle income but closer to the industrial area are small squatter settlements housing the low income residents.

In Eastlands the development of low cost housing has been extensive. This is a zone of a heavy concentration of population especially of low income groups. The population densities here range from as high as 20,000 to 40,000 with a greater concentration in wards such as Pangani, Muthurwa, Mathare, Shauri Moyo, Bahati, Makongeni, Maringo and Mbotela. Most houses in this zone which were built during the colonial period are in a state of deterioration and can as well be referred to as slums (Obudho and Aduwo, 1988). According to the 1979 census, Maringo with a population density of 40,440 persons per sq. km. followed by Pangani with 35,550 persons per sq. km. were the most dense.

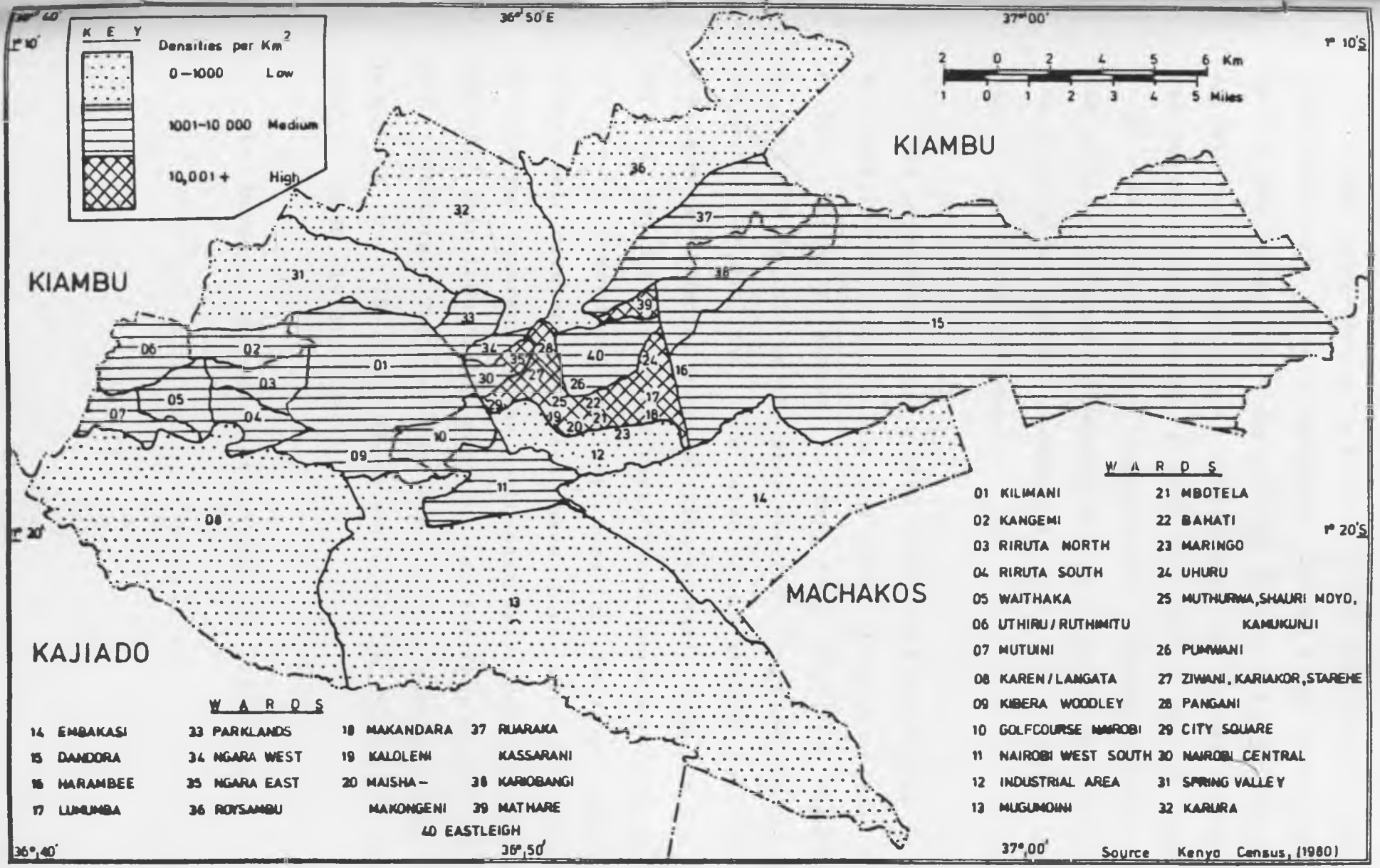

FIG. 1·4: NAIROBI: DISTRIBUTION OF POPULATION BY DENSITY PER WARD, 1979

After independence a series of new residential estates have been developed further eastwards. These have mainly served the middle low income and middle income groups and the most prominent is Buru Buru which so far represents one of the largest urban residential developments in East and Central Africa. Towards the north east are low income resettlement schemes such as the site and service schemes in Dandora and Kariobangi. More such schemes are developing further westwards among them being Umoja and Kayole low income projects.

The expanding and varied industrial activities in Nairobi are normally accommodated in the level land extending from the railway property almost to the Jomo Kenyatta International Airport (JKIA) This is the area where the railway activities are concentrated but the line also passes through such low income settlements as Umoja, Dandora, Kibera, Kariobangi, and a greater part of the suburbs in the west. These zones are today served by the newly introduced Railway Commuter Services (RCS). Other industrial development areas have been extended in Ruaraka, Dandora and Kasarani in the north-east away from the central area and the main industrial area but so far they do not attract as much commuters. The central area still employs over 150,000 people or over 75 % of those employed in the formal sector in Nairobi (NUSG, 1973).

The boundary extension of Nairobi in 1963 brought in large

areas of farmland and forest in the east, west, and north while in the south the Nairobi National Park (NNP) has limited the city's growth towards this direction. Apparently the city's residential development is extending mainly towards the east and north east. Towards the west and north west the growth is being restricted by the presence of a rich agricultural land set aside for farming in the neighboring Kiambu District. High density settlements however exist towards this direction in the form of Dagoretti, Kangemi, Kawangware, Riruta and Uthiru zones which are predominantly occupied by the low income. In general a considerable amount of land still remains under the GOK and the NCC and this has made it possible for the development and expansion of many public utilities, a process which still continues on.

1.2 STATEMENT AND NATURE OF THE RESEARCH PROBLEM

The essence of any urban transportation problem is lack of mobility, severely limited mobility and mobility purchased at a very high social and economic cost. In Nairobi the current situation of urban transport is alarming. Despite the relatively low levels of private automobile ownership, the city's transportation problems are severe in degree, in daily duration and in the size of the areas affected. These problems are especially felt during the peak demand hours which are often characterised by considerable jostling and stampede amongst the

travelling public in search of the means of public transport. The situation of chaos is further stimulated by the carelessness and apparent lack of concern amongst the Public Service Vehicles (PSVs) operators.

For most commuters the problems faced include, increasing walking distances, long waiting hours, severe struggles while getting on and off the available public services vehicles, insecurity and pick-pocketing, traffic jams, accidents, vehicles breakdowns,and a general atmosphere of bad tempers. Basically, the major problems is that of congestion mainly witnessed in form of overloaded buses and matatus, and traffic jams experienced more so in the CBD which is the major activity zone. The centralization of activities in this zone has ensured that the commuting trend involves a movement from here to the surrounding expanding residential areas.

Underlying all these problems, however, is the acute shortage of resources in the provision of a long life urban transportation infrastructure sufficient enough to match the large additions of population and the emerging patterns of population distribution and demands for public transport services. A rapid deterioration in urban transport conditions in Nairobi is in prospect if present trends continue unchecked. The current exceptional rates of urban growth are unlikely to diminish in the near future and may well accelerate (NUSG, 1973).

Moreover as the city expands and the workers live further away from their work place a more than proportional expansion of public transport facilities and services is required.

Various methods have been considered and some applied towards achieving this but with minimal success. Among them is the recent introduction of a railway commuter services but this can only serve in areas along which the line passes, and has so far proved rather expensive to run and maintain apart from being unable to meet the demands even of those areas which it serves. Other measures such as the introduction of GOK operated Nyayo Bus Services (NBS) to supplement the services offered by the Kenya Bus Services (KBS), have been helpful but also insufficient to meet the existing demands apart from facing such technical problems as lack of parking spaces in the CBD. A study currently being conducted by Transurb-Consult on behalf of the government of Belgium has considered many long term solutions among which is the introduction of a light rail transport system and the use of busways. However, this study has taken quite a long time and may even take longer to implement in future due to the limited executing capability which a country as Kenya faces and due to lack of funds.

At the moment we are therefore left with the option of a low cost strategy which should be of immediate importance in a city growing as fast as Nairobi. Such a strategy involves reshaping

the management of the existing infrastructure in order to achieve a more efficient and agreeable equilibrium between demand and supply (Thomson, 1977). To some extent the deficiencies of the existing public transport system in Nairobi have been alleviated by matatus which have continued playing an expanding role (Kapila et. al., 1982).

This study analyses the matatu mode of public transport in Nairobi within the context of showing the system's role, efficiency, and quality of service. It attempts to measure these especially as relates to issues such as the system's role in generating employment and incomes, the proportion of passengers using them, the factors which influence their public transport modal choice, the factors which influence the distribution of their services, the relationships between their service characteristics and that of the much favoured public bus systems, and other operational characteristics which they have.

The study basically seeks to show that policy should not be easily swayed by current popular sentiments. Some of the many popular criticisms levelled at Nairobi's public transport system and the matatus in particular are not warranted since they are not based on empirical findings. Indeed, it is true that there is need to overhaul the city's public transport system so as to cope with the ever increasing demands but this can only be done if there is a clear understanding of the wide range of problems

faced by the system. The practical value of all existing and new policy options need to be analyzed and understood so as to comment on possible solutions and priorities especially concerning the current and future role of matatus in Nairobi. The degree to which previous attempts at solving the problem have been implemented in practice also need to be analyzed.

So far numerous debates concerning the desirability of allowing matatus operations have ended either inconclusively or with a general feeling that anything that the matatus can do, the buses can do better. It is because of this that attempts have been made, for example, to introduce more buses to cope with the increasing demand as can be seen in the recent introduction of the NBS. Very little has been done towards seeking to salvage the reputation of the matatus whose role seem to be underrated. However, supporters of the matatus often see them as adjunct to the large bus operations. The matatus, it is thought, should ply along the light trafficked routes where the large buses operate with too low a frequency. They should cater for short-distance "feeder" traffic collectors and distributors and should be excluded by the high costs from the main line hauls.

Impressive though such a priori argument may be, they remain based on preconceptions rather than reality. It would be instructive to confront such prepositions with real evidence from the real world. This study offers a geographical analysis to

Nairobi's urban transportation situation in that it provides a systematic framework for the description, analysis and explanation of this urban public transportation phenomenon. Even though such a framework inevitably uses findings of many other disciplines, the conceptual organization is geographical in derivation.

1.2.1: The Study Objectives.

The main aim of this study was to gather and analyze information on matatus so as to identify their level of productivity, efficiency and quality of services in Nairobi area as well as their future role. In order to do this the study set out to achieve the following objectives,

a) To identify how matatus promote the level of mobility and accessibility in Nairobi area.

b) To identify the factors which influence the distribution of matatus in Nairobi area.

c) To identify the factors which influence public transport modal choice in Nairobi especially with reference to the quality attributes of matatus which make them preferable.

d) To look at means of continuing the financial viability of matatus while improving upon their major service characteristics.

e) To meet the need for a better understanding of the matatu system by filling an important gap in the existing knowledge as a basis of relevant policy as well as to improve knowledge for its own sake.

1.2.2: The Research Hypotheses.

In connection with the issues under investigation and the major objectives advanced above, this study advances and statistically tests the validity of two major hypotheses (or assumptions), namely, that;

a) Matatus in Nairobi area have emerged and operate mainly with a view to improving mobility and accessibility needs of the residents of Nairobi.

H_0 - There is no strong functional relationship between the distribution of matatus and population distribution or public transport demand in Nairobi.

H_1 - There is a strong functional relationship between the distribution of matatus and population distribution in Nairobi.

b) Matatu operations have consistently continued to attract more and more commuters because of certain quality attributes which they are better placed to offer than other existing modes of public transport in Nairobi.

H_0 - There are no significant quality attributes of matatu operations which have attracted commuters to use them apart from the mere fact that they are most frequently available.

H_1 - The relative attractiveness of matatu operations in Nairobi can be attributed to many other quality attributes which they offer and which are highly valued by their users rather than frequency of service alone.

From these hypotheses, this study sought to conclude that matatus therefore play an important role and should be preserved but with certain incremental changes especially because of their being a low cost option towards solving the immediate needs of the excessively high public transport demand facing the city of Nairobi. Their role in generating incomes and employment opportunities especially for the low income is also considered.

1.3: REVIEW OF LITERATURE.

The fundamental interest in public transport in urban centres of the LDC's is a relatively recent phenomena. Early transportation studies in the 1940's and 1950's were mainly concerned with highways often giving very little consideration for public transportation systems. It was only from the mid-1960's onwards that public transportation systems received more serious attention in national and international policy making circles. It is also during this period that literature concerning this theme started appearing. But most of this is still based on the urban centres of the MDCs where the main concern has been that of easing traffic congestion by tremendous improvements in the level and quality of public transport services.

There are several aspects of urban public transportation systems in the LDCs which set them apart from any other technological investment. In the first place, these systems almost always are both multi-modal in their technological and other operational components, but are integrated in the functional service which they offer. Most cities in the LDCs have developed a bewildering array of public transportation modes including the intermediate public transport systems of which matatus form part. These offer complementary and or competitive services to other systems or modes of public transport. In the second place, the systems offer a monopolistic service within urban areas where the excessively high demand for public

transport services has ensured that the operating modes can operate with little or no care of the users' needs. This has resulted in the prevailing tremendous deterioration in the level and quality of service offered by all modes of public transport operating in the LDCs.

Almost all previous work concerned with explaining modal choice, or levels of usage of different modes of commuting in urban areas has been carried out in the MDCs. Most such studies attempt to tackle this issues within the context of explaining the modal split mainly involving the public transport system and private automobile use. A study by L. F. Schnore (1962), for example, relates the use of public transport in different cities to factors such as the size, density and the age of the city. On the basis of this, he argues that public transport is more widespreadly used than private automobile in large densely populated cities especially those which originated during the industrial revolution in Europe. A more comprehensive study by W. T. Adams (1959), develops regression equations explaining city-wide use of public transport vis-a-vis private automobiles in terms of five independent variables namely, the population over five years old, the quality of service, income, land-use distribution, and the urbanised land area in square miles. M. E. Beesley (1965) has looked at the use of public transport in relation to the number of cars per 1000 population and to urban population density. He considers the use of public transport as a

simple function of population density and income.

All such studies tend to be of little use when applied to the LDCs. They mainly attempt to find ways of improving upon the use of public transport through improvements or to increase the disincentives to private automobile use which is a major cause of congestion in the MDCs. Most of the models developed cannot be easily applied in the LDC urban centres where public transport demand has reached excessively high proportions and where public transport systems operate differently. Moreover, research and findings have indicated that different levels of modal choice and modal use often vary even when related to the same factors in an urban area. For these reasons it would be advisable to develop a model capable of operating in specific areas within an urban complex so that it would be directly related to those sections which appear to have different levels of use of a particular mode of travel.

In the LDC s, urban transportation problems have been perceived in a number of ways depending upon the location, wealth and the motorization levels of the wide variety of urban centres concerned (Zahavi,1976). However, planning responses to such problems have essentially been based upon standardized traffic and transport procedures whose assumptions and perceptions owe their origin to professional practices in the MDCs. According to G. Banjo and H. T. Dimitrou (1980), the application of these

standardized approaches to the LDCs have not only failed to resolve their movement problems but have themselves created additional transport problems mainly because they often employ inappropriate assumptions and perceptions. H. H. Werlin, (1984) observes that most of the urban poor in LDCs are dependant on their own feet to get them where they want to go, hence in many such cities, half of all work trips are made on foot often covering long distances while the existing motorized modes of public transport often tend to be unreliable and inadequate. Transport planners in the LDCs should therefore be more concerned about these aspects which are of immediate importance.

In a sector policy paper, the World Bank (1975) identifies the problems of public transport in the LDCs as unique and different from those in the MDCs. These include congestion, the failure to expand road networks relative to urban growth, the very poor state of the public bus systems, and the spontaneous growth of intermediate personal transport services to alleviate the deficiencies of the existing modes of public transport. A UNCHS (1984) study supports this view and argue that the many comprehensive land use/transportation studies which have been undertaken for large metropolitan areas in the LDCs have not considered the indigenous conditions of transport in the areas concerned. In addition, it adds that, "such studies are seldomly accepted by all the authorities and even when accepted, they are only implemented after a long delay (or not at all).... due

to lack of funds or limited executing capability of the countries concerned"(p.16). The long delay in carrying out and implementing phases of the Belgium government sponsored feasibility study project in Nairobi can testify to this problem which is faced by most LDCs.

Another World Bank (1986) report notes that, "solving urban transportation problems has become one of the chief tasks confronting governments in the LDCs ..... primarily because of the importance of efficient transport to urban productivity and to national development"(p.24). This report states the priorities for future World Bank lending to LDCs and emphasises the importance of policy options such as,

"(a)strengthening the existing transport institutions;(b) using low cost measures such as traffic management and road improvements and maintenance;(c) improving the public transport particularly bus and minibus services; (d) improving road networks with an emphasis on the needs of commercial traffic and of public transport especially those serving poor neighbourhoods; and (e) giving preference to capital-intensive improvements such as major improvements on road networks and transport systems that produce high rates of return"(p.40-41).

This study on matatus in Nairobi also highlights the importance of these options which stress the importance of conservation and improvement of the existing transportation systems.

Very few studies have concerned themselves with the phenomenon of intermediate forms of public transport or paratransit in the LDCs. Most existing such studies highlight the urban centres of Asia and Latin America and include, Ocampo

(1982), Fouracre and Maunder (1979), Oxley (1987), Walters (1979), Sanlia (1981), Luna Jr. et al (1978) and Sahabandu (1987) among others. Ocampo (1982) offers an integrated approach to the understanding of low cost transport systems in selected South East Asian urban centres each of which has unique characteristics. He sees each one of them as adapted to their specific environment hence he argues that,

> "their roles and prospect have been shaped by population pressures, urban structures and the general transportation system prevailing in each of the cities concerned ..... their visibility as a problem in mass transportation is unwarranted since they are more of a solution to that problem under present circumstances."(p.5)

The same argument applies to the Nairobi matatus whose role and prospects is analyzed in this study. In Nairobi so little comprehensive work has been done on the problems of productivity, efficiency and quality of service of the existing public transport systems. Most of the existing available studies are fragmentary since they are mainly based on a single variable and often view from a single point of view. Studies as those carried out by the GOK or the civic authorities often represent the views of the overall operator of the city's public transport system. They are mainly designed in form of surveys and some are not policy oriented but only throw light on some aspects of the city's public transport system. The list of such studies include, Situma (1977), Barwell (1979), NCC (1980) and Coopers and Lybrand (1980).

A pioneering study by Situma (1977) provides extensive data

on matatu terminals with extensive maps and tables, fare structures, operating speeds, vehicle types and registration dates, and the passenger capacities. He makes various recommendations for future consideration to the NCC among which are, the introduction of new by-laws to cater for the long distance matatus, the education of the operators, the reorganization of matatu associations, the introduction of NCC licenses and symbol identification of matatus in Nairobi, the taxation of their income, and the use of government sponsored inspection of matatus twice a week for every matatu. This study provided a framework for current NCC and GOK attitude towards matatus but it is fragmentary in the sense that it only performs a wider ramification of some issues at the expense of others. Most of the findings have also been overtaken by events. A more recent study is that of the NCC (1980). This recognises the fact that commuters in Nairobi use matatus as means of travel irrespective of the inherent dangers and problems. This is because of the excessively high peak hour demands which cannot be met by the public bus system alone. The report therefore assumes a positive approach to the problem of improving matatu operations with a view to encouraging the following,

> "(a) making matatus an effective part of the public transportation system in Nairobi, (b) ensuring that they will supplement and not compete with the buses (c) ensuring that their operation will continue to provide employment to the low income groups (d) ensuring that there will be a continuous operation of the buses even after the KBS franchise expires by 1985, and (e) ensuring that all safety factors in vehicle operations and maintenance are enhanced to the maximum."(p.10-15)

Apparently these are the major policy guidelines which the NCC

uses in dealing with the matatus today. However, the above study only has broad guidelines and does not show how each one of them can for example be implemented in practice. It does not specifically look at the role of matatus as an effective part of Nairobi's public transport system.

Kapila et. al. (1982) offers a detailed study concerning matatu operations in Metropolitan Nairobi. He is rather optimistic about their future development hence he argues that the system can be improved, planned and changed for even more successful operations and services. However, he does not give even a single clue on how these can be done especially in view of their increasing numbers which have made it difficult to manage their operations. No attempt is also made to look at the dynamics of their geographical distribution. Ogonda (1976) identifies the spatial structure of transportation networks in Nairobi and those factors which have favoured their growth. He also analyses the number and composition of motor vehicles, their usage and practical implications to transport planning but without specifically pointing out the public transportation problems which the city faces. Fortunately, this is among the things which this study has set out to achieve.

1.4: THEORETICAL FRAMEWORK, OPERATIONAL CONCEPTS AND DEFINITIONS

1.4.1: Theoretical Framework.

In its attempts to develop a framework for analyzing

commuter behaviour in a situation of multiple modes of public transport travel, this study adopts the Abstract Mode Approach to the demand for travel which it also uses to explain the role of matatus in promoting the level of accessibility of commuters in Nairobi area. However, due to difficulties of strictly applying such a model in Nairobi's public transport situation, the approach is adopted for a much wider and slightly different application. This approach was designed by Quandt and Baumol (1966) especially to forecast a future abstract new mode of travel but has been expounded on by Young (1969), Kraft and Kraft (1976), Williams (1978) and Mayberry (1970) among others.

The basic assumption of this model is that the demand for travel, like the demand for any other commodity is a function of the various attributes of that commodity in question. The main hypothesis for such an approach is that the demand for travel and use of different modes of travel is actually determined by this demand function. The explanatory variables of this type of demand function include modal characteristics such as cost, time or speed, frequency, reliability or regularity, comfort, and safety as well as socio-economic variables of population or the level of travel demand and the level of income.

In their original formulation of the Abstract Mode Model, Quandt and Baumol (1966) suggested the notion of abstract mode by defining it as a function of the attributes or the

characteristics of transportation facilities. For empirical application, they suggested that the travel volume from one place to another may be reasonably explained by some modal characteristics such as the cost, journey time and the departure frequencies, and the general prevailing socio-economic variables of the population distribution and the income level. They also implicitly suggested that such a functional relationship between travel volumes on one hand and modal characteristics of the transportation facilities and socio-economic variables on the other hand, indeed represents the demand function for travel (Young,1969). On the basis of this they developed a statistical demand function,

$$T_{ijk} = \exp(\alpha^1) \; (P_i P_j)^{\alpha^2} \; (Y_i Y_j)^{\alpha^3} \; (C_{ijk}^*)^{\alpha^4} \; (H_{ijk}^*)^{\alpha^5} \; (D_{ijk}^*)^{\alpha^6} \; \frac{(C_{ijk})}{(C_{ijk}^*)} \; \frac{(H_{ijk})}{(H_{ijk}^*)} \; \frac{(D_{ijk})}{(D_{ijk}^*)}$$

where,

T_{ijk} = the volume of travel measured in terms of number of one way trips from i to j and from j to i by mode k.

$P_i P_j$ = the product of the population at i or j (in thousands of persons).

$Y_i Y_j$ = the product of the per capita income in i or j (in dollars).

C_{ijk} = the product of the cost of travelling between i and j by mode k.

$C_{ijk}*$ = the competing cost which is best (cheapest) cost of travelling between i and j by any mode (alternatively denoted by C_{ijb})

H_{ijk} = the journey time between i and j by mode k.

$H_{ijk}*$ = the competing journey time which is best (fastest) between i and j by any mode (alternatively denoted by H_{ijb}).

D_{ijk} = the daily departure frequency from i to j by mode k.

$D_{ijk}*$ = the competing daily departure frequency which is best (highest) departure frequency from i to j of any of the modes (alternatively denoted by D_{ijb}).

According to Kraft and Kraft, (1976) mode demand and use is determined by a preference ordering of the mode characteristics. The demand for any mode is derived from an individual's utility function and it is not only a function of the mode's price and other quantifiable characteristics, but it can also be explained by an analysis of the mode's reflective characteristics such as comfort, convenience, safety, or even privacy. Due to the difficulties involved in applying such a model in the strictest sense to the situation of public transport in Nairobi, this study only uses the same approach to explain the extent of demand for and use of both the public bus system and matatus by commuters in the various zones in Nairobi. It is based on the notion that matatus play a significant role in increasing the options available to the travelling public. They should therefore be left to continue offering a healthy competition to the public bus system and other future modes of public transport to facilitate a future improvement in the services offered.

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It is clearly understandable that the extent of demand and use of both systems depend on some of their attributes which are highly valued by most commuters in Nairobi such as comfort (sitting and or luggage space), safety, frequency of service, time or speed, regularity or reliability, flexibility, and cost of travel. However, apart from these factors their general use or demand and distribution depend on socio-economic factors or variables most important being the population distribution and the income levels of the users. One of the hypothesis of this study is that matatu services distribution and flow is functionally related to the population distribution which is representative of the demand for public transport services. However, the role of other factors in influencing this distribution of matatus is also considered and analyzed vis-a-vis that of population distribution. These include the general income levels of the users, the profitability levels or the level of profit which the matatu owners and operators make, and the distances covered in the various trips made for each zone or route served by the matatus. These factors are all related and all influence the distribution of matatu services in Nairobi but this study attempts to show that there is a stronger functional relationship between the distribution of matatu services and population distribution. In looking at the public transportation system in Nairobi further, this study notes that because of the excessively high demand for public transport services and the

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resultant congestion or overcrowding witnessed especially during the rush hours, the users (commuters) tend to have very to choose from between the public bus system and the matatus. But after observing the increasingly important role played by the matatus, this study attempts to explain the increasing demand for and use of their services using the Concept of Attractiveness. (Quarmby,1964. p.438). According to this concept, the number or proportion of commuters who can tolerate the level or quality of service of any public transportation mode or system is a function of the relative attractiveness of an alternative mode or system whose level and quality of performance may be considered better by the commuters. This function can be expressed as;

$$Ct = f1(Ta) \quad . \; . \; . \; . \; . \quad (1.2)$$

where Ct = the congestion or overcrowding level which people will accept to tolerate

Ta = the relative attractiveness some other form of public transport not subject or less subject to the same level of congestion or overcrowding.

Furthermore, the relative attractiveness of the alternative mode of public transport (Ta) is a function of the general level of public transport demand as expressed in the level of congestion or overcrowding, and also of some of its service characteristics or attributes and how they are valued by most commuters. This can be expressed as:

$$Ta = f2(Ct, C) \quad . \; . \; . \; . \; . \; . \; . \; . \quad (1.3)$$

where C = the service characteristics of the alternative mode. eg cost, frequency of service, speed, etc.

In Nairobi available time series data show that the proportion of commuters using the public bus system has been on the decline relative to those who use matatus (Jarabi,1982; Transurb-Consult,1986). This can be attributed to the relative attractiveness of the matatus whose level and quality of performance has improved due to a tremendous increase in their numbers relative to the increasing public transport demand, and also due to a number of service attributes or characteristics which they have such as their flexibility, frequency of service, speed or travel time, and comfort or sitting and or standing space. This study tries to identify these factors apart from showing how commuters in Nairobi value some of these attributes and whether matatus are better placed to provide them than the public bus system or any other system. The aim is to show that even though matatus have been regarded as undesirable in some respects, they have certain operational advantages which could be utilised to make them provide better complementary services in future.

1.4.2: Operational Framework Concepts and Definitions.

Any urban public transportation mode and its related operating components can constitute a system or subsystem which is usually a complex entity than is often assumed. Studies on the

productivity, efficiency, and quality of service of such a system must therefore conceive the system in its totality and then dissect it appropriately (Tomazinis, 1975). This study considers the matatu mode of public transport and its related components as constituting an urban public transport system. For the purpose of a comprehensive study of the productivity, efficiency and quality of service of this system, this study is basically concerned with its three major components namely the network, the primary services, and the auxiliaries.

The Network - refers to the geometric pattern layout of the transport system, or the location of the routes or a set of geographic locations interconnected in a system by a number of routes. Network analysis concepts which this study uses therefore include the analysis of the location of intersections, nodes and terminals; the density and lengths of routes; the accessibility of individual points; the areal coverage of any road network; and the distances travelled in order to reach every point on a network. These notions are related to the factors which condition the development of transport. Various Graph Theoretical Measures of whole transportation networks have been devised to assess the degree of accessibility and connectivity. These constitute what is generally termed the Graph Theory which provides simple accessible tools for constructing models and solving problems dealing with discrete arrangement of objects

(Kansky, 1963; Garrison and Marble, 1974). They are used in determining the potentiality and possibility of connections. In this study they are used to provide insights into the zonal inequalities in public transport connections (ie the areal coverage of the matatu road network in various users zones as explained in chapter two).

The Primary Services - refer to the public transportation activities performed by the system over its network. It is this aspect of the matatu system that this study is mainly concerned with hence it basically looks at the demand supply relationship of these services especially as a means of analyzing the matatu system's efficiency levels as well as the quality of service offered by the system.

The Auxiliary Functions - are the support functions available to the system on the network and or the primary transportation services of the system. In most cases the desirable performance of the network and the services themselves clearly depend on the performance of these support functions. In this study such functions of the matatu system include the matatu terminal facilities, their garages, and their overall organizational strength.

In looking at each of the above system's components three

major analytical concepts are highlighted namely the general system's role, efficiency and the quality of service.

This study considers the matatu system or mode of transport as an integral part of the overall urban public transportation system in Nairobi. They have played an important role in providing a locally adapted means of public transport. The system is seen within the light of its role as a major source of employment mainly to the low income and its long term provision of a major service to the city's rapidly increasing population and demand for public transport services. Matatus are also seen as representing a significant aspect of the emerging motor industry in Kenya, hence they now constitute a dominant position not only in the transport sector but in the economy of Kenya as a whole. The fact that they have continued to expand or increase at a phenomenal rate is largely a reflection of their profitability as well as the equally high demand for their services. This study therefore looks at their in terms of the number of persons employed within the whole system and it related components, the net revenue earnings of the matatu industry to the GDP, and its general contribution towards the motor industry. The objective here is to establish the comparative position of the matatus as an urban transportation system among other more or less comparable systems especially the public bus system which seems to be more favoured at the moment. In view of the current lack of resources, they are viewed as representing a viable low cost

option to transportation planners.

Efficiency - refers to the rate of success of any operating process or system or the quality of the entity whose productivity is under review. It is used here to refer to the rate at which the matatus have succeeded in promoting the level of accessibility or mobility of Nairobi's residents.

Quality of Service - refers to the level of efficiency and productivity of a system's processes. However there is no clear-cut measure of this level since the users or consumers and the operator or supplier of the system differ in their assessment of the quality of service. However in most cases the best assessor of the quality of service are the users whose assessment also varies due to differences in tastes and perceptions. Hence a system can have a high level of productivity or efficiency but its quality attributes can better be assessed by the users or consumers. The attributes of the quality of service of a transportation system that are intrinsically associated with the extent to which the services of the system are considered desirable and therefore usable from the users point of view, can be thought of as forming a multi-dimensional space. They are of two types, namely, (a) those associated primarily with the short range considerations in forming trip patterns and (b) those which are more pervasive in nature with pronounced long range delayed impacts on ridership patterns and modal choice.

The first group include quality attributes such as convenience of getting to and from the vehicle, comfort riding (such as finding a seat) avoidance of transfers, and frequency of service. Among the second group of attributes are the reliability of the system in its current and long range performance, its availability for service for any other purposes and at any time when it is needed, and its general safety records. This study is mainly concerned with the first group of quality attributes which in the long run influences the ridership and modal choice patterns.

Public Transport - refers to the facilities and services that are prepared for the user by a third party and are intended for use by a large number of clients, collectively or separately, under specific control schedules. In this study the word is used to refer to passenger transport services which are provided on an organised basis for all or part of the community. Such services are offered in mass as opposed to private facilities such as private cars, taxis, and institutional buses or cars.

Matatus - are small-scale transporters of commuters and goods which are owned and licenced as PSV's. They represent an intermediate form of public transport whose services fall somewhere between the conventional buses and the taxis, and have emerged spontaneously as a result of the inadequacy of the buses.

They offer a complimentary service to the buses especially during the peak demand hours and are more or less competitive to the buses during the off-peak hours since they both use the same routes. However they are more flexible in their services and are sometimes demand-responsive in as far as the route which they use. Their official carrying capacities range from 8 to 25 passengers but they often carry even up to 40 passengers illegally.

1.5: OUTLINE OF THE CHAPTERS.

This thesis is divided into six chapters in addition to the front and back matter. The first chapter provides a background to the study area and explains the nature of the study problem, the objectives and the hypotheses to be tested. This is followed by an analysis of the operational framework and concepts which this study uses. The second chapter describes the methodology used in the collection and analysis of the data used in the study. This is followed by the third chapter which assesses the past and present role of public transport systems in Nairobi and the practical responses to the problems faced by the system. The fourth chapter looks at the spatial distribution of matatu services in Nairobi and attempts to explain the factors which influence this distribution while the fifth chapter is concerned with the factors which influence public transport modal choice in Nairobi with particular reference to the attitude and perceptions of the commuters towards matatus. The last chapter presents a

summary of the study findings, the implications, recommendations and the conclusion. This is then followed by the back matter which consists of a list of the book references made in the study and the Appendices.

CHAPTER TWO.

METHODOLOGY.

This chapter is crucial since it is the basis through which all the references and conclusions of this study are based. This chapter is divided into three main sections. The first section looks briefly at the major research difficulties or the limitations faced especially during the fieldwork stage of the research while the second section deals with the data collection techniques among which is a detailed description of the sampling procedure. The third section deals with the analytical methods used especially how they are used to statistically test the research hypotheses. It also appraises the research methods used and identifies and discuses the weaknesses and strength of some of the data analytical methods used.

2.1: MAJOR RESEARCH LIMITATIONS.

The initial plan of this study was to cover all aspects of the matatu mode of public transport in Nairobi. It was later realised that some of the aspects covered in the proposal could not be covered either because the data on such aspects was not available at the time of the survey or because of limited time and funds plus other research resources. In some cases secondary data had to be used to supplement or to verify the primary data collected from the field. Problems were particularly experienced

in interviewing the matatu owners and or operators whose response was relatively low especially because some of the respondents were suspicious. The research period coincided with a period during which there was a crackdown on the matatus by the Police force. During the same period threats were issued by certain GOK and NCC authorities to ban them. The period also witnessed a two day boycott by the operators of the matatus and the country buses who were resisting new GOK regulations.

However, assistance was sought and got from two Matatu Vehicle Owners Association (MVOA) wardens based in the terminals who voluntarily made arrangements for the author and research assistants to interview some respondents. The results of the sample size and the sample responses are shown in Appendix III. Out of a sample size of 150 matatus which represents 22.6 % of the approximate population of matatus in Nairobi, only 135 matatus responded positively. This is a high rate of response by any standards representing 90 % of the sample size and 30 % of the population.

Not all questions were well responded to especially those relating to the income or the revenues received by each matatu. Since most of the data was collected from the field it had to be coded, edited and tabulated. Even the scanty information that the matatu owners and or operators parted with was governed by some degree of inaccuracy. The matatu data that appears in this study

has undergone various approximations and estimations after a comparison with data from various other sources including the use of the author's own common sense observations. Attempts to get access to the MVOA files proved futile at first until later on when one of the officials accepted to offer some data from the files. A major source of secondary data used to verify the inaccuracies were documents and copies of the TRANSPORT magazine, a registered company of the Matatu and Country Bus journal.

The Commuters interview survey was equally made difficult to conduct due to a few respondents who simply refused to be interviewed stating that they had no time to waste. This indifference, however, was only in a few instances. Otherwise the response was commendable as is shown in Appendix VI. The subject matter of the study aroused much interest among most commuters hence they were generally cooperative and felt this was an area that required much attention.

The two questionnaires had been constructed with a view to getting the points of view of both the commuters and the operators of the system. In administering the questionnaires however, some difficulties had to be encountered. Most noticeable was the fact that some respondents chose not to answer some questions generally because "they did not have time". Moreover, a major weakness of the questionnaires which the author found out in the cause of conducting the interviews was that some of the

questions did not give the respondents pre-constructed problems and solution suggestions on which to put their feelings. Such questions instead expected them to give their views without any directions but in the later stages of the fieldwork, after this difficulty had been discovered, it was possible to discern the stated suggestions (especially concerning the problems and the suggested solutions) by a classification of the wide variety of answers given.

This study covers the whole of Nairobi area which also made it rather difficult and complex to handle hence the fieldwork had to be organised in stages or phases and carried out on a team basis. This made it rather expensive and time consuming but in the end it was possible to collect the available data.

2.2: DATA COLLECTION.

This study relies on both the secondary and primary sources of data. In some cases, both are used interchangeable to verify or supplement in cases of loopholes or suspected inaccuracies. The early stages of the research was spent on an intensive review of pertinent literature on transportation in Nairobi. These included,

(a) reports on transportation planning and policy in the city from the NCC library.

(b) KBS Research papers and files.

(c) Matatu Vehicle Owners Association (MVOA) documents.

(d) technical papers of the Nairobi Urban Study Group (NUSG) report,

(e) Transurb Consult-Belgium government report on Nairobi's public transport system.

Various other books and publications on Transportation Geography in general were also consulted. Maps concerning the city's road network were collected and later analyzed to identify the matatu routes and terminals, to measure the matatu road network density or areal coverage in various matatu users zones, and to phase out how the work was going to be carried out. Data on population distribution as per the 1979 census and projections were also collected. The NCC library and documents were also used to estimate the average income levels of the residents of the various administrative wards.

The first stage of the fieldwork involved conducting a matatu traffic volume census. This was done for a period of one month (November 1987). Three research assistants were assigned to count and record the vehicle registration numbers, their body types, and the official carrying capacity of each one of the vehicles serving each particular route. They also recorded and provided estimates of the numbers of people employed in each matatu (Appendix I) The results of this survey were corroborated with MVOA figures to estimate the number of matatus serving each zone or route in Nairobi. This was later used in the designing the sampling procedure for the matatu owners and or operators.

In order to understand the daily operations of matatus in various routes the second stage of the fieldwork involved assigning the same research assistants to make trips on an average of ten matatus in every route. In doing this they had to maintain an inventory of the matatu travel times, the number of times they stop to drop and to pick passengers,and the number of excess or standing passengers in each. In each case a brief description of the methods of collecting the commuters especially in the CBD terminals is also given. (Appendix II). This process took roughly ten days with trips being made for each route during the following daily periods;

a) Morning rush hours (7.00 a.m to 9.00 a.m)

b) Lunch time hours (1.00 p.m to 2.00 p.m)

c) Evening rush hours (5.00 p.m to 7.00 p.m)

d) Morning non rush hours (10.00 a.m to 11.00 a.m)

For each time period at least two trips had to be made for every route within Nairobi area. While all this was going on the author had to carry out survey visits.

2.3.1: SAMPLING PROCEDURE.

Any study on the efficiency and quality of service of an urban transportation system should implicitly be concerned with the view points under which the study is supposedly conducted. Traditionally, most analysts have adopted the view of the

operator-supplier of the system's services to proceed to examine the system from this point of view. However, such studies do not provide us with a comprehensive view of what are the inputs of the system and of what is produced by the system since the operator-supplier does not control or invest all the required inputs nor does he benefit from or utilises all the outputs that the system produces. Instead all those involved in the system's functions including the commuters or users and the policy makers should have their points of view considered together with that of the operator-supplier of the system.

In order to get these views, this study had to interview a sample of matatu owner and or operators together with the commuters both of whom are the major actors in the system's provision of public transportation services. To represent the policy makers whose views are equally important as a means of identifying the key policy issues, some key respondents who are directly involved in Nairobi's public transportation system were also interviewed. This included personnel of the MVOA, and NCC personnel. The first two points of view involved large populations hence the need to choose a representative sample of the matatu owners and or operators and the commuters. The details of how this was done are presented below.

a) Matatu Owners and / or Operators Sampling Survey.

For the purpose of this survey the matatu was regarded as

the unit of study. The matatu drivers and or conductors were interviewed with a view to knowing the points of view of the operator-supplier of the system (Appendix III and IV). In each case either of the two was interviewed since it was assumed that each has an equal knowledge of the main operational dynamics of the system. The interviews were carried out in each of the matatu terminals shown in Figure 2.1. Since the number of matatus

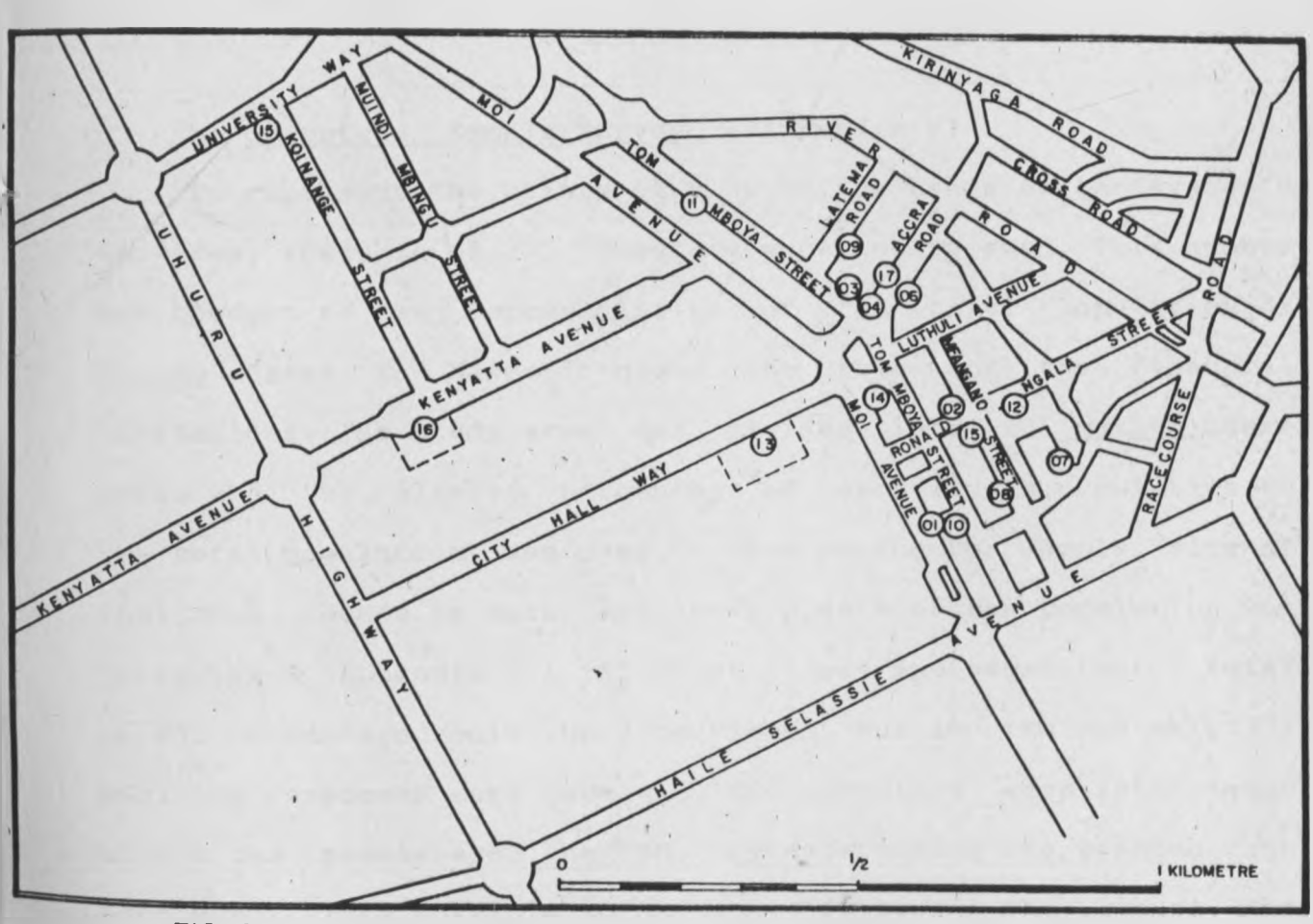

FIG. 2.1: MATATU TERMINALS IN THE NAIROBI CITY CENTRE

serving various routes and operating in the various terminals vary, the following sampling procedure was adopted for a random selection of the matatus to be surveyed.

No of Matatus using terminal and \ or serving zone or route.	Select Every;
1 - 10	2nd.
11 - 30	3rd.
31 - 40	4th.
41 - 60	5th.

b) Commuters Sample Survey. (Appendix V)

To represent the points of view of the users of the system's services, a sample of 371 commuters were interviewed. This number was thought to be representative of the total population of matatu users in Nairobi given the time and the financial limitations. The study area was divided into 13 matatu users zones and the relative percentage of each zone's population to the total population was used in determining the sample size of that zone. Hence in each case about 0.04 % of the population was interviewed (Appendix VI). At first it was envisaged that a total of 400 commuters would be interviewed but in the end only 371 positive responses were received. The commuters were interviewed within the premises of the CBD terminals during the evening rush hour when it was possible to get most of them in the queues. The

random sampling procedure used depended on the sample size hence the procedure for selecting every 2nd,3rd,4th.., or 5th. commuter met within the terminal was used as is the case of the matatu owner and operators survey. In most cases the questionnaires had to be administered as quickly as possible to the convenience of the commuter respondents most of whom were often in a hurry to reach their destinations.

2.3: DATA PROCESSING, ANALYSIS AND PRESENTATION.

2.3:1. DATA PROCESSING.

This involved two stages namely, editing and tabulation. Both were mainly done manually or mechanically with the help of scientific calculators. Though this was a laborious job hardly free from mistakes which may be inherent in the analysis, it was the only alternative available to the author who sought the help of two research assistants who had been in the field with him. But the tables and graphs were compiled using an IBM Epson Micro-Computer.

a) Editing- refers to the removal of facts which do not lend themselves to analysis in this study. This was necessary in cases where the information collected was in excess of what was required. Such data or information had to be summarized and heavily truncated. This was especially done to data collected from the field interviews where it was found necessary to consider only the variables important for this study. In case

where the data was unavailable for certain aspects of the study, it became necessary to look for such data elsewhere (secondary sources) or not to cover such aspects as had been envisaged in the proposal. Since some questions in the two questionnaires were structured, pre-coding of some data was possible. After the completion of the survey a code book was prepared and the required or already edited questionnaire data coded in computer sheets.

b) Tabulation- refers to the processing of raw data with a view to presenting them in forms suitable for the study requirements. The main technique used in the analysis of this tabulated data was the calculation of percentages, and the drawing of graphs and matrices which was done using an IBM Epson Micro-Computer.

2.3:2. DATA ANALYSIS.

This study uses two major quantitative techniques to statistically test the validity of the two hypotheses it advances. These hypotheses and the statistical methods used to test each one of them are presented below.

(a) Hypothesis 1: The relationship between the distribution of matatus and population distribution in Nairobi.

This hypothesis is advanced to show whether matatu in

Nairobi have emerged and operate with a view to improving the mobility and accessibility needs of the city's residents. It is assumed that the distribution of population is a major factor influencing public transport demand in Nairobi hence areas of a high population density often also have the highest public transport demand than those of a lower population density. The null hypothesis advanced by this study states that there is no strong functional relationship between the distribution of matatus in Nairobi and population distribution. Instead, there are other factors or variables which influence the distribution of matatus much more than population distribution. Among these variables are the distances covered by the matatus in the various trips which they make, the profitability levels of the routes in which they operate, and the income levels of the residents of the routes or zones which they serve. To some extent all these factors are related to each other and all of them influence the distribution of matatu services in Nairobi.

Such an hypothesis would probably bring forth a few dissenting voices because it is population distribution which actually influences public transport demand, but unanimity as to the relative importance of population distribution in influencing the distribution of matatu services distribution in Nairobi as compared to other factors, or the closeness of these relationships over the entire area is less certain. This called for the use of correlation analysis techniques which designated

the distribution of matatu services as a dependent variable whose relationship with other independent variables is analyzed in order to prove this hypothesis.

The data used to characterise the variables required a special type of processing before the analysis could proceed because, the results of the analysis were desired in a form suitable for geographical description and analysis hence the study area was divided into 26 routes in which the distribution of each of the variables was considered. This conspired to create several problems that were inevitable taking into consideration the fact that such statistical techniques were being used here to map variations from place to place. In order to by pass such problems most of the data used herein applies to points or the routes' terminals and unit area of the various zones. This study assumes that matatu routes are inclined to serve only particular zones which is represented by the route terminal. Hence the number of matatus serving a particular zone or route for example only do so by making trips to and from their destinations. In other words, the number of matatu plying through and using a particular numbered routes is considered in this analysis as serving only those within it's destination's zone. (Figure 2.2). Such an assumption had to be made bearing into consideration the fact that during the peak demand hours the matatus have to make non-stop trips to their destinations hence they mainly serve

those in the zone where the residential destination lies. In each case, the last residential terminal was chosen to represent the destination point/node of the matatu operations. The selected 26 zones/routes are listed in Table 2.1 below which is also a key to Figure 2.2.

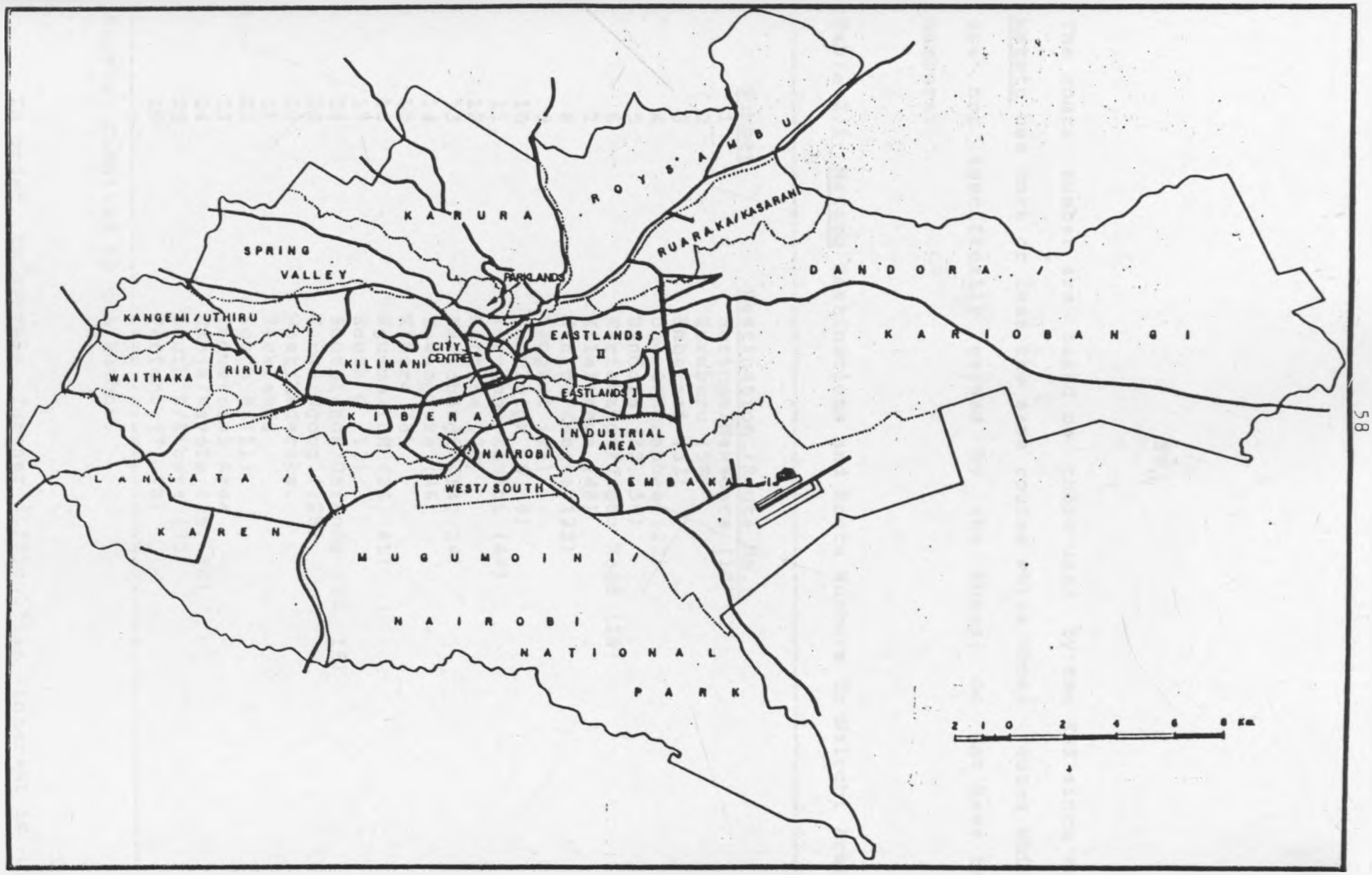

FIG. 2.2: NAIROBI: MATATU ROAD NETWORK DISTRIBUTION

The route number are based on those used by the KBS since the matatu use more or less the same routes while those routes which are not specifically served by the buses, do not have the numbers.

Table 2.1: Matatu Destinations and Route Numbers in Nairobi Area.

Number	Destination.(Route No.)
1	Maringo/Makadara (10)
2	Buruburu (58)
3	Embakasi (33)
4	Uhuru/Harambee (23)
5	Dandora (32, 36)
6	Kariobangi/Jogoo Road (26)
7	Kileleshwa (48)
8	Uthiru/Kabete (22)
9	Kangemi (23)
10	Eastleigh (6, 9)
11	Roysambu/Kamiti (44)
12	Mathare (30)
13	Kariobangi (14, 24)
14	Kawangware (46)
15	Kibera (8)
16	Ngummo/IDH (33, 41)
17	South C (12)
18	Southlands/Otiende (14, 15)
19	Karen/Ngong (125)
20	West/Madaraka.
21	Parklands
22	South B (11)
23	Industrial Area
24	Umoja/Kayole (35, 60)
25	South B/Kibera (33)
26	Jericho (7, 8b)

Source; Compiled by the Author.

In order to by-pass further difficulties inherent in the analysis of such data standard measurements of each of the

variables had also to be carried out, including a measurement of the matatu road network areal coverage. The methods used in each case are presented hereafter.

a) Measurement of the Matatu Road network distribution.

The areal coverage of the matatu road network in each zone had to be measured as part of the process of showing and comparing the efficiency of matatus in promoting the level of accessibility in the study area. For comparison sake the study area was divided into Fifteen matatu users zones and the matatu routes passing through each zone identified. (Figure 2.3). The following two equations were used as measures of the network's areal coverage in each zone. (Ruppert,1979).

(1) $DS = A/L$ . . . . . (2.1)

(2) $Ca = Al/A$ . . . . . (2.2)

where,

DS = the network's density of access by fraction.
Ca = the network's comprehensive accessibility by the ratio.
L = the total length of operational matatu routes in each zone
A = area of each zone in kilometre squared.
Al = area within a distance of 200m from the operational matatu route.

These two equations measure the areal coverage of the matatu road network. Since matatus almost always stop anywhere along their routes, every point along the route is considered an access point. Equation 2.1 estimates an average amount of area for the access routes .

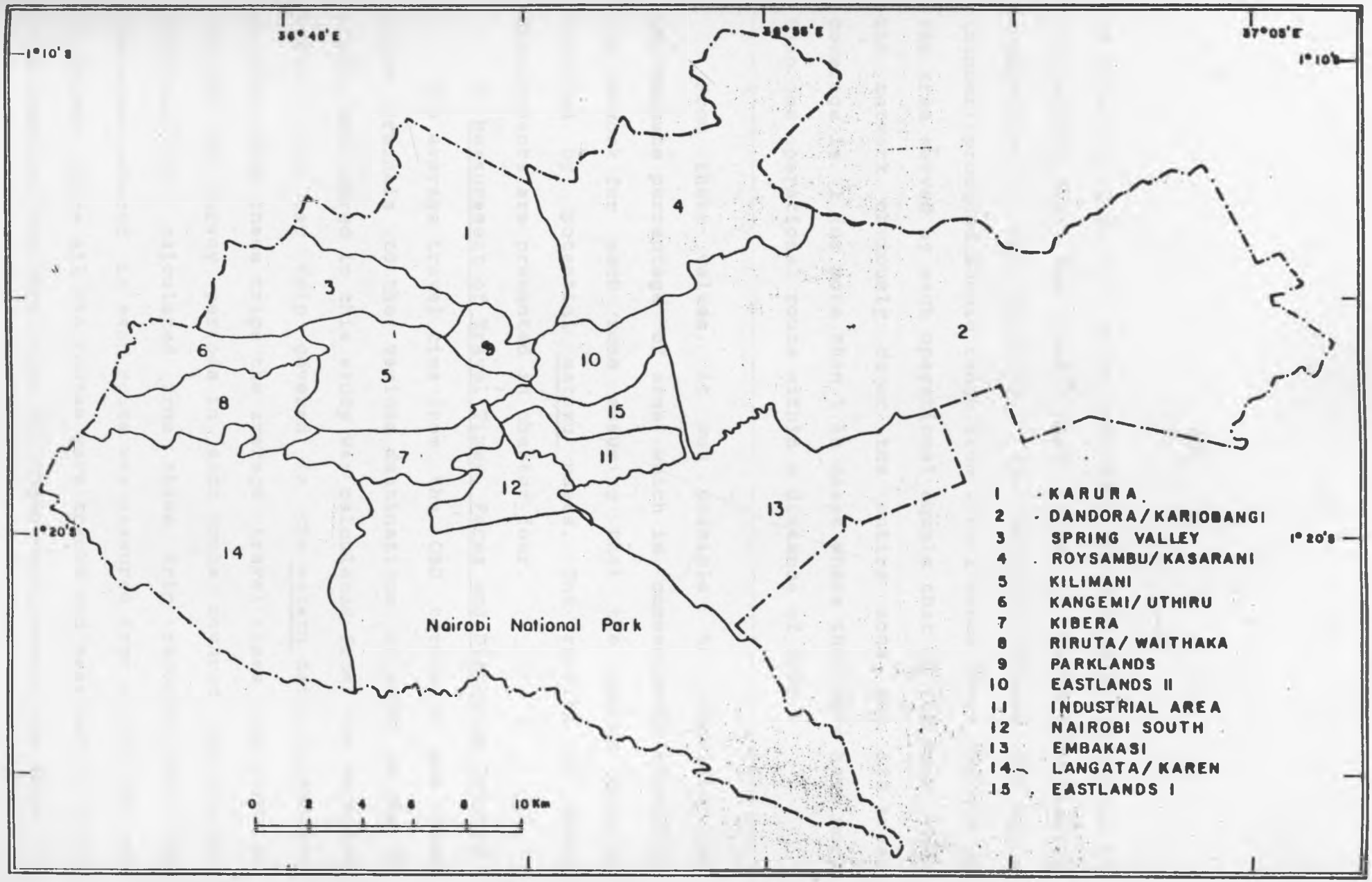

FIG. 2.3: NAIROBI: MATATU USERS ZONES

In Equation 2.2, this study considers those within a distance of within 200m from the operational route as being conveniently accessible to the route and the services offered. The value (number) produced should range from 0 to 1 hence where the sum of the area served by each operational equals that of the zone, then the network obviously cover the entire zone and its areal coverage is 1 (or more than 1 in cases where the users have more than one operational route within a distance of 200m.)

From these values, it was possible to calculate the approximate percentage of area which is conveniently served by the network for each zone assuming that the entire zone is occupied by potential matatu users. The results of these measurements are presented in chapter four.

b) Measurement of Travel Times, Fares and Distances Covered

The average travel time from the CBD terminals and other outer terminals to the various destinations of each of the 26 routes considered in this study was calculated from the recorded travel time per trip covered in the matatu daily operations surveys. From these trips the average travel times was computed for all the survey periods in each route covered. The average fare was also calculated from these trip records while the distances covered in each route was measured from a 1:50 000 map of Nairobi where all the routes were traced and measured to scale in Kilometers. The results of all these measurements are shown in

Appendix VII.

c) Measurement of Population Size, Density and Income Levels

The major source of population data included the Nairobi Study Group Report (1973) and technical papers, the 1979 population census, the Transurb-Consult Belgium Government report (1986) and projections made by Jarabi (1982). Since it was difficult to get the exact population served by matatus in each route, the population for each administrative ward or a combination of wards based on the 1979 census was used. In order to provide a rough estimate of the current (1988) population for each zone or route, the Naive Model was used (Kashuba,1974 p.28). This model assumes that the proportion of a zone's future population to the total future population of a region is the same as the proportion of the zone's present population to the present population of the region. ie.

$$Fz = Ft \cdot Pz/Pt, \quad . \quad . \quad . \quad . \qquad (2.3)$$

where,

Fz = future zone population.

Ft = future population of the region.

Pt = present population of the region.

Pz = present population of the zone.

The data on the actual population density for each zone was obtained from the NUSG (1973) projections while those for the average income levels of residents in each ward are based on a NCC (1986) projections which provide an estimation of the range of incomes earned by residents of each ward.

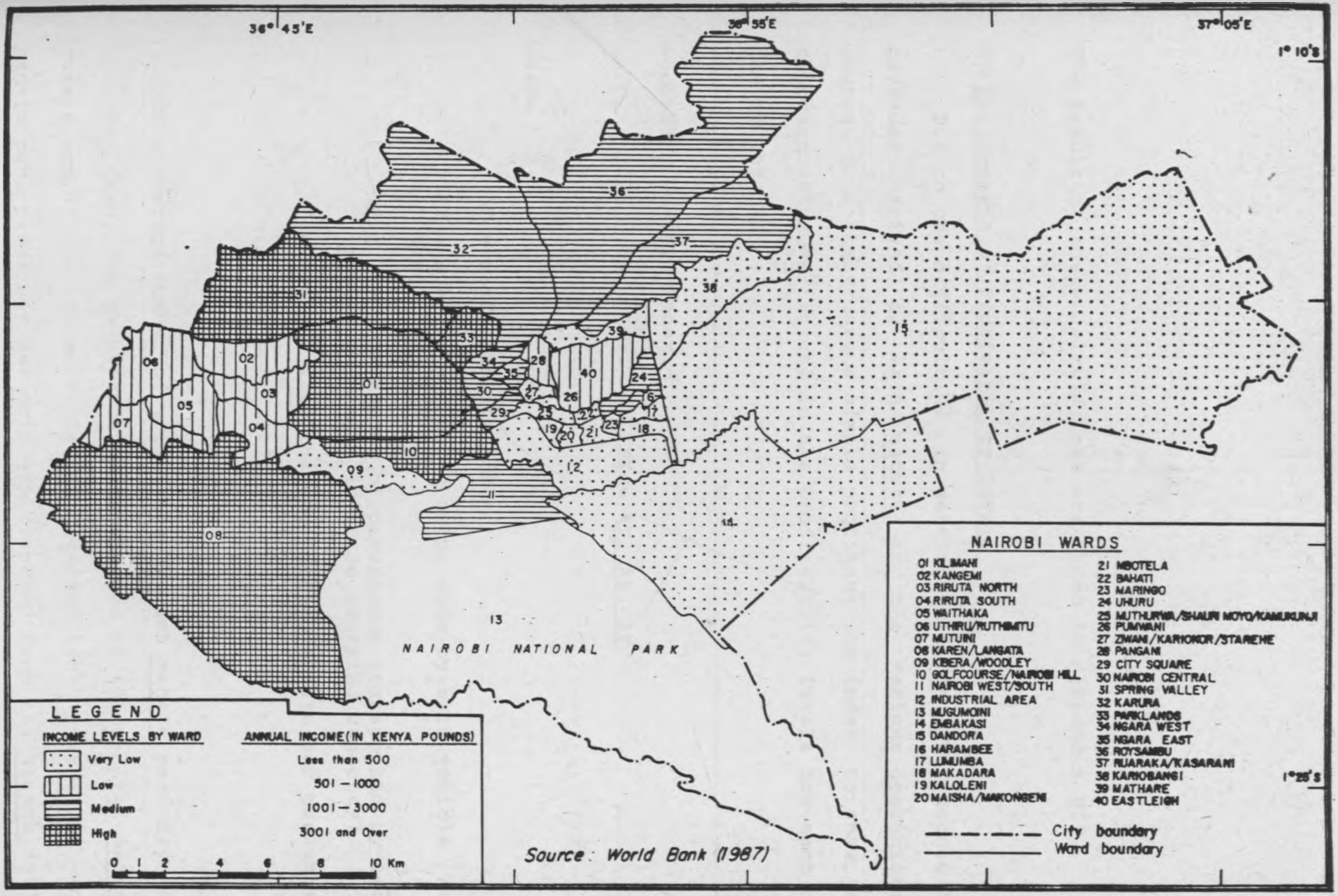

FIG. 2·4 NAIROBI: THE DISTRIBUTION OF INCOMES BY WARDS

The result of these calculations are shown in Appendix VII.

d) Measurement of Profitability Levels.

Due to the difficulties in getting data on the incomes or revenues derived by each matatu in the various operational routes, this study uses a simple profitability index to show the representative variations in the profitability levels for each of the routes.

According to this index:-

$$PI = \frac{AT.\ AP.\ AF}{k} \quad \ldots\ldots\ldots \quad (2.4)$$

where

PT = profitability index

AT = average number of trips made by each vehicle in that route per day.

AP = average number of passengers transported by each matatu per trip (average carrying capacity).

AF = average fare charged by each matatu per passenger

k = a constant (100).

The average number of trips made by each matatu per day was computed from the questionnaire responses of the sampled matatu owners and or operators while the average fare charged by each matatu per passenger per trip was computed from the matatu daily operators survey. The average number of passengers transported by

each matatu per trip was computed from records of the matatu traffic volume census. In order to make a better approximation of this, the vehicle carrying capacity for 25-seator matatus was put at 45 taking into consideration their ability and tradition of being capable to overload and carry this much while that of the 18 seator matatus was put at 20. From this, it was possible to calculate the total number of passengers who can be transported by all the matatus in each route per trip. This value was then divided with the number of matatus serving each of the routes to approximate the average number of passengers transported by each matatu per trip for every route. (Appendix IX).

In each of the above measurements for each matatu users zone or route in Nairobi, the differences between the various routes or zones was considered and the relationship of each of the variables to the zonal distribution of matatus was considered. To show whether the relationships in each case was strong or weak, positive or negative, and to identify the variable which has the strongest functional relationship with the distribution of matatus, two kinds of correlation coefficients were obtained from the above set of data namely,

(1) the Coefficient of Simple Correlation (r) which describes the degree to which two of the variables are associated. The formula for the calculation of this correlation r from the original values used in this study is,

$$r_{xy} = \frac{\Sigma (xy) - nMx.My}{\sqrt{[\Sigma (x^2) - nMx^2][\Sigma (y^2) - nMy2]}} \quad . \; . \; . \; . \; (2.4)$$

where n = the total number of routes considered = 26
y = each of the independent variables
x = the dependent variable.
M = the mean.

In order to display the degree of association between the variables, a correlation matrix was produced in which the correlation coefficient of each of the relationships was shown. The correlation coefficient is an index of the degree of linear association between a pair of variables. It is defined as the ratio of their covariance. The coefficient varies from -1.0 for a perfect negative relationship through 0.0 for no relationship, to 1.0 for a perfect positive relationship. The correlation matrix was used to display the strength and direction of the relationship between the variables. It indicates those variables which are associated to a greater extent or a lesser extent together with the direction of the relationship between the variables.

In order to measure the percentage to which the variance in the dependent variable (Y) is determined by the independent variable (X), the Coefficient of Determination (r^2) was computed

for each of the relationships. This provided a more direct and unequivocal way of stating the proportion of the variance in the dependent variables which is associated with the independent variables in each case. The Coefficient of Determination is defined by the equation,

$$d_{xy} = r^2_{xy} \quad . \quad . \quad . \quad . \quad (2.5)$$

(2) <u>The Coefficient of Partial Correlation</u> which measures the correlation between the dependent factor (matatu vehicle capacity distribution) and each of the several independent factors or variables while eliminating any (linear) tendency of the remaining independent factors to obscure the relation. This was done using the formula;

$$r_{ij.k} = \frac{(r_{ij}) - (r_{ik})\ (r_{jk})}{\sqrt{1-r_{ik}^2}\ .\ \sqrt{1-r_{ik}^2}} \quad \ldots\ldots\ldots \quad (2.6)$$

if variable k. is eliminated.

where, Rij = the partial correlation coefficient between the dependent variable (matatu vehicle capacities) and factor i and j controlling for factor k.

The Partial Correlation Coefficient eliminates the concomitant relationships among other variables while examining the relationship of any pair. This removes the effect of spontaneous

correlations with other factors. The relative sizes of the coefficients of partial correlation provide a truer description of the relative correspondence of each of the independent variable with the dependent variable, hence it is used here to further confirm the hypothesis that the distribution of matatus services is functionally related to population distribution. Since most of the variable pairs were highly interrelated, it was not possible to apply Multiple Correlation Analysis in estimating the variance explained by the independent variables taken together. In such a case, Partial Correlation Analysis was preferred. However, before arriving at any conclusions, the following test had to be carried out.

(a) Testing for the Reliability of the Correlation Coefficients

This was done using the Fisher's Method for determining the reliability of correlations (Fisher,1928, p.664). This figure (graph) is based upon the idea that although we cannot be sure of the true correlation in a given sample, we can estimate a minimum value for the correlation with a given chance of being wrong. It has been calculated from Fisher's results to show that such probable minimum correlation in the universe with the probability that the statements based on the figure will be wrong for 1 sample out of 20 on an average. On this basis the results have been plotted for different sizes of samples and observed correlations and are graphically presented in the figure. Thus if the coefficient of simple correlation r_{xy} = 0.65, is obtained

from a sample of 22 cases, a researcher can know from the figure that if he makes the statement that the true correlation in the universe is at least 0.38, he will be wrong in only 5 % of such statements on the average.

Alternatively, a test of the significance of the observed correlations was carried out by calculating the t-value where,

$$t = \frac{\sqrt{n - 2}}{\sqrt{1 - r}} \quad . \quad . \quad . \quad (2.7)$$

This value was also used to indicate whether the correlation was significant or not, and hence to show whether the findings were consistent with the hypothesis that there is a strong functional relationship between the distribution of matatu services and population distribution.

(b) Testing for Multicollinearity.

This is a phenomenon that occurs when two or more independent variables tend to move together in the same pattern showing that they are highly correlated and it is difficult to separate their respective effects on the dependent variable. There are various measurements which have been designed to check for this but this study chose to use that of computing for the determinant expansion of the matrix of the correlation coefficients r. (Wynn and Holden, 1974) The determinant expansion of the matrix r is referred to as the Correlation Determinant (c,d), [r] which has

the boundaries 0 and 1, demarcating the range between perfect multicollinearity and the total absence of any linear independence between regressors. Hence if for example, X_i is perfectly correlated with X_j so that X_i has the same zero-order correlation coefficient with X_k, and X_c as has X_j, then this represents a situation of perfect multicollinearity. In such a situation the elements of the first two rows and columns in matrix r will exactly correspond in which case, its determinant expansion is zero as shown below.

$$\begin{vmatrix} 1 & 0 \\ 0 & 1 \end{vmatrix} = 0 \quad \text{(PERFECT MULTICOLLINEARITY)}$$

$$\begin{vmatrix} 1 & 1 \\ 1 & 1 \end{vmatrix} = 1 \quad \text{(ZERO MULTICOLLINEARITY)}$$

Since the correlation coefficient values could only be used to make summary statements concerning the relationships between the distribution of matatus and population distribution in the entire area, they could not be relied on alone. There was need to show whether the relationships hold close to regional variations. This called for the use of the linear regression equation. It was meant to express the average relationship that exists between the two and it is expressed as:

$$Y = a + bX + e \quad . \quad . \quad . \quad (2.8)$$

where, Y = the dependent variable.

a = intercept

b = slope coefficient.

X = the independent variable

e = error term.

After drawing scatter grams to show the nature of this relationship, the linear function was found to be usable only in a few of the relationships. The values of a and b were computed using the formulas below,

$$b = \frac{(xy) - nMx\ My}{(x^2) - n(Mx)^2} \quad . . . (2.9)$$

$$a = Mx - bMx \quad . . . . . (2.10)$$

The line of best fit was then determined in which the value of a represents the height of the line of the independent variable, X = 0 while the statistic for b indicates the difference in the dependent variable, Y for every different 1 unit in X, on the average of all the observations, and only within the range covered by the original observations of X.

(b) The 2nd. Hypothesis: <u>The Quality of Service Attributes of Matatus in Nairobi.</u>

This hypothesis was advanced with a view to explaining why matatus have continuously attracted a relatively high number of commuters than the buses or why they are frequently used than the buses by most of the city's commuters. This study bases its arguments on the abstract mode model which highlights the importance of a mode of transport's quality attributes in explaining the demand for its services. According to this approach the demand for travel by any mode is a function of the various characteristics or attributes of the mode as well as the general socio-economic conditions confronting the users. This study attempts to apply this argument to an urban public transportation situation in which it is used to explain the demand for travel by matatus vis-a-vis the buses. However, it considers the socio-economic conditions affecting Nairobi's commuters as uniform. In view of the excessively high demand for public transport services, the study attempts to explain the factors which account for the increasing use of matatus despite the inherent dangers associated with their operations.

The study advances the Null Hypothesis that there are no significant quality attributes of matatus which explains their usage apart from the fact that they are most frequently available. In other words, the frequency of service of matatus vis-a-vis the buses is the only factor which accounts for their usage and that of other modes of public transport. Alternatively, the relative attractiveness of matatus can be attributed to many

other factors or quality attributes which they posses and which are highly valued by most commuters in Nairobi. Among these factors which this study considers are, comfort, safety, speed or time taken, reliability or regularity and cost which were ranked in order of preferences by the sampled commuters interviewed.

As a test of the significance of the results of the commuter responses, the Concordance Coefficient (W) was calculated using the formula below (Kendall, 1955 p.24),

$$W = \frac{12\ S}{m^2\ (n^2 - n)} \quad . \quad . \quad . \quad (2.11)$$

where, S = sum of squares of the deviations of the ranks from their mean.

m = the sample size.

n = number of objects (quality attributes) considered.

This provides a means of assessing the degree of consistency among the ranks. Hence if in accord with the scale hypothesis, the respondents can be regarded as having fully supplied replications of the theoretical class of observations, the expected value of this coefficient W will be 1.0. The coefficient W permits the evaluation of the extent of agreement among the ranks. If all the respondents agree perfectly, it has a value 1.0 while if they disagree maximally, it has a value 0.0.

In order to identify the factors which most influence public transport modal choice especially as concerns the buses and the matatus, this study uses the Thurstone's Law of Comparative Judgement Case V. (Thurstone, 1927). This is a model that estimates scale values from sample preference proportions. It allows for the construction of a unidimensional interval scale using responses from variability data collection procedures such as paired comparisons. In this study, it is used as a means of estimating scale values derived from the respondents' ranking of quality attributes in order of how they value each one of them. The scale values, therefore, show which factors are highly valued by the respondents in their choice of modes of public transport in Nairobi. The procedure used is presented below.

(1st) The total number of times each factor is preferred to the other is calculated.

(2nd.) A matrix of sample proportions is generated based on the formula,

$$P_{jk} = C_{jk}/(C_{jk} + C_{kj}) \quad . \quad . \quad . \quad . \quad (2.12)$$

where, P_{jk} = the proportional number of times j is preferred to k

C_{jk} = the total number of times j is preferred to k.

C_{kj} = the total number of times k is preferred to j.

$(C_{jk} + C_{kj})$ = the total number of times the two are compared. (ie the sample size)

This produce a 6 x 6 matrix of sample proportions. The maximum

perceived similarity between any two factors would have the values 0.5 which also represents an increase in the perceived dissimilarity between the factors in question. A measure of the perceived dissimilarity, d_{jk} therefore becomes $P_{jk} - 0.5$, hence if $d_{jk} = 0$ then there is no dissimilarity meaning that the number of times each of the two factors is preferred over the other is equal (or the same).

(3rd) From the matrix of sample proportions, a matrix of Z-scores is then calculated using the formulas and procedures presented below.

$$Z = \frac{x - x}{S} \quad . \quad . \quad . \quad . \quad (2.13)$$

where, $S = \sqrt{S^2}$

$$S^2 = \frac{\Sigma x^2}{N - 1}$$

and

$$\Sigma x^2 = \frac{\Sigma x^2 - (\Sigma x)^2}{N}$$

If $P_{jk} < 0.5$ then the value is a negative while if $P_{jk} > 0.5$ then the Z value is a positive.

(4th.) The column totals of the Z values are then computed and the scale values for each factor obtained by calculating the simple average of each column's Z values. This scale value expresses each factor as a derivation of the mean of all the

scale values. (corresponding to the 6 factors). Using this procedure, the mean of all the 6 scale values will always be zero.

(5th.) The reference point of zero is determined. This is done by arbitrarily considering the least valued factor to have a scale value of zero then fixing all other factors on a single line based on their relative position to the least considered factor. From this linear scale it is then possible to determine how much one factor is preferred to another on this aggregate attribute.

One advantage of this method is that from the scale values we can work backwards to approximate how well the model fits the original proportional data. For example, if factor x had a scale value of 0.09 and factor y had a scale value of 1.06, then it is possible to predict the proportion of respondents preferring factor x to factor y and vice versa. This is done by first getting the scale difference, (0.09 - 1.06 = -0.97). From a table of inverse normal distributions, the proportion of the area under the standard normal curve corresponding to a Z-value of -0.97 is looked up. A Chi-square test was then used to estimate the goodness of fit or to determine how close the predicted proportion is to the observed proportions using the formula below.

$$X^2 = \frac{\Sigma(O''_{jk} - O'_{jk})}{821/n} \quad . \quad . \quad . \quad (2.14)$$

Source; Mosteller, (1951).

where, O'_{jk} = arc sin$\sqrt{P_{jk}}$; = the observed proportion

O''_{jk} = arc sin$\sqrt{P_{jk}}$; = the predicted proportion.

n = number of people making comparisons (sample size).

821 is given.

degree of freedom = (k -1) (k - 2)/2. (k = number of factors.)

The computed value of x can be compared with the critical x value at the 95 % confidence level and a decision made as to whether the model fitted the data well.

The use of the stated consumer preference (as is done in this study) as a means of analyzing the most preferred or highly valued variable in studies of choice behaviour has been a long time subject of debate. The opponents of the stated preference approach, where the respondent provide subjective judgement by ranking his preference, argue that the limitations of using the questionnaire to obtain preference include the difficulty of designing and administering it. They argue that one cannot presume that the respondents can reliably report their preference ranking of a set of alternatives because people may consciously or unconsciously convey a preference that is at odds with their true preference, and than it may not be scientific to assume that people will consider all the major attributes of the factors which influence their preference before they rank them.

Moreover, it may not be scientific to assume that people will consider all the major attributes of the stimuli that influence their preference before they rank the stimuli. According to P. Gould and R. White (1974), when respondents are asked to rank stimuli, they will find some comparatively easy to rank while others may pose serious problems. Most people may find it easier to rank the factors which they like and dislike but there will nearly always be a number of factors which lie in the middle to which the respondents are indifferent hence the order in which these are ranked may be blurred. Due to this, the first and the last factors are often easily distinguishable while there is some kind of random noise in the middle.

The other approach, the Revealed Preference Approach, relies on the observation of the actual overt choice. Most commuters in Nairobi are "captive travellers" whose choice of a mode of public transport depend mainly on the "first come first used or chosen" argument. Because of the excessively high demand for public transport services, most of the city's commuters often choose the mode of public transport that is most available or most frequent. Due to this the actual (observed) choice in this case may not necessarily be representative of the preference.

Under such circumstances, this study was therefore left with little alternative but to use the stated preference approach in attempting to explain the factors which are most highly valued by

the commuters in Nairobi in their choice of modes of public transport. It relies on the assumption that the stated preference is the most suitable especially because it actually represents the views of the commuters under ideal conditions.

CHAPTER THREE.

URBAN STRUCTURES AND PUBLIC TRANSPORT SYSTEM IN NAIROBI.

This chapter is divided into two main sections which are primarily concerned with a description of the urban pattern and public transport system prevailing in Nairobi. The first section describes the origin and growth of Nairobi's public transport system within the context of showing how the combined effects of geographical, historical and contemporary forces have shaped the city's public transport problems and prospects. It mainly looks at this with reference to the growth and development of each of the modes of public transport operating in Nairobi, especially the increasingly important role played by matatus. The second section looks at the past and current planning responses to these problems and the existing institutional framework for transport and implementation.

3.1: THE ORIGIN AND GROWTH OF NAIROBI'S PUBLIC TRANSPORT SYSTEM.

The present role and prospects of Nairobi's public transport system and the matatu mode of public transport in particular, has been shaped by the population pressures, urban structures and the general transportation system prevailing in the city. The current profile of the city has in turn been shaped by the influences of the geography, the historical factors and contemporary forces some of which have already been discussed in Chapter 1.

Many of the current problems that plaque public transportation in Nairobi are attributed to the high urban population growth rate, the lack of vehicle capacities, energy costs, utilization of infrastructural facilities, location of high density residential areas, lack of road and vehicle maintenance, road safety, manpower training and development, and policy and institutional developments (NUSG, 1973). These problems are not new to Nairobi nor are they unique from those existing in other LDCs. In order to understand their evolution, it is therefore equally paramount to understand the city's history, preferably both the colonial and post-colonial eras, and the regional economic, social, and geographical interactions between the city and the region surrounding it. Colonialism and the political legacy of colonial communication patterns have had both negative and positive major effects upon the modern public transportation policies and much of the development of post independence transportation systems (Situma, 1987). Nairobi's land-use development portrays a classic example of this colonial influence. The street layout, the residential locations, the CBD location, the racial residential separation, architectural peculiarities, and several other urban features portray these colonial and alien planning concepts. These concepts have influenced the city's public transport system. As a colonial settlement, the configuration of Nairobi during the colonial period was essentially tripartite in character with the

Europeans, Indians and Africans occupying different residential zones and making contacts mainly on official and business matters. Within this configuration the residential areas of the Europeans which were sited in the wooded ridges of fertile red soils to the north and west were well served by transportation facilities hence it was relatively trouble-free in terms of movement problems. Typically the earliest urban form pattern in Nairobi by the 1920's was dominated by a major trunk road commencing from the CBD to the hinterland with a spur to the industrial area. Meanwhile, the residential areas of the Africans were left to develop towards the east away from the major trunk road. This accommodated the vast majority of Nairobi's population and were characterised by poor transport access both to the city's transport network and within the area itself. The continuous flow of rural migrants into these residential areas accentuated their already congested situation both in terms of living and movement space so that the already high residential density levels were incessantly being increased. Table 3:1 below shows the rate of increase of population of the various racial groups in Nairobi as from 1906 to 1979.

Table 3:1, Nairobi: Population Growth By Race; 1906 to 1979.

Year	Africans	Europeans	Asians	TOTAL
1906	6,351	579	3,582	11,512
1926	19,112	1,492	9,260	29,864
1931	26,761	5,195	15,988	47,919
1948	65,939	10,830	41,810	118,579
1962	115,388	21,476	87,454	266,795
1969	421,079	19,185	67,189	509,286
1979	695,353	33,511	108,911	837,775

Sources; Based on Kenya,(1948, 1962, 1969 and 1979) Population censuses

Characteristically, however, this growth in the population of the Africans did not immediately manifest itself in many additional journey to work movements from their zone to other parts of the city since most migrants confined themselves within their residential localities in Eastlands. Their sustenance revolved around the activities within their residential areas, moving around on foot or on newly bought bicycles leaving the more established members working further away to commute daily.

This state of affairs partly accounted for the relatively trouble-free movement of people during the colonial period, and the generally lower demand for public transport services then. When the KBS started their operations in Nairobi in 1934, it could only operate 12 buses as by 1950 and even these were just enough to serve the existing population's public transport demand. Moreover, most residential areas such as Pangani, Landi-Mawe, Muthurwa, Pumwani, Shauri Moyo and Kamukunji were within walking distance to the CBD hence walking was a predominant mode

of commuting for most residents then. These neighbourhoods still remain the most densely populated and even by 1970 it was estimated that 48 % of the commuters in Nairobi walk to their places of work (NUSG, 1973).

The need for public transport services increased as the city expanded and witnessed an increase in the number of well to do Africans. Within the African residential zones, mainly in Eastlands, the motorization levels slowly increased as Africans who were observing the rapid growth in the local population hired and bought vans mainly used to bring foodstuffs from the rural areas to feed the growing population. This led to an emergence of informal public transport services within these areas and these became very common as the African residential areas grew and the travel demand increased. It is during this period that the matatus emerged especially in the 1950's when they were mainly used in transporting the residents of the African neighbourhoods to the nearby rural villages. The word "matatu" is derived from the local term "mango'tore matatu" meaning thirty cents which was the standard fare charged then.

Since the African residential areas were invariably outside the interest and activity spaces of the colonialists, the official knowledge about their development was confined to heresay and their movement problems passed largely unrecognized. They did not figure in any major transportation plans of the

time. Their high population density and low levels of basic infrastructural facilities were in stark contrast to the low density developments and good infrastructure provision in the European residential areas. The distribution of access roads within the later areas were both well planned and well maintained providing good access to Nairobi's wider transportation network as a whole and its business and administrative centre in particular. The predominantly European residents here were as a result very much mobile with a high private vehicle ownership. Indeed a factor that is readily always appreciated is that the vehicular growth rate not only in Nairobi but also in other colonial capital cities in Africa took dramatic proportions then. (Table 3:2).

Table 3:2, Average Post-War Vehicle Growth Rates of African Colonial Cities: 1950-1960.

Country	% age growth rate per annum.	
Kenya	8	Nairobi, 6.8 % (1960-70)
Tanzania	11	
Ghana	12	
Nigeria	14	Lagos, 15.5 % (1960-70)
Uganda	18	

Source; Hawkins, (1962).

More evidence point out to the fact that by 1928, Nairobi was the most motor-ridden city in the world proportionately to its European population (Hake, 1977 p.22). This high private vehicular ownership is said to have contributed to the early thinning out of Upper Nairobi. It also presented one of the

transportation problems of the day; others being, how to improve the road access to industrial area and how to accommodate the increasing motorization in the CBD.

Towards the granting of independence and after, the decline in economic resources and deterioration in the infrastructural facilities began. This was partly due to the gradual run-down of the past colonial investment in the country up to independence, the increasing urban population and the scarcity of resources in general. It led to a decline in whatever infrastructure existed, so that in the face of increased population growth and increase in travel demand a marked deterioration of Nairobi's transport network and services took place. As independence approached, more and more Africans were assimilated into the roles and functions being left vacant by the departing colonialists. There soon emerged elitist groups who developed values and aspirations so similar to those of the previous colonial masters. They aspired, for example, for car ownership while in the case of some civil servants and company employees this was further encouraged by the provision of loans to assist in car purchases. Many took residence in the former colonial areas and this accelerated the changes away from the previous socio-economic and cultural divisions within the city. This period saw a further increase in car ownership levels with a growth rate level of about 6.8 % per annum during the period 1960-70. By 1970 it was estimated that 25 % of Nairobi's commuters used private automobiles to reach their

places of work. The use of public transport was not so predominant with only about 24 % users (NUSG, 1973). According to a World Bank (1975) estimate the number of buses as per 1000 population in Nairobi by 1970 stood at 1.5 buses only.

The resultant post-independence movement patterns together with the additional travel demands generated mainly by an increased migration from rural areas, exerted pressure on the urban form and its infrastructure which were ill-equipped to serve them. A major problem here has been the centralization of activities in the CBD which by 1970 was estimated to employ over 75 % of the commuters. This area has for a long time been a victim of numerous traffic problems more so due to lack of space even within its vicinity. The Post-independence period also witnessed a relaxation (not by design) of traffic regulations, parking restrictions, and land-use control. Hence within a few years after independence much of the previously formalised land-use urban patterns previously superimposed on the original settlement structure was eroded away (Kiamba, 1988).

Since 1970, the city of Nairobi has expanded tremendously and a new population distribution pattern has emerged. More important is the fact that a large percentage of the low income public transport users today live further away from the CBD, partly due to such factors as the introduction of such housing schemes as the site and service schemes and the general policy of

demolishing squatter settlements sited near the CBD to give way to other developments. Apparently such neighbourhoods as Bahati, Maringo, Ofafa, Ziwani, Landimawe, Kaloleni and Pumwani which were specifically for African settlement away from the city centre,are now part of the core of central Nairobi. Numerous other neighbourhoods have sprang up in far off places and developed into congested settlements boasting of hundreds of thousands of residents. Towards the east low-income settlements have emerged in places like Dandora, Kariobangi, Kayole and Umoja and the process of expansion continues further eastwards. In the West, the city has expanded to include peri-urban settlements as Kawangware, Riruta and Kangemi townships which are today undergoing the most rapid rates of expansion. Towards the north, new settlements are also rapidly emerging and expanding within the Ruaraka/Kasarani zone while in the south the process of residential development has seen the emergence of middle income estates such as Otiende and Ngei Estates just to mention a few.

This expansion of Nairobi has not been matched by a similar expansion in the transport facilities and services.
Table 3:3 shows an estimate of the overall public transport demand in Nairobi in 1985 and projections for 1990 and 2000. From the table it is clear that the annual rate of growth of passenger journeys per day is currently increasing at a rate of about 5.3 per cent per annum which is high by all standards.

Table 3:3, Nairobi: Public Transport Demand 1985, 1990 and 2000.

Year	Passenger Journeys per day (000)	Growth rate per annum
1985	676	
1990	873	5.82
2000	1,393	5.95

Source: Transurb Consult (1986).

A clear manifestation of the excessively high demand for public transport services is witnessed in the daily stampede and jostling which characterize most of Nairobi's transport terminals especially during the rush hours and the overflowing number of passengers transported by the existing modes of public transport. For a long time now, matatus have operated alongside the KBS as the only major suppliers of Public transport services in Nairobi. Other recently introduced services have only come in to supplement their services. These are, the RCS which operate only during the morning and evening rush hours in areas along which the line passes and the NBS whose services are offered more so during the rush hours.

3.1.1: The Role of the Kenya Bus Services and Matatus.

The KBS Ltd. has existed as the sole legal supplier of public transport services ever since it was incorporated as a private company in 1934 with an authorized capital of Ksh.

20,000. It was converted into a public company in 1950 jointly owned by the United Transport Overseas Company (UTC), a British company operating and managing over 100 other such companies all over the world, and the NCC. Since then, the KBS has operated public transport services in Nairobi under various franchises granted by the NCC. An agreement was signed in 1966 at which time the NCC acquired 21 % of the shares of the company thus formalising the partnership the company had been keen to develop with local community interests. The latest franchise is being extended while negotiations take place concerning longer term arrangements for the city's commuter services. The Chairman, the Town Clerk, and the Treasurer of the NCC are board members of the KBS.

The buses owned are a mixture of the Leyland Guy Victory, the ERF Trailblazers and the recently introduced DAF. These are compatible in terms of service requirements and have been specifically adapted for the local road conditions in Nairobi. Their engines have been designed to minimize fuel consumption which is an essential factor in running profitable transport services as well as minimizing the overall need for foreign exchange. The assembling and body building is done locally by the Labh Singh Harnam Singh (LSHS) body builders. The KBS has only one bus depot situated at Eastleigh but it recently acquired land at Riruta with a view to constructing a second depot which could be considered in future if the number of buses increase.

The KBS has a fully staffed engineering department with a staff of 550 hence it is mandatory that each bus must be taken to the workshops for check-up every ten days even without having specific mechanical problems. However, a persistent problem which the company is faced with has been that of maintenance . On an average 20 buses break down daily due to minor mechanical problems and it often takes lengthy periods to tow them for repair. Other problems include the lack of a cheaper source of spare parts, and the company's inability to maintain crew punctuality and discipline. The result of these have been that for a long time now, the company has been complaining of running at a loss of profits and hence there has been a tremendous deterioration in the services offered. Despite these operational complexities of running a full commuter network, the KBS manages to deploy 264 buses daily. This efficiency ratio of 88 % is high by any standards. As is shown in Table 3:4, the rate of growth of its fleet has not been consistent with the increasing demands. The decrease in the number of KBS's daily passengers starting from 1973 up to 1977 can be attributed to the tremendous competition offered by the matatus whose numbers have consistently increased since the same period (Byabafumu,1982). Since 1977, the average daily number of passengers transported by the KBS has been increasing but it faces stiff competition from matatus whose market share stands at 4.3 (Jarabi,1982).

Table 3:4, Kenya Bus Service Ltd: Fleets and Passengers and their Growth Rates: 1962-1988.

Year	Fleet Size	Growth Rate (%)	Average Daily Passengers (000)	Growth Rate (%)
1962	100	3.0	66	2.2
1964	106	9.4	69	12.8
1966	*	*	98	42.2
1967	*	*	105	7.14
1968	146	9.4	116	10.0
1969	*	*	122	5.17
1970	166	9.4	151	23.7
1971	195	17.4	209	38.4
1972	239	22.6	233	11.5
1973	264	5.4	240	3.0
1974	284	7.6	237	-1.2
1975	290	2.1	230	-2.9
1976	288	-0.1	229	-0.4
1977	285	-1.04	229	0.0
1978	291	2.1	250	9.17
1979	317	8.9	270	8.0
1980	310	-2.2	273	1.1
1981	316	1.9	282	3.3
1982	309	-2.2	329	16.7
1985	273	-11.6	382	16.1
1987	300	9.9	410	7.3
1988	313	4.3	*	*

* = data not available.
Sources: Jarabi, (1982); KBS, (1987) + own calculations and estimations.

Despite this state of affairs, the KBS has increased its services' areal coverage with operations extending even outside the city's boundaries to places such as Kiambu, Limuru, Ndumberi, Ruiru, Ngong, and Athi River. The total length of trips covered by the buses has therefore increased from about 8.2 million km. per year in 1966 to 32.4 million km. in 1987 (KBS, 1987) Table 3:5 summarizes the KBS trading position and shows how the company's operations tend to be redundant especially in

responding to the ever increasing demand for public transport services.

Table 3:5, KBS: Trading Position and Statistical Analysis;1970-1984.

Year	Annual Passengers. (millions)	Total length of km. covered. (millions)	Revenue (in millions of K.pounds)	No. of Staff (000)
1970	55.2	13.1	1.055	1.112
1971	67.2	15.1	1.295	1.352
1972	85.2	18.2	1.659	1.633
1973	87.6	18.9	1.977	1.762
1974	86.4	22.4	2.492	1.802
1975	84.0	22.7	3.108	1.804
1976	83.6	23.3	3.579	1.837
1977	83.6	23.9	4.312	1.766
1978	91.2	23.6	5.142	1.824
1979	98.4	25.7	5.553	2.126
1980	99.7	24.9	6.912	2.201
1981	103.0	26.3	8.372	2.289
1982	115.6	27.6	9.912	2.295
1983	131.1	28.7	11.990	2.375
1984	125.5	28.2	12.772	2.322
1985	136.0	30.8	14.183	N.A

Source: Transurb Consult Report (1986).

For a long time now, the deficiencies of the public bus system in Nairobi has been alleviated to some extent by the matatus. Over the last few years they have assumed an expanding role especially for those whom the buses do not serve adequately. In the early 1960's the total number of matatus operating all

over Kenya was under 400 and the Police pursued them as "pirate taxis". In 1973, a Presidential decree declared that matatus were a legal form of public transport and could carry fare paying passengers without having special licenses to do so. At the same time, it was emphasized that the existing insurance and traffic regulations must be complied with.

This decree intervened in an anomalous situation of unlicensed matatus operating despite the existence of a monopoly franchise for public transport by the KBS. It was also probably a response to persistent lobbying by the matatu operators and owners for recognition of the role which they play (Kapila et al, 1982). Since then matatus have increased in numbers and in the daily number of passengers they serve. (Table 3:6). By 1980, matatus had captured at least a third of the public transport market in Nairobi (Kapila, et al, 1982). Apparently this number has increased such that today they provide a big threat and challenge to the public bus system. Table 3.7 the increase in the percentage share of matatus in the market since 1973 when their operations were first legalized.

Table 3:6, The Growth of Matatu and their Average Daily Passengers 1971 - 1981.

Year	Fleet Size	Growth Rate (% age)	Average Daily Passengers (000)	Growth Rate (% age)
1971	217	36.4	38	10.6
1973	375	43.5	47	29.3
1974	538	30.1	63	16.1
1975	700	38.4	74	31.1
1976	969	36.2	101	32.7
1977	1320	8.6	140	15.8
1978	1434	9.3	164	17.3
1979	1567	4.2	195	15.5
1981	1704	5.6	263	54.4

Sources, Kapila, (1982); KBS, (1982) MVOA, (1982) and Jarabi, (1982).

Table 3.7: KBS and Matatus: Percentage Share of the Market.

YEAR	MATATUS	KBS
1973	16.0	84.0
1974	21.0	79.0
1975	24.0	76.0
1976	31.0	69.0
1977	38.0	62.0
1978	40.0	60.0
1979	41.0	59.0
1980	42.0	58.0
1985	48.0	52.0

Sources; (a) 1973 to 1979 data from Ngariuya M. N. (1982)
(b) 1980, 1982 and 1985 data from KBS (1986).

However, there have been zonal variations in their rate of increase with the high population density zones experiencing higher rates of growth in the number of matatus serving them than

in the lower density higher income zones. Table 3.8 below shows the percentage annual increase in the number of matatus in various zones or routes during the period 1987 and 1988 for the registered members of the MVOA.

Table 3:8, Percentage Growth in Number of Matatus in Selected User Zones/Routes. 1987-1988.

Route Destination	Total Registered Number of Matatus July 1987	July 1988	% Growth Rate
Eastlands	43	54	25.6
Buru Buru	15	18	20.0
Umoja	21	24	14.3
Eastleigh	34	50	47.1
South C & B	41	64	56.1
West & Madaraka	13	16	23.1
Industrial Area	19	27	42.1
Otiende/Southlands	18	25	38.9
Parklands	20	26	30.0
Kangemi/Uthiru	36	75	108.3
Kieleleshwa	4	7	75.0
Kamiti/Kahawa	14	20	35.7
Kibera	16	24	50.0
Outer Ring	14	20	42.9
Dandora	27	33	22.2
Kariobangi	44	50	13.6
Kawangware	30	51	70.0
IDH/Ngummo	24	36	50.0
TOTAL	433	619	43.0

Source: MVOA Registration Files. 1988.

From the table above, it is estimated that matatus increased in numbers by about 43 % during this period. But the rate of growth varies and ranges from 14.3 % in Umoja to 108.3 % in the Kangemi/Uthiru route. The growth in the number of matatus is greater in the zones which also experience higher population growth rates and those which are generally associated with

predominantly low income residents. These include, Kibera, Kangemi/Uthiru, Kawangware, and Kahawa/Kamiti. Other zones like Eastleigh, South B/C and Kieleleshwa have attracted more matatu services mainly because they are nearer to the city centre hence the vehicles operate at relatively higher profits.

Most of those in this trade are there as businessmen who are concerned with the search for profitable returns on their heavy investments. Matatus are obviously expensive vehicles both in their purchase price and their maintenance costs hence the increasingly large number of those in this trade is largely an indication of their lucrativeness. The rapid increase in their numbers is also a strong indication of the equally high demand for their services due to the inability of other modes of public transport to cater for these needs and demands.

In January 1983, the Central Bureau of Statistics (CBS) conducted a pilot survey of the matatus plying the city's roads. The survey was restricted to matatus starting and terminating in Nairobi area and 860 such vehicles were counted. These employed nearly 2000 drivers and conductors who earned K£ 1.3 million per year and realised a total fare receipts worth K£ 11 million per annum. These results suggest that matatus employ an average of two persons each and collect K£ 12,825 in fares per annum. A driver and conductor each gets an average of K£ 750 per annum. Returns from the Registrar of Motor Vehicles on the number of PSV

licenses indicate that there was a sharp rise of 17 % to a total of 7,012 matatus licenced and operating in the country in 1985 as compared to an estimated 6,000 in 1984 when the exercise of giving them PSV licenses began. In view of this, it is estimated that the sector engaged around 14,000 persons who earned approximately K£ 9 million in 1984. Over 35 per cent of these matatus serve those within Nairobi area while 25 per cent operate along the routes adjoining the city to other parts of the country (MVOA, 1988).

Similarly it was further estimated that this sector collected revenue amounting to K£ 90 million in 1985 compared to an estimated revenue of K£ 75 million in 1984. Assuming that 30 % of the total fare revenue collected is equivalent to the GDP generated, then this sector contributed about K£ 27 million to the GDP in 1985 compared with an estimated revenue of K£ 22 million in 1984 (Kenya, 1983; Kenya, 1986). The results of the matatu traffic volume census carried out in this study shows that the Nairobi matatus alone employ roughly about 2,600 drivers and conductors and with their annual rate of increase of 43.5 percent, it is estimated that they generate slightly over 1,000 jobs per year. The responses from the matatu owners and or operators survey further reveal that a greater percentage (72.8 per cent) of those interviewed are employed by the matatu owners and earn between Ksh.1,500 to 2,800 per month. Over 42 per cent of them are paid amounts ranging from Ksh. 100 to 130 per day.

Matatus also had developed an organizational strength in form of associations which were recently banned. Their past history had shown that if these organizations were well organised they could play an important role. On a national level the most active of these organizations was the Matatu Vehicle Owners Association (MVOA) which had a registered membership of 3,000 branches affiliated to it. It was formed in order to restore order and discipline within the matatu operations and also to represent the owners and operators to the authorities as a united body. Their operations were mainly concentrated in Nairobi where their function basically was to provide assistance to their members in dealing with the NCC and the Police and to streamline parking at the terminals set aside for them by the NCC. Apart from these they also performed a wide range of activities including organizing seminars where the operators were given road safety instructions and instituting a code of conduct which all their members were supposed to adhere to. They did not achieve maximum success in these efforts and for a long time they were beleaguered by the ailments of splinter groups and political gimmicks which eventually led to their being banned by a Presidential decree in December 1988. Today, the organization of matatus in the terminals is done with the help of KANU youth wingers who have played a significant role in streamlining their operations while awaiting the formation of another organization.

Despite the important role which the matatus play, they have been an object of persistent public criticisms, government restrictions, and proposals to phase them out in favour of more modern forms of public transport have been raised. They have been viewed as uneconomical, unruly and a hazardous means of transporting the growing mass of urban population in Nairobi. Their operations have not only grown beyond unimaginable heights, but they now constitute a gigantic problem in their own in the management of the city's traffic and public transport system. They have been accused of being the cause of the most dreadful accidents and of performing the most chaotic operations. It is indeed most unfortunate that their enormous growth has not been matched by a corresponding growth in their regulation and control so as to streamline their operations and ensure safety and comfort to commuters and other road users. Numerous complaints have been levelled at the matatu operators who have generally shown disregard for traffic regulations. They have often been identified with over-speeding, overloading, and being involved in other haphazard operations which make them a major cause of road accidents. Other operational characteristics which they have and which people resent to include, their continuous hooting and touting for passengers, their chaotic parking and stops, their harassment and abuse of commuters and other road users, and their general disregard for many other traffic rules which often interfere with the smooth flow of traffic in Nairobi.

However, despite these problems, some of which should not be wholly blamed on them, they have often been identified as beneficial than most transport "modernizers" assume. It is often accepted that they should stand some improvements together with other elements of Nairobi's public transport system. The following section looks briefly at the past and current planning responses to Nairobi's public transport system especially as relates to matatus and the practical measures which have been taken to solve the city's public transport problems.

3.2: PAST AND CURRENT PLANNING RESPONSES TO NAIROBI'S PUBLIC TRANSPORT SYSTEM.

The internal planning response to the above situation of public transport in Nairobi since independence has been slow. The GOK has placed a great deal of emphasis on national spatial economic policies rather than urban development. The various attempts at relying upon industrialization and modernization to achieve national economic goals has only further accentuated transport problems in the urban areas. Much of the resultant industrial investment in Kenya has taken place in Nairobi, thus generating additional transport demands on the already inadequate and congested transport system. The technological forces released by the industrialization and modernization development strategies has also generated new travel patterns, as well as different travel behaviours and life styles all of which have mixed with the old. According to Banjo and Dimitrou, (1980), this represents

the second generation of urban transportation problems faced by all LDCs alike during their immediate post-independence stage. Due to the absence of an inadequate technical and administrative capacity to tackle the problem, such countries as Kenya have often turned for assistance from the MDCs. The result of this has been the appointment of international consultants from the MDCs, commissioned to examine the urban transport problems that the city faces and prepare ways and means by which they can be tackled. Such consultants have either been appointed on the basis of their previous transport planning experience in other LDCs or as a result of the expertise they have acquired in their own countries such as in the case of the Transurb Consult-Belgium Government study in Nairobi. In most cases such consultants who have limited understanding of the local urban movement problems use standardised planning procedures which are based on irrelevant assumptions. They have for example failed to concern themselves with the phenomena of intermediate or informal modes of public transport and lack an understanding of how the system works. As a whole such assumptions have resulted in a penalization of the non-motorized community, the destruction of certain urban forms and structures, and the failure to incorporate the informal or intermediate sector into transport plans among others (World Bank, 1985).

Hence, while it is appreciated that many standardized planning approaches are not on the whole inappropriate to the

LDCs, their implications are much more critical in such countries in the light of the limited resources and other much more crucial problems which they have. Such countries like Kenya are therefore left with the option of a low-cost strategy such as the use of traffic management schemes. In Kenya very little has been done even along this line more so because of the tremendously increasing population and demands for public transport facilities.

The first ever post-independence transportation study on Nairobi was carried out in 1970 by the Nairobi Urban Study Group of the NCC. Research was carried out on transportation and a report presented in the Nairobi Metropolitan Growth Strategy Report (1973). This report identified the problems of public transport facing the city and made forecasts concerning the future demands for public transport and the future distribution of this demand. However, it did not analyze the role of matatus but only laid emphasis on the future development of buses operating on highways and a mass transit system. It mistakenly favoured buses due to "likely benefits to local employment and the vehicle manufacturing industry" forgetting that matatus also play a major role in these areas. Other recommendations which were made by this report included, a policy of restraint on the ownership and use of private cars in association with measures to encourage public transport usage, progressive reduction in public transport fares to a significant effect, staggering working hours

in the CBD in order to spread the effect of traffic peak over a considerable period, and the provision of segregated busways and more roads.

In 1978, the Nairobi City Transport Unit (NCTU) was formed and placed within the NCC's Engineers Department with a view to control both the city's public transport policy and the complimentary parking policy among other things. The Nairobi Busways and Feasibility Study (1978) further recommended the construction of 27.7 km. network of bus priority routes aimed at the regulation and administration of private and public transport, CBD parking supply, demand ,control and traffic circulation. The Nairobi Urban Study Report (1979) which followed comprises a series of components such as the creation and improvement of infrastructure, policy matters, and monitoring procedures. This report points out that "most of the projects are long overdue and if not implemented as soon as possible, the national energy losses will be colossal". (NUSR, 1979 p. 15)

Since then, the NCC policy documents and studies have recognised the important role which matatus play. Among these is Situma, (1977) who summarizes the NCC findings to establish certain physical and micro-economic features of matatus. As a result of a planned World Bank Matatu Assistance Scheme, (WBMAS) more studies were carried out under the Kenya Urban Transport Project (KUTP) in 1979. (Barwell,1979). However, nothing was done

in this respect and none of the proposed assistance to the matatu owners and operators ever reached them. The NCC's recognition of the matatus can also be seen in the practical efforts which have been made to provide the matatus with exclusive terminals in the CBD, a process which the matatu operators have resented to because of what they see as an attempt to favour the KBS which is given exclusive right to operate in some terminals.

In 1980, Leyland (Kenya) ltd. studied a standard matatu prototype in compliance with the specifications laid down by the GOK but this project was not implemented as it was discovered to be financially inviable although mechanically the design was good. The study therefore recommended the continuous use of various types of matatus except those overloaded beyond the manufacturers' specifications. (Coopers and Lybrand,1980). For a long time now, the major policy issues in Nairobi's public transport system have been the role of the matatus and the future of the KBS franchise agreements. The recent introduction of the NBS to supplement the KBS and matatu services especially during the rush hours and the RCS major practical measures which have been taken to increase the supply of public transport services. The NBS are now run by a government parastatal organization and have expanded their operations very fast. Today it operates over 80 buses serving mainly the densely populated zones and it is likely to continue expanding it's services.

A noticeable problem however, has been the lack of terminal facilities or parking spaces for the buses in the city centre. The RCS operate in the high density residential areas such as Kibera, Dandora, and Kariobangi as well as the suburbs of Kangemi, Limuru, and Kamiti. It therefore only serves a few areas which have the line passing through them and does so only by making only one morning and evening rush hour trip. The service also faces a lot of problems, most important being the high operating costs. Ever since it was started, it has only been making losses. (Irandu,1988). Moreover very few people use it even in the areas which it serves especially because of its few regular operations and other factors such as the unfavourable location of its terminals and frequent congestion during the rush hours. The responses from this study concerning the usage of the railway commuter services reveal that only 7 per cent of those interviewed within the areas which it serves use it frequently. About 25 per cent use it occasionally while 68 per cent have never used the services it offers.

A study first conducted in April 1984 by Transurb-Consult for the Belgium Ministry of Foreign Affairs, Foreign Trade and Development Cooperation, highlighted three options to deal with the present mass transportation problems in Nairobi. The first option suggested the use of specially constructed busways while the second was that of introducing a light rail transit system. The third option which seems to have got the GOK's approval

introduces the concept of guided or articulated buses. Meanwhile, investigations are still going on but it is evident that any modern transportation system in Nairobi will require a complete and complementary bus and matatu networks (Transurb-Consult, 1986). In its continuing efforts to minimize road accidents mainly caused by such factors as overloading, poor roads, vehicle unroadworthiness, careless driving and other illegal operations often associated with the matatu operations, the GOK has introduced various new legislations. In 1984, a Presidential directive ordered matatus to acquire PSV licenses. The Road Safety Section of the Kenya Police Traffic Branch, which is entrusted with the execution of road safety regulations released details of the Traffic Amendment Act, 1984. This has rules covering driving licenses, obstruction, maximum driving hours, excess passengers, touting, unroadworthy vehicles, and notices to attend court on default of any of the traffic rules. (Kenya, 1984). Using such legislation attempts have been made to clamp down especially on matatus and other PSVs but with minimal success. The situation in Nairobi has often been that whenever the authorities become too harsh on the PSV operators, they respond by boycotting to offer their necessary services. This has been the case at times when such actions have dramatised the plight of the city's commuters. (Boro,1986 p.32).

As is clearly stated in a Daily Nation Editorial,

"no amount of warnings to public transport operators will stop the inexplorable growth of recklessness on our roads .....

something most enduring must be done."(Daily Nation, 15th. February, 1987 p.14).

The present campaign on road safety should involve the PSVs as much as the travelling public which tends to value their lives and comfort much less than the immediate need to get to their destinations. The haste, the jostling, and the stampede which characterise PSV terminals are equally a cause of chaos and confusion as the apparent lack of concern amongst most of the PSV operators. Recent measures aimed at reducing the such chaos such as the use of queues have so far proved successful and popular but more needs to be done for the sake of a long term solution to Nairobi's public transport system. Meanwhile, because of their role in increasing the accessibility levels of an increasing number of the city's commuters they should not be considered as a problem but as a solution to the current public transportation problems which the city faces under the present circumstances.

CHAPTER FOUR.

THE SPATIAL DISTRIBUTION OF MATATU SERVICES IN NAIROBI AREA AND THE FACTORS WHICH INFLUENCE THEIR DISTRIBUTION.

The results of the analysis presented in Chapter 2 are the basis of discussion in the following chapters. This chapter corresponds to the first hypothesis in that it discuses the findings of the analysis of this hypothesis.This Chapter is divided into two sections. The first section looks at the distribution of matatu services in Nairobi area within the context of trying to explain the factors which influence this distribution. The second section discuses the relationship between the distribution of matatus and population distribution or public transport demand so as to show how matatu services are a spontaneous response to the demands for public transport services in Nairobi.

4.1: THE SPATIAL DISTRIBUTION OF MATATU SERVICES IN NAIROBI.

Nairobi is well served by a public transport road network which covers nearly all the residential areas around the CBD. The road network consists mostly of tarmac roads which are generally well maintained except for the presence of potholes in some places. Four major problems associated with this network are

those of congestion, the absence of a by-pass for avoiding the CBD, the presence of only a few outlets and inlets to and from the CBD and the lack of enough parking space in the CBD. Congestion is caused by many factors among which are that the roads are not adapted to the city's traffic intensity, the parking obstructions, lack of driver discipline, the few inlets and outlets to and from the city centre, and the lack of a staggering of the peak demand hours. Presently, a significant part of the traffic has to pass through the CBD. According to I. Barwell (1979), about 67 % of the by-passable movements were identified. Another problem is that of the capacity of the parking spaces in the city centre which causes illegal parking often obstructing traffic. The number of off-street parking spaces and car parks in Nairobi decreased from 3,331 spaces in 1972 to 1,846 spaces in 1983 which represents a 45 % reduction (Transurb-Consult, 1986). The available parking and road space is likely to continue on decreasing in view of the ever increasing number of private vehicles using the CBD and the increasing number of matatus and buses which also use the CBD road space and require terminals for parking.

The matatus road network which is shown in Figure 2.2 predominantly follows that of the KBS but with minor differences especially in situations where the KBS offers temporary or seasonal services. Along some routes, such as Parklands, matatus offer fast and short distance services while in some cases their

routes are flexible depending on the need to make a faster trip especially during the rush hours. Apart from these, matatus also offer their services to and from the CBD directly to the surrounding residential areas unlike the KBS whose buses mainly operate along routes passing through the CBD. The newly introduced NBS services are mainly offered during the rush hours to supplement both the KBS and the matatus especially in the high demand routes and they also operate to and from the CBD.

One strong feature of the matatu distribution is that the road network density is related to the population density with the built-up areas immediately adjoining the CBD having a greater concentration of operational routes. The high density network is concentrated within the central area, Eastlands, the Parklands-Westlands zone, Nairobi West-Southlands and Industrial area. Elsewhere, the densities are relatively low and mainly consisting of long straight routes leading out of the study area to places such as Kikuyu, Thika, Limuru, Ngong, Ongata Rongai, and Athi River. These routes mainly serve those outside the boundary of Nairobi area but are also used by those living around the areas where they pass. In order to measure the extent of areal coverage of this network so as to indirectly show the matatu system's efficiency the study area was divided into 15 matatu users zones for comparison's sake. (Figure 2.3). The details of how this was done are explained in chapter 2 section 2 (a). The results of the measurements are presented in Table 4:1 below.

Table 4:1, Matatu Road Network Density in Various User Zones in Nairobi.

ZONE	SIZE (AREA) in sq. km.	TOTAL LENGTH OF OPERATIONAL MATATU ROUTES	DS	Ca
Karura	36	13.5	2.67	0.150
Dandora/ Kariobangi	174	35.5	4.90	0.082
Spring Valley	23	10.0	2.30	0.176
Roysambu/ Kasarani	16	12.0	1.30	0.300
Kilimani	24	22.0	1.09	0.367
Kangemi/Uthiru	11	6.5	1.69	0.236
Kibera	12	14.5	0.83	0.483
Riruta/Waithaka	16	13.5	1.18	0.337
Parklands	4	8.0	0.50	0.800
Eastlands 11	12	14.5	0.83	0.483
Industrial Area	10	9.5	1.05	0.380
Nairobi South	13	15.0	0.87	0.462
Embakasi	62	13.0	4.77	0.084
Langata/Karen	74	32.0	2.31	0.173
Eastlands 1	6	24.5	0.23	1.633

Source: Compiled by Author.

The values DS and Ca represent measures which this study uses to compare the areal coverage of the matatu road network in various user zones in Nairobi. The value Ca is specifically important because it can also be used to estimate the approximate hypothetical number of persons who are within a distance of 200m. from the network in each zone. From the table it is worth noting that the network is mainly concentrated in areas of dense population such as Eastlands I (1.633), Parklands (0.80), Eastlands II (0.48) and Kibera (0.48) while those which are less densely populated have a lower concentration of the matatu road network. However, a look at the built up parts of Nairobi area

reveals an uneconomic use of space. There exists too much open space between some residential zones which lowers the general level of accessibility to the road network.

It would be wrong to base our conclusions on the areal coverage of the road network alone since it is the distribution of the public transport services which matters most. In order to identify the spatial distribution of matatu services in the various user zones or the routes, it was necessary to identify the number of vehicles serving each route or zone. It was later on realised that even this was not a strong enough basis through which the variations in the distribution of matatu services could be explained. There is a high positive correlation between the number of vehicles serving each route/zone and the vehicle capacities ($r = 0.5004$), but only 25 % of the variations in the vehicle capacities can be explained by the number of vehicles. This implies that the number of vehicles serving each route/zone do not necessarily show their capacities or level of provision of service in any particular route/zone. This is because different types of matatus with different capacities serve different zones/routes. The vehicle capacities for all the matatus in each zone or route was therefore used after the realization that the capacity of individual vehicle units was highly variable. The vehicle capacity is used here to refer to an hypothetical number of passengers who can be transported for every trip made by all the matatus in a particular route or zone. To calculate the

vehicle capacities in each of the routes chosen, this study relies on the fact that matatus operating within the study area have the ability and often carry standing or excess passengers due to the extremely high demand for their services especially during the rush hours. This study identifies and classifies two types of vehicles whose carrying capacity and distribution in the various routes also varies. These are the 18-seator kombis or Nissan minibuses and the 25 seator minibuses. Using the Matatu Traffic Census Survey results, it was possible to calculate an hypothetical number of persons who can be transported by all the matatus in each route per trip especially during the rush hours. The value derived is termed the OVERLOADED VEHICLE CAPACITY which is used here to refer to the total available travelling space in terms of the total number of passengers who can be transported per every trip by all the vehicles serving a particular route or zone during the rush hours. To calculate this, this study relies on the assumption that the 18-seator minibuses can carry only up to 21 passengers when overloaded while the bigger 25-seator minibuses can carry up to 40 passengers and therefore have a greater carrying capacity or space. Table 4:2 below shows the calculated overloaded vehicle carrying capacities, the number of vehicle and the normal carrying capacity in each of the chosen routes. The Normal carrying capacity is calculated on the assumption that there is an ideal situation where all the passengers are seated hence it shows the available sitting space for the passengers in the matatus serving each of the various

routes. Normally because of the excessively high demand for public transport services in virtually all the routes, overloading is a common phenomenon especially during the rush hours.

Table 4:2, The Distribution of Matatus and their Vehicle Carrying Capacities in Nairobi Area.

Zone (Route)	No of Matatus	Normal Capacity	Overloaded Capacity
Makadara/Maringo	34	801	1234
Buruburu	16	330	540
Embakasi	10	194	256
Uhuru/Harambee	14	336	526
Dandora	33	825	1320
Kariobangi/Jogoo Rd.	17	147	608
Kieleleshwa	7	168	262
Uthiru/Kabete	21	483	732
Kangemi	54	1000	1260
Eastleigh	50	1180	1820
Kamiti	19	370	590
Mathare	25	457	568
Kariobangi	50	1208	1895
Kawangware	51	1184	1806
Kibera	24	600	960
Ngummo/IDH	36	900	1440
South C	16	288	352
Southlands/Otiende	25	499	676
Ngong/Karen	7	175	280
West/Madaraka	16	295	370
Parklands	20	360	440
South B	48	934	1236
Industrial Area	24	488	672
Umoja/Kayole.	22	410	520
South B/Kibera	9	197	288
Jericho	27	626	954
TOTAL	675	14,455	21,600

N/B The total number of Passengers overloaded per trip = 6,664
Approximate percentage due to overloading per trip = 45.97 %

Source; Compiled by the Author.

The above calculations approximate that about 46 % of the passengers using matatus during these hours are overloaded

(standing or excess passengers). This is indeed a high proportion by any standards and shows how critical the problems of public transport in Nairobi is. The matatus can transport up to a total of 21,600 passengers per trip in all the zones/routes covered but with a greater concentration of passengers transported from Makadara/Maringo, Dandora, Kangemi, Eastleigh, Kariobangi, Kawangware, Kibera, Ngummo/IDH, Jericho and South B. There are a variety of factors which account for this, among them being, the high population density or size, the relative concentration of low income residents, and the shorter distances covered per trip in some of the routes.

4.2: FACTORS WHICH INFLUENCE THE DISTRIBUTION OF MATATU VEHICLE CAPACITIES.

The matatu mode of public transport represents a system whose commuter services are only slightly subject to limitations or regulations by the local or national authorities. They generally operate within their own more or less independent standards of service, fare levels and choose their own routes depending on the owners or operators response to a number of factors. They are demand-responsive in terms of their frequency of service. The only efforts towards restricting or controlling their operations have mainly been restricted to introducing and implementing legislation to curb road accidents and promote the

level of road safety in Nairobi. Such measures as those of the 1986 Traffic Amendment Act and others such as the frequent clamp down on their operations are basically aimed at reducing their unruly behaviour and hazardous operations which are considered a major cause of accidents. Otherwise, no attempt has been made towards regulating their numbers or even restricting them to certain routes. As a result, their distribution depends on a number of factors which should explain the spatial pattern of their vehicle capacities in the various routes in which they operate.

In essence there are four main elements in the explanation of the spatial pattern of their vehicle capacities or services distribution. The most basic is the demand for public transport. The second element is the availability of funds for the supply of the capacity. The third element is the presence of complimentary facilities, and finally there is the competitive element of alternative facilities (Hay, 1973, p.108). A major problem however, has been that of identifying a suitable framework of explanation for their interaction upon one another. Difficulties, for example, exist in attempting to measure transport demand and the complexities involved in its definition. Due to this, specific demand functions have not been used as an independent variable in studies of the supply of capacity. Similarly, there is no simple way of estimating the funds available for the purchase of capacity. As a result, a number of studies have

tended to use a more general measure of economic activity as a surrogate for both these aspects - for example GNP per capita, or the average annual incomes. Among these studies are those which use the Abstract Mode Approach which also provides the theoretical framework for this study.

Suitable measures of complimentary facilities such as the network mileage or the areal coverage have already been done using formulas (a) and (b) in Chapter 2. There is however an important logical problem in relying on this alone. It might be assumed that vehicle capacity and the network capacity will be positively associated but there are many cases where improvements of network facilities may not necessarily lead to improvements in the vehicle capacities. In other words, it is wrong to assume that the existing network distribution is an expression of the level of service or efficiency of any public transport system. The presence of competitive facilities also raises a few problems of measurement in concept although the exact definition may be difficult in certain cases.

The most widely used devise for relating these determinants to vehicle capacity in geographic space is correlation and regression analysis. This theoretical agnostic tool also raises severe technical problems including the need to standardise geographical units of investigation and the problem of spatial auto-correlation. (Tanner, 1963; and Cliff and Ord, 1970). Apart

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from these, there are also problems in interpreting the regression and correlation coefficients. Despite these shortcomings, this study attempts to use the regression and correlation approach to explain the spatial pattern of matatu vehicle capacity distribution in Nairobi. The elements which are identified here and used in explaining the spatial patterns of matatu vehicle capacities in Nairobi, include the population distribution, the average income levels in the zones covered, the distances covered in each route and the profitability levels in each of the routes or zones covered as is represented by the calculated profitability indices for each zone. Due to the strong functional relationship between public transport demand and population density in Nairobi, the former is given more prominence as a determinant of the public transport demand. This strong relationship between the two is clearly shown by a study carried out by Jarabi,(1982) who identified the strong functional relationship between population distribution and public transport demand. This study therefore uses regression and correlation analysis based on standardised geographical units to explain the factor which has the strongest functional relationship with the distribution of matatu services in Nairobi area. The study area is divided into 26 standardised geographical units for this purpose. Table 4:3 below presents the results of the simple correlation coefficients showing the relationships between each of the variables. In the table the numerals I, II, III, IV, and V refer to the following variables.

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I = the matatu vehicle capacity distribution (this represent the distribution of matatu services which is regarded as the independent variable.

II = the population size.

III = the distances covered per trip in kilometers.

VI = the profitability indices. (represents the level of profitability for each route or zone).

V = the estimated average (mean) annual income.

Table 4:3, Matrix of Correlation Coefficient Values showing the Relationships between the Variable influencing the Distribution of Matatu Services.

VARIABLES	I	II	III	IV	V
I	1.0000	0.7171	-0.0763	0.2205	-0.4749
II	0.7171	1.0000	0.1919	0.2524	-0.7378
III	-0.0763	0.1919	1.0000	0.4265	-0.0941
VI	0.2205	0.2524	0.4265	1.0000	-0.1409
V	-0.4749	-0.7378	-0.0941	-0.1409	1.0000

Source: Compiled by Author.

The coefficient of correlation value 0.71714 representing the relationship between the matatu vehicle capacity distribution (I) and the population distribution (II), confirms the general hypothesis that variations in the distribution of matatu vehicle capacities and hence the general distribution of matatus in Nairobi area can mainly be explained by population distribution. The Correlation of Determination (r^2 = 0.4149) approximates that about 41.5 % of the variation in the distribution of matatu vehicle capacities can be explained by population distribution. In a similar manner, the correlation coefficient between the distribution of matatu vehicle capacities and the other variables provide descriptions of the degree to which variations of these correspond to that between the distribution of matatu services and population distribution. The negative coefficients -0.0763 and -0.4749 obtained for the distances covered and the income levels shows that these two variable or factors (the distances covered and the average annual incomes respectively) are inversely related to the distribution of matatu vehicle capacities. The common view that the urban poor are always nearest to their places of work is an anomaly in Nairobi. Instead, the low income are continuously being pushed to the periphery of the city resulting in long distances between their residential places and their places of work. This has placed an even heavy demand on the public transportation services and it explains the inverse relationship between distances covered and

the income levels (-0.0941). Even though the relationship between the two is low, current trends show that the low income residents of Nairobi will increasingly move to the periphery in view of the souring house rents in areas nearer the CBD. This process is further being escalated by the establishment of low income housing projects such as the site and service schemes which are located further away from the CBD. On the other hand, the strong inverse relationship between the population distribution and the average annual income levels is confirmed by the correlation coefficient -0.7378. This is because in Nairobi, most low income zones are also areas of a dense or large population. A comparision of the Figures 1.4 and 2.4 clearly testify to this. It is such zones that are relatively better served by matatu services accounting for the correlation values of 0.7171 and-0.4749 for the relationship between matatu distribution and population and income levels respectively. There is also a strong relationship of 0.4265 between the distances covered and the profitability levels. This show that the matatus which operate over longer distances also make relatively more profits, because it is in these zones that the demand for their services is greater.

With these series of coefficients, the second use of the analytical tool namely, as a comparative devise is apparent. But the areal association between the distribution of matatu vehicle capacities and the distribution of population is clearly not so

clear. When more than two variables are being considered, as in this case, judgement of this kind as to the relative importance must be made with caution since the simple correlation coefficient values show that there are some negative relationships in some cases. In order to eliminate the effect of concomitant relationships among other variables while examining the relationship of any pair, this study used the Coefficient of Partial Correlation to clearly show the strength of the relationship between matatu vehicle capacities distribution and population distribution. This yields a single measure summarizing the degree of relationship between two variables controlling for the others. It is meant to ascertain whether or not the other variable(s) is(are) responsible for some correlation in the first two. Table 4:4 below shows the results of the Partial Correlation Analysis which were carried out in this study to further determine the importance of population distribution as a factor influencing the distribution of matatu services in the study area. In this case, the subscripts stand for the following variables or factors.

1 = the matatu vehicle capacity distribution,

2 = the population size. (or distribution),

3 = the distances covered per trip in kilometers,

4 = the profitability indices, and

5 = the estimated average annual income.

Table 4:4,Coefficient of Partial Correlation Values Showing the relationship between the factors.

$r_{12.3}$ = 0.7178 $r_{12.4}$ = 0.7008 $r_{12.5}$ = 0.6173	$r_{14.2}$ = 0.0571 $r_{14.3}$ = 0.2084 $r_{14.5}$ = 0.1763
$r_{13.2}$ = 0.0896 $r_{13.4}$ = 0.0201 $r_{13.5}$ = 0.0361	$r_{15.2}$ = 0.1152 $r_{15.3}$ = 0.4712 $r_{15.4}$ = 0.4596

Source: Compiled by Author.

From the above values, it is clear that there is a strong relationship between the distribution of matatus (as is represented by their vehicle capacities) and population distribution or size. The values 0.7178, 0.7008, and 0.6173, indicate the partial correlation coefficient values for the relationship between the distribution of matatu services and population distribution if the other three factors of distances covered, the profitability levels and the average annual incomes respectively are controlled. In each case, it is clear that these factors only minimally influence the relationship between the distribution of matatu vehicle capacities and population distribution. This shows that population distribution plays a much more important role in influencing the distribution of

matatu services much more than any of the other factors. The Partial Correlation Coefficient value 0.7178 which is the highest, shows that the relationship between the distribution of matatu services and population distribution is highest when controlling for the distances covered. This implies that the factor distances covered plays a relatively minor role in influencing the distribution of matatu services compared to the population distribution and all the other factors.

Before arriving at any conclusions, however, it was important to ensure that problems related to muticollonearity are done away with. This refers to the linear dependence or correlation between two or more of the independent variables of the regression model. In an extreme perfect situation, it is quite impossible to distinguish between the way in which the values of a dependent variable are related to the independent variable hence the least squares estimator breaks down. The inspection of a matrix of zero-order correlation coefficients provides only a limited check except where there are only two regressors. A more general check is therefore that of a determinant expansion of the matrix r. This is referred to as the correlation determinant [r] with values ranging from 0 to 1. In this study an examination of the matrix r shows that the coefficients range between 0.644 and 0.003. This may be suggestive that there is lack of any element of multicollinearity but it was still necessary to test this by obtaining the

correlation determinant shown below;

$$[r] = \begin{bmatrix} 1.0000 & 0.7171 & 0.0763 & 0.2205 & 0.4749 \\ 0.7171 & 1.0000 & 0.1919 & 0.2524 & 0.7378 \\ 0.0763 & 0.1919 & 1.0000 & 0.4265 & 0.0941 \\ 0.2205 & 0.2524 & 0.4265 & 1.0000 & 0.1409 \\ 0.4749 & 0.7378 & 0.0941 & 0.1409 & 1.0000 \end{bmatrix} \quad 0.542$$

The results show that, although there was an element of multicollinearity in the data, it is not that serious as to render the analysis null and void. According to R. F. Wynn and K. Holden, (1974), most of such measurements of multicollinearity have a serious drawback in that they do not produce a sharp, unambiguous distinction between what is serious multicollinearity and what is only the usual acceptable multicollinearity to be expected when using some sample data. But the test was used here to give a fairly clear idea of whether the results have been seriously affected by multicollinearity which is not the case as can be seen from the results.

From the simple and partial correlation results, it is clear that the distribution of matatu services is functionally related to population distribution than any of the other factors. Using Fisher's method of determining the reliability of the coefficient of correlation between the distribution of the matatu services and population distribution (0.7171); we can contend that the

true correlation in the universe is at least 0.46 and that we can only be wrong in 5 % of such statements on the average. Using the student's t-distribution test (table) the null hypothesis (Ho) was rejected and the alternative hypothesis (Hi) accepted at 99.9 significance level. The average relationship between the distribution of matatu services and population distribution in Nairobi can be expressed by a linear regression equation where, $Y = 0.62 + 0.53X$.

The high relationship between the distribution of matatu services and population distribution can be explained by the fact that it is difficult to provide an adequate and economic public transport services for low density areas. In addition, low density areas in Nairobi tend to be occupied by the middle and higher income groups with the result that the levels of car ownership are higher and consequently the demand for public transport services are lower. Conversely, the high density areas can be economically and adequately served by matatus and other forms of public transport. Indeed some of the low income areas in Nairobi have developed in conjunction with the matatu system and are therefore oriented towards the use of matatus. In addition the lower income residents in Nairobi tend to occupy the high density residential areas thus car ownership and use is lower here. The functional relationship between the distribution of matatu services and population distribution therefore implies that matatus have an important role to play in view of the ever

increasing population of Nairobi. Their services are mainly provided in the high density areas where they offer complimentary services to the public bus system which cannot cope with the existing demands. The current trends in the city's growth show that there will be a greater concentration of public transport users especially in the city's periphery where matatu services are also in greater demand. The following chapter identifies the factors which influence public transport modal choice and use with special reference to the reasons why matatus are continuously being used.

CHAPTER FIVE.

FACTORS WHICH INFLUENCE PUBLIC TRANSPORT MODAL CHOICE IN NAIROBI.

5.1 INTRODUCTION.

In an attempts to develop a framework for analyzing commuter behaviour in a situation of competing or complementary modes of public transport; as is the case of the matatus and the public bus system in Nairobi; this study adopted the Abstract Mode Approach to the demand for travel which it also uses to attempt to explain the role and prospects of the matatu mode of public transport in Nairobi. The basic assumption of this approach is that the demand for travel and use of a particular mode of public transport is a function of the modes' quality attributes or the modal characteristics as well as certain socio-economic variables. The explanatory variables here therefore include the modal quality attributes such as the costs of travel or fares charged, the speed or time taken to reach destination, the frequency of service, the reliability or regularity, the comfort, and safety, as well as the general socio-economic variables of population distribution or level of travel demand, the distances covered, and the income levels of the users.

This chapter addresses itself to the public transport modal choice characteristics or quality attributes and the socio-economic variables and explains how they influence the use of the

different modes of public transport especially the Nairobi matatus. It therefore concerns itself with the second hypothesis which sought to explain why matatus have consistently attracted more and more users despite the inherent dangers posed by their operations. According to this hypothesis, matatus are seen as having attracted relatively more users because they are frequently available rather than because of any other quality attribute which they possess. This chapter ascertains whether or not there are any such quality attributes or characteristics of matatus which explain their choice and use and whether the users have similar perceptions of what constitutes a suitable mode of public transport. It also attempts to explain the role of some socio-economic variables in influencing these perceptions.

The chapter is divided into two sections with the first section discussing how the users value the choice factors and their general perceptions and attitudes towards the matatus and the other modes of public transport as per the survey responses. The second section attempts to explain the role of the socio-economic variables of population distribution or travel demand, the distances covered, and the income levels in explaining the commuters' attitudes and perceptions towards the existing modes of public transport.

5.2: THE RELATIONSHIP BETWEEN PUBLIC TRANSPORT QUALITY ATTRIBUTES AND MODAL CHOICE.

Any assessment of the quality attributes of a transportation system or mode will always differ depending on the different tastes and perceptions of the users. According to M. E. Campbell (1963), the main parameters which go to make up what we might call people's transportation preference function are, the time taken or speed, safety, frequency of service, comfort, reliability or regularity and cost or the fares charged. Little is known about how people value these and there is tremendous variability between different people and even the same people at different times. It is because of this that this study sought the points of view of the commuters or users of the matatu mode of public transport to determine whether there are any other factors apart from their frequency of service which explain their use. It was equally important to ascertain how they value each of the various choice factors or quality attributes.

This required that the sampled respondents provide the researcher with a subjective judgement of how particular choice factors are more or less preferred to each of the others. The respondents were therefore asked to rank the six major quality attributes or choice factors of comfort (or the availability of sitting space, frequency of service, speed, reliability or regularity, safety and cost in order of the most preferred to the least preferred. As a test of the significance of the results of the survey responses, the coefficient of concordance (W) was computed. This provided a means of assessing the degree of

consistency among the ranks or the extent of agreement amongst the respondents. Table 5.1 shows the order of rankings for each of the choice factors by the 371 respondents. The result was a low coefficient of concordance value of 0.286. This shows that there was little agreement amongst the respondents on how they rank the various choice factors. It is estimated that only 28.6 per cent of the respondents maximally agree on their rankings. Despite this generally low level of agreement on the rankings of all the choice factors there was a greater consistency in the ranking of both the most preferred factor and the least preferred factor.

Table 5:1,Ranks of Public Transport Choice Factors in order of Preference by the Sampled Respondents.

	NUMBER		OF		RESPONDENTS	
RANKS	Regularity	Comfort	Frequency	Speed	Cost	Safety
1st.	33	147	92	63	11	25
2nd.	46	93	117	52	32	31
3rd.	72	82	86	58	41	32
4th.	90	35	33	93	60	60
5th.	68	13	27	61	101	101
6th.	62	1	16	41	126	122
TOTAL	371	371	371	371	371	371

Source; Compiled by the author.

This is because these two were relatively easy to rank hence 39.6 percent and 33.6 percent of the respondents chose the factor comfort and cost as the most preferred and the least preferred

factors respectively (Table 5:1). The other factors whose position lies in the middle are not so consistently ranked by the respondents. As is stated by P. Gould and R. White, (1986) most people often find it much easier to rank attributes they like and those they dislike, hence they are often indifferent to those attributes which lie in the middle. This explains the failure to reliably and consistently rank the public transport choice factors in this study. In an attempt to get a more consistent and reliable order of preference, the coefficient of concordance was computed for each of the pairs of the choice factors. This revealed a higher value of 0.826 for the following pairs of choice factors;

(a) Comfort and Frequency,

(b) Regularity and Speed, and

(c) Cost and Safety.

This shows that there is higher level of agreement amongst the respondents when the factors are considered in pairs as above. This implies that the respondents do not value only one choice factor in each case but often consider two or more factors in their choice of public transportation modes. However, apart from this, the low level of agreement on the ranking of the choice factors can also be attributed to some socio-economic differences amongst the users who were residents of different user zones. The effects of these variables are looked at in the second section of

this chapter.

Using Thurstone's Law of Comparative Judgement Case V procedures to compute the scale values for each of the choice factors, a matrix of sample proportions was derived (Table 5:2). From this matrix of sample proportions, another matrix of Z-scores was computed (Table 5:3). The column totals of the Z-values were then computed and the scale value for each factor obtained by calculating the simple average of each column's Z-values (Table 5:4).

Table 5:2: Sample Proportions of Public Transport Choice Factors

	Regularity	Comfort	Frequency	Speed	Cost	Safety
Regularity	-	0.129	0.256	0.493	0.712	0.671
Comfort	0.870	-	0.536	0.730	0.870	0.827
Frequency	0.744	0.464	-	0.571	0.879	0.817
Speed	0.507	0.269	0.429	-	0.679	0.639
Cost	0.288	0.129	0.121	0.321	-	0.501
Safety	0.329	0.173	0.183	0.361	0.499	-

source; Compiled by author.

Table 5:3: Matrix of Z-Values for the Public Transport Choice Factors.

	Regularity	Comfort	Frequency	Speed	Cost	Safety
Regularity	-	-0.743	-0.489	-0.013	0.424	0.343
Comfort	0.743	-	0.073	0.462	0.743	0.657
Frequency	0.489	-0.073	-	0.143	0.759	0.635
Speed	0.013	-0.462	-0.143	-	0.359	0.278
Cost	-0.424	-0.743	-0.759	-0.359	-	0.003
Safety.	-0.343	-0.657	-0.635	-0.278	-0.003	-

Source; Compiled by Author.

Table 5:4: The Scale (Z) Values For the Public Transport Choice Factors.

CHOICE FACTORS	SCALE VALUES.
Comfort	+ 0.536
Frequency	+ 0.391
Speed	+ 0.009
Regularity	- 0.096
Safety	- 0.383
Cost	- 0.457
Mean =	0.000.

Source; Compiled by Author.

The scale values express each factor X as a derivation of the mean of all the scale values (corresponding to the 6 factors). Using this procedure, the mean and sum of all the 6 scale values is zero. If the factor with the lowest scale value (cost) is placed at a reference point zero it is possible to fix all other factors on a single line based on their relative position to the least preferred factor. From this a linear scale was derived showing the relative preference levels of each of the factors. (Table 5:5).

Table 5:5, Relative Linear Scale Values for each of the Public Transport Choice Factors.

CHOICE FACTORS	LINEAR SCALE VALUES.
Comfort	0.993
Frequency	0.848
Speed	0.466
Regularity	0.361
Safety	0.074
Cost	0.000

Source; Compiled by Author.

From the above results, it is clear that the relatively most valued public transport modal choice factor is comfort with a relative scale value of 0.993 followed by the frequency of service factor (0.848) while the least valued factor is that of cost (0.000).Using the same procedure, it was possible to compute scale values for paired choice factors with the following results,

Table 5:6, Relative Linear Scale Values for Paired Public Transport Choice Factors.

PAIRED CHOICE FACTORS.	LINEAR SCALE VALUES.
Comfort and Frequency	1.683
Speed and Regularity	0.754
Cost and Safety	0.000.

Source; Compiled by the Author.

Since there was a greater agreement amongst the respondents in ranking the same pairs of choice factors, it is therefore clear that both the factors frequency of service and comfort are the most highly valued by the respondents in their choice of modes of public transport while the factors safety and cost are the least valued. But before attempting to look at the implications of these results, it is worth noting that all the respondents were matatu users in the sense that they were interviewed while queuing for the matatus. Their stated preference rankings do not necessarily provide us with the reason why they use matatus. For most commuters in Nairobi there has always been a limited choice in the situation of an excessive demand for public transport services. The choice and use of a mode of public transport is therefore mostly determined by the most frequently available mode.

But the users of matatus tend to value comfort within the context of the available sitting and or luggage space available in the matatus. It is mainly because of this that they were queuing for the matatus. The matatus are also frequently available and relatively flexible and faster and it is because of these quality attributes that the respondents tend to highly value the factors of frequency of service and speed or time taken. The factor cost is least valued because both the public bus system and the matatus operate and charge more or less the same fares. Matatus operate at a generally higher cost per seat

kilometre than the buses. Estimates based on the calculation of the cost per seat kilometre for all the route covered in this study reveals that they operate at about 30 cents per seat kilometre compared to the buses (KBS) which operate at about 25 cents per seat kilometre. This difference is negligible especially in view of the desperate need by the commuters to arrive at their destinations. It is also offset by the greater frequency of service of the matatus, their flexibility, and speed. These factors basically account for their ever increasing occupancy rates. An exception to this, however, is in route number 23 (Uhuru/Outer Ring) where the popularity of matatus is also closely associated with the fact that their fares are lower than that of the buses. But as a whole, the factor cost is least valued by most of the matatu users. In such a situation, they also tend to take little consideration for their safety hence it is because of this that the factor safety is also less valued.

When asked the total number of times they use either the buses or the matatus in a week, 75.2 percent of the respondents tend to use the matatus more times than they use the buses. The total number of bus trips made per week by the 371 respondents was 1343 with a mean number of bus trips of 4.93 as compared to that of the matatus which is 2003 and 5.4 respectively. The results of the survey responses did not reveal as much difference in the use of the matatus when going for duty and when travelling back to the residential areas. About 36.4 percent of the

respondents prefer using them when going back to the residential areas while 34.6 percent prefer using them when going for duty. The remaining 29.0 percent of the respondents tend to prefer and use them equally for both trips.

When listing the reasons for their use of matatus in order of preference, 30.8 percent of the respondents consider speed as the major factor. This is followed by the flexibility of their routes and terminals (29.4%), the availability of sitting and or luggage space (22.4%), their frequency of service (16.7%) entertainment (0.7%) and safety (0.0%). These basically represent the major reasons why matatus are used. Table 5:7 below summarises the percentage commuters responses when asked to compare the public bus system and matatu services in Nairobi in reference to their relative position in the provision of the six major quality attributes of regularity, frequency of service, comfort, speed, safety and cost. From the responses it is clear that the public bus system is favoured and considered to be more regular and reliable, safer, cheaper and relatively more comfortable. The matatus on the other hand are considered to be faster and offer more frequent services.

Table 5:7, Percentage Respondents' Preferences for the Public Bus System and the Matatus.

QUALITY ATTRIBUTES	Percentage BUSES	Preference MATATUS	for; BOTH
Regularity	75.3	17.8	6.8
Comfort	31.4	22.6	27.0
Speed	32.2	50.7	17.1
Frequency	13.7	79.5	6.8
Safety	66.4	2.7	30.9
Cost	58.2	8.9	32.9

Source; Compiled by Author.

However, when considering only the three factors of comfort, frequency of service and speed which are also more highly valued by the same respondents, the reasons why they use matatus become more clear. The fact that two choice factors of speed and frequency of service are highly valued and are provided for much more by the matatus, implies that they are mainly used because of these two reasons. Even though the buses are considered as providing relatively more comfort by 31.4 percent of the respondents as compared to the 22.6 percent who prefer matatus, it is worth noting that the proportional difference here is minimal. There is a large proportion of the respondents (27.0 %) who are indifferent as to comfort provision component of the two modes of public transport. This is because, with the excessively high demand for public transport services in Nairobi most commuters tend to travel in less or no comfort in both the public bus system and the matatus. The matatus are therefore better placed to provide the two other highly valued choice factors of frequency of service and speed hence it basically because of

these that they are mostly used. However their demand for and use cannot only be explained by these quality attributes which they possess. There is no reason to expect that the survey respondents' rating of a mode on each of the choice factors or quality attributes are independent from one another. The six factors were chosen for inclusion in this survey on the basis of their potential importance both in planning policy determination and in an attempt to correspond with the latent psychological dimensions by which consumers (users) evaluate alternatives when making modal choice decisions. The Null Hypothesis in this study had been based on the assumption that commuters in Nairobi often choose and use the most frequently available mode of public transport given the excessively high demand. But their stated preference shows that apart from this, the factor comfort, which is seen within the context of available sitting space, is highly valued than the frequency of service. It is basically because of this that the users would rather often queue in order to get the sitting space than use "overloaded" modes of public transport.

This research addresses the question; Can attributes expressed by survey respondents' ranking or rating of their choice alternatives on the basis of a comprehensive set of descriptive attributes be used to explain travel modal choice decisions ? The answer to this question is positive provided that certain other information involving the perceived accessibilities to the choice alternatives is also employed. Since the respondents here were frequent users of the city's public

transport services, it is assumed that they were aware of, and had a long time experience to enable their stated preference be regarded as expressing their revealed preference. Moreover since they were interviewed while queuing for the matatus it is most likely that they were doing so well aware of the alternatives available to them hence their use of matatus is strongly related to their stated preference or ranking of the choice factors. One would therefore assume that they were using matatus because it tends to offer them greater comfort, frequency of service, and speed which are their most highly valued public transport modal choice factors. Since the respondents were from different operational zones and had different attitudes and perceptions it is equally important to assess how certain socio-economic variables associated with their different destinations or operational zones influenced their assessment of the choice factors.

5.3: SOCIO-ECONOMIC VARIABLES AND PUBLIC TRANSPORT MODAL CHOICE.

In order to assess general the role of socio-economic factors in influencing public transport modal choice and use of matatus, the survey responses in selected matatu user zones and the socio-economic characteristics of the different users were analyzed. The procedures of Thurstone's Law of Comparative Judgement Case V were used to compute the linear scale values for each of the public transport choice factors and hence show the differences in the users' perceptions towards these choice

factors. Since each users zone could be identified with certain generalized socio-economic variables, it was possible to use these to explain the differences in perceptions towards the choice factors. The results of scale value computations are shown in Table 5.8. From the results it is clear that each of the factors has a different scale value in each of the selected zones. Their position in the linear scale also differs in some zones. This is because of differences in the level of travel demand or in the use of public transport services, the distances from the CBD, and in the income levels of most of the residents of each zone. These factors can be used to explain the public transport modal choice factors in each of the users' zones.

Table 5:8, Relative Linear Scale Values for the Public Transport Choice Factors in Selected Matatu user zones in Nairobi. (including the Z-values).

(a) KIBERA.

Choice Factor.	Z-Value.	Linear Scale Value.
Frequency	+0.506	0.952
Comfort	+0.292	0.738
Regularity	+0.132	0.578
Cost	-0.239	0.207
Speed	-0.245	0.201
Safety	-0.446	0.000

(b) EASTLEIGH.

Choice Factors.	Z-Value.	Linear Scale Value.
Comfort	+0.703	1.196
Frequency	+0.341	0.834
Regularity	-0.400	0.453
Speed	-0.220	0.273
Cost	-0.291	0.202
Safety	-0.493	0.000

(c) DANDORA-KARIOBANGI.

Choice Factors.	Z-Value.	Linear Scale Value.
Frequency	+0.281	0.697
Speed	+0.157	0.563
Comfort	+0.132	0.543
Cost	+0.082	0.493
Regularity	-0.241	0.170
Safety	-0.411	0.000

(d) BURU-BURU-UMOJA.

Choice Factors.	Z-Value.	Linear Scale Value.
Comfort	+0.618	1.357
Frequency	+0.197	0.936
Speed	+0.072	0.811
Regularity	+0.012	0.751
Safety	-0.160	0.579
Cost	-0.739	0.000

(e) EASTLANDS.

Choice Factors.	Z-Value.	Linear Scale Value.
Comfort	+0.490	0.942
Frequency	+0.237	0.689
Speed	-0.064	0.388
Regularity	-0.076	0.376
Safety	-0.135	0.317
Cost	-0.452	0.000

(f) SOUTHLANDS.

Choice Factors.	Z-Value.	Linear Scale Value.
Comfort	+0.255	0.712
Frequency	+0.253	0.710
Speed	+0.108	0.565
Regularity	+0.056	0.513
Safety	-0.215	0.242
Cost	-0.457	0.000

Source; Compiled by the Author.

Based on a comparision of the linear scale values of the choice factors in each of the selected zones, we may conclude that all respondents tend to agree on the most and least preferred choice factors. But a closer examination of the values and position of the choice factors especially in Eastleigh, Kibera and Dandora-

Kariobangi zones proves otherwise. These three have a majority low income residents and the levels of public transport services demand is relatively higher. As a whole, the concern for comfort and frequency of services as choice factors is very significant given the fact that most of the respondents and users of public transport services in Nairobi often experience and tend to fear overcrowding in the buses and matatus. It is because of this that they tend to highly value the factor comfort in the sense that they consider the availability of sitting space as very important. Their choice and use of a particular mode of public transport therefore mainly depends on the availability of this space.

However, in situations where the demand for public transport services is relatively more excessive especially during the rush hours, the factors frequency of services and speed often play a significant role in determining their choice of modes of public transport. Under such circumstances, most commuters simply have no choice but use the mode that is most frequently available hence it is because of this that the respondents tend to rank the factor frequency of service as a major choice factor. Under the same circumstances, the dire need to arrive at the various destinations as fast as possible accounts for their ranking the factor speed or time taken as the third most important choice factor. The other factors (regularity or reliability, safety and relative cost) are relatively taken into little consideration. Despite the theoretical importance of the factor relative cost in

determining the choice of modes of public transport it tends to be given little consideration mainly because there is a minimal difference in the fares charged by the existing modes of public transport. An exception to this however can be noticed in the responses of the residents of Dandora-Kariobangi, Kibera and Eastleigh who have placed it in a relatively better position because of the differences in fares charged by the public bus system and the matatus and also partly because of the fact that most of the respondents here earn lower incomes. The factor cost has little meaning to matatu users except in the context of their income and what they are willing to spend as well as the within the context of the availability of an alternative mode which is cheaper.

It is significant that the respondents from Kibera and Dandora-Kariobangi view the factor frequency of service as a more important factor than comfort. This is because of the relatively excessive demand for public transport services in the two zones which also tend to have a greater frequency of service by both the matatus and the public buses. As is shown in Table 4.2, these zones are also served by more matatus. The results of a matatu frequency of service survey carried out in this study (Appendix X), shows that these two zones together with those of Mathare North, Eastleigh, South B, Uthiru/Kangemi and Maringo have a higher frequency of service. The difference between off-peak and peak hour frequency of service in these zones is also relatively low showing that the trip pattern here are also unique. This

implies that commuters here tend to make trips for a variety of reasons apart from those of attending to normal office working duties whose trips are generally concentrated in the peak hours. In the survey responses, it was possible to discern these differences in the trip patterns for the residents of various zones. A larger proportion of the respondents in Kangemi/Uthiru (56 %), Dandora/Kariobangi (64 %) Eastleigh (54 %) and Kibera (59 %), tend to make trips different from those made during normal working/school hours. This aspect of trip patterns is different from that put forward by J. O. Wheeler, (1970) who argues that there is a predominance of trips to work in all metropolitan areas. This study has recognised the existence and predominance of non-work trips especially amongst residents of the above low income zones in Nairobi. Such trip patterns also explains the reason why the respondents here tend to highly value the factor frequency of service. In Dandora-Kariobangi, the factor speed or time taken is placed second to frequency of service and is relatively more considered by the respondents than the factor comfort or availability of sitting space. This may imply that the commuters here are often in a greater need to arrive at their destinations much faster. Since this zone is relatively further away from the city centre than any of the other selected zones, the concern for speed is greater. This fact is further reinforced by the relatively lower position of the factor speed or time taken in both Eastleigh and Kibera which are relatively nearer the city centre than the other selected zones. This view supports

that of J.S. Wabe (1965) whose study in metropolitan London revealed that peoples' valuation of time varies according to the length of the journey to work. Since these two residential zones are nearer the city centre, the respondents here tend not to regard the factor speed or time taken as relatively less important. From the above analysis of some of the factors responsible for the differences in the perception of public transport users from different residential zones, one would be tempted to conclude that matatus are more suited to providing services especially in the low income residential zones whose respondents tend to value their frequency of service and speed. As has already been noted these are the major factors which can be used to explain the continuous use of matatus. So far, they have played a major role in offering more frequently available and flexible services to a majority of the city's commuters who also tend to value these quality attributes. Apart from these, they also offer faster services which are highly valued by those living in Nairobi's residential suburbs such as Uthiru, Kangemi, Kamiti, Kahawa, Roysambu, Ndumberi, Kabete, Embakasi, Dandora, Kayole, and Riruta just to mention a few. As the city expands, the trend is that most commuters living in such suburbs will need more and more public transport services. The public bus system cannot cope with these demands especially during the rush hours when most commuters tend to prefer and use a more frequently available mode of public transport which is also fast enough and flexible. Under such circumstances, these positive quality

attributes of the matatus should not be underestimated.

CHAPTER SIX.

CONCLUSION AND RECOMMENDATIONS.

This study aimed at investigating various aspects of the matatu mode of public transport in Nairobi with a view to showing the system's general role, efficiency and quality of service. This last chapter begins by restating the major findings of the study before proceeding to examine the implications of these findings to the urban public transport policies pursued by the GOK.

6.1: SUMMARY OF THE MAJOR FINDINGS.

This study basically sought to gather and analyze information on matatus so as to identify their level of efficiency and quality of service in Nairobi as well as their future role. In doing this it has considered the following major issues and uses them to provide a better understanding of the matatu system's operations.

1.) The role of the matatus in promoting mobility and accessibility needs of Nairobi's commuters with special reference to the factors which influence their distribution and the positive quality attributes which they have and which account for their continuous use by an increasing proportion of commuters.

2.) The importance of their financial viability and role in

generating incomes and employment opportunities to the low income.

This study has tried to show that matatus are an integral part of the overall urban public transport system in Nairobi. Their origin and growth has been traced to show how they provide a locally adapted means of public transport which has emerged due to the city's public transport services demands. They are seen as providing the city's planners with a low cost option which should be of immediate importance in a city which is undergoing such a rapid rate of growth as Nairobi. Such a strategy involves reshaping the management of the existing infrastructure in order to achieve a more efficient and agreeable equilibrium between demand and supply. This study sees matatus as part of this infrastructure which should not be banned in view of their complimentary role to the public bus system in providing an immediate low cost public transportation alternative. Their role in generating income and employment opportunities especially for the city's low income residents is also appreciated while it is noted that they have so far been associated with the most dreadful accidents and other traffic management problems. This is basically because their enormous growth in numbers has not been matched by a corresponding growth in their regulation and management or control so as to streamline their operations and ensure safety and comfort to commuters and other road users. This study has attempted to show that such problems can be solved hence matatus should not be considered as a problem but as a

solution to the city's public transport problems under the present circumstances where the need for their services surpasses the problems they pose.

These issues are handled in Chapter 3 which describes the urban pattern and public transport system prevailing in Nairobi with a view to showing that matatus have continuously played an important role. This chapter has traced the origin and growth of Nairobi's public transport system within the context of showing how the combined effects of historical and contemporary forces have shaped the city's public transport problems and prospects. It has looked at the role of the existing public bus system (KBS) and matatus, noting that the public bus system has not been able to cope with the ever increasing demands. The system has also been plagued by various problems which have continuously placed it in a weaker position to respond to the increasing demands. The matatus on the other hand are seen as having responded positively to these demands as can be seen in the continuous increase in their numbers. The increase in the proportion of passengers who use them is also a strong indication of the increasing demand for their services which should not be underestimated. In looking at the past and current planning responses to the city's public transport situation, this study has also identified the practical measures which have been employed especially in response to the matatus and notes that these are not enough. More needs to be done especially in implementing some of the recommendations which

have already been suggested as well as those that this study aims to make.

In order to show that matatus in Nairobi have emerged and operate with a view to improving the mobility and accessibility needs of the city's residents this study set out to test the hypothesis that there is a strong functional relationship between the distribution of matatu services and population distribution. This is tackled in Chapter 4 which looks at the factors which influence the spatial distribution of matatu services so as to show which one has the strongest functional relationship with the distribution of the services. The extent to which the matatu road network promote accessibility is also measured to show and compare the distribution of the road network in various zones. But since this is not necessarily related to the level of service provision, it was important to consider the actual distribution of matatu services and attempt to explain how this is related to population distribution, the distances covered, the income levels of the users and the profits derived from operating in each zone or route. From the results of the simple correlation analysis, which is carried out to relate each of these factors, it is clear that they are related to each other and each of them has a role to play in influencing the distribution of matatu services in Nairobi. But the strength and nature of the relationships differ in each case. The factor population size has a relatively stronger functional relationship with the distribution of matatu

services hence there is a greater concentration of such services in areas of a high population size and density. The strength of this relationship is further shown by the Partial correlation results which have been computed by controlling the other factors. Since the factor population size is also strongly related to the level of travel demand in Nairobi, the study therefore concludes that matatus operate in response to these demands and are therefore mainly demand-responsive. In doing so they play a major role in influencing the mobility and accessibility of a majority of the city's commuters who live mainly in the zones of high population density.

In order to explain why matatus have consistently continued to attract more and more users vis-a-vis the public bus system (KBS),this study then attempts to explain the factors which influence public transport modal choice in Nairobi with a view to showing how these factors are related to the demand for and use of matatus in the various zones. This is the content of Chapter 5 which tries to identify whether there are any significant quality attributes of matatus which have attracted their users to use them apart from the mere fact that they are often most frequently available. The results of the scale values computed for each of the public transport choice factors from the survey responses show that most of the users tend to prefer the factor comfort or the availability of sitting space as a major factor determining their choice of any mode of public transport. It is because of

this that the respondents would rather queue for the matatus during the rush hours than use the public buses when they are not assured of the sitting space. But since the level of agreement amongst the respondents in ranking these choice factors was low, it is important to note that their choice is not basically dependent on one factor. The respondents tend to agree that both the factor comfort and frequency of service are equally important. These two factors can therefore be best used to explain the use of matatus. But apart from these, matatus are also considered to provide much faster and flexible services. These are also highly valued by their users.

The factor relative cost is the least preferred or valued choice factor mainly because both the public bus system and the matatus in Nairobi tend to charge the same fares in most routes. Apart from this, the excessively high demand for public transport in Nairobi has ensured that most commuters tend to be more concerned about the need to reach their destinations much more than such factors as the relative cost and safety. It is because of these that the two factors are the least valued public transport choice factors. The study has however identified differences in the assessment of the choice factors amongst the residents of each of the different residential zones. These differences are used as a basis of explaining how socio-economic factors or variables influence public transport modal choice. From the results presented, it is clear that respondents'

different perceptions depend on such factors as, the level of public transport demand and use, the trip patterns, the distances covered and the income levels of the users. From this assessment, it is clear that matatu services are more suited in areas where the public bus system operates with a low frequency of service and where commuters are in dire need to arrive at their destinations in time. Since most of the city's low income residents are continuously increasing in numbers especially in the city's peripheral zones, it is important that they should have access to modes of public transport. Matatus could play a major role in increasing the mobility and accessibility needs of people not easily accessible to the public bus system. The matatu services are more so important because most of the low income residents in such zones have trip patterns which require frequently available services.

6.2: IMPLICATIONS AND RECOMMENDATIONS.

The inadequacies of Nairobi's urban passenger transport services can be accounted for by a variety of factors some of which are out of the scope of this study in the sense that they are not accounted for by the operations of matatus. These include, the uneconomic spread of the city's morphology, the great population pressure due to rapid urbanization, the shortage of enough public transport services in form of the available

buses, matatus and the railway commuter services, the lack of accessibility to certain parts of the city, and the inadequate street layout and road space. Apart from these, other problems stem from the inability of the city authorities to implement policy recommendations which have been made to solve the inherent problems. These include the failure to implement efforts geared towards the creation of public transport priority lanes and roads, and to reduce the uniform work schedule which has created a concentration of trips during the morning and evening rush hours. There are also problems associated with the continuous concentration of activities in the CBD which ensures that most trips are made to this point, apart from the problem of inadequate resources to repair the city's roads and to provide other modern urban transportation facilities.

These inadequacies are serious but not impossible to remedy. The following broad recommendations may help in solving the current urban transport problems which the city faces, especially with regards to the future role of the matatus;

6.2.1: General Recommendations.

1. While it is recognised that urban growth is an inevitable process of socio-economic change, the pace of growth of Nairobi could be reduced. The shift of the administrative and other functions from Nairobi to other urban centres

could go along way i n reducing population pressure in Nairobi. The District Focus Policy for Rural Development (DFPRD) which is currently being employed by the GOK could go a long way in ensuring the success of this re-allocation process (Obudho et al, 1988). There is need to strengthen the programme and improve the working and living conditions of people in other urban areas and in the rural areas. This will improve the general standard of living of the people and check the drift of people from rural to urban areas. The current high rates of population growth in Nairobi is basically the cause of the city's major problems and its' inability to sufficiently provide the facilities required by the increasing population. The problem of population growth in the city should therefore be urgently addressed to bearing in mind the fact that it is mainly caused by rural-urban migration (Obudho, 1987).

2. Within Nairobi, a deliberate de-concentration process should be initiated to remove pressure on the CBD. The relocation of employment and other activities from the CBD to the outskirts need to be given immediate and practical attention so that some traffic flow can be attracted from the CBD to the other zones. So far, such zones have been identified and it is very important that they be firmly established as satellite CBDs to offer some of the facilities currently being offered at the CDB. The notable growth of Westlands

and Hurlingham centres, for example, is a step in the right direction but future consideration should be given to the establishment of more such centres closer to the low income residents who are continuously increasing in numbers and residing mainly in the city's suburbs. Since they are also the major users of public transport services, it is important that their trip patterns should be changed to ensure that they do not have to cover long distances and spend a substantial amount of their income commuting to the CBD. The sites which should be given due considerations in efforts aimed at changing the trip patterns include, Kangemi/Uthiru, Riruta, Kahawa/Kasarani and Embakasi.

3. The uneconomic use of space in Nairobi should be discouraged. An overview of the built-up sections of Nairobi area, reveals an amorphous pattern. There exists too much open space between these continuously expanding residential zones and those immediately surrounding the city centre. These suburbs which include Kangemi/Uthiru, Riruta, Roysambu, Kahawa, Embakasi, and Njiru are today expanding at a tremendous rate and provide residence to a majority of the city's low income earners. There is need to intensify and strengthen the city's infilling process so that a more compact city form is achieved in order to enhance accessibility to the road network and public transport

services. This could inevitably increase the areal coverage of the city's public transport road network by increasing the network's density of access. The results of the measurement of the areal coverage of the matatu road network presented in Chapter 4 shows that there are wide differences in users access to the operational routes in different zones. This is because of the existing wide spaces in some zones. Future efforts should therefore be geared towards decreasing these differences in the areal coverage of the road network by infilling the wide open spaces through the construction of more residential estates. These could be served by the increasing number of matatus and the public bus system.

4. The allocation of the available financial resources should be sensitive to the needs of the public transport sector. This is because a majority of the city's residents are users of these services. Funds should therefore be provided for the procurement of new and more buses, spare parts, fuels and other accessories so that there is an adequate number of serviceable buses. The recent introduction of the NBS and the subsequent formation of a parastatal to run these services is a step in the right direction since these buses today offer a complimentary service. Because of the excessively high demand more buses should be introduced especially to offer an all round service in the high demand

routes. For a long time now, the monopoly enjoyed by the KBS has ensured that it considers less the comfort and safety of the users and it has done very little to increase the number of buses and improve on its services in response to the ever increasing demands. The competition offered by the NBS will inevitably lead to a change in this state of affairs more so because the NBS has so far proved popular because of its disciplined staff. As a whole, the increase in the number of buses will increase their frequency of service apart from providing more sitting space to the commuters. This study has shown that these two factors are highly valued by users of public transport hence there is need to increase the number of buses more so during the rush hours so as to provide more sitting space and increase the frequency of service. Each bus should be able to establish and carry a maximum number of passengers to ensure that it is not so much overcrowded. The NCC should also be able to set up a research wing to undertake investigations into the changes in traffic characteristics of Nairobi. This would provide information upon which future bus timetables could be based, and upon which the buses could be redistributed in response to the demands.

The Railway Commuter services which were recently introduced also serves a useful purpose in offering services during the rush hours for residents of the city's suburbs hence

more funds should be allocated for an improvement of the services more so to ensure that it operates more trips than it currently does. This study has shown that there is a large proportion of commuters who tend to highly value the factor frequency of service much more than the regularity of services. Most of them are low income earners who are predominantly living in the city's periphery. They tend to make trips outside the normal office working trips and are therefore inclined to use the mode of public transport that is most frequently available rather than one whose services are regulated by the normal office working trips. On the basis of this, future efforts should be geared towards increasing the number of RCS trips per day to cater for them too.

4: The present street layout and road space in Nairobi is inadequate. The NCC should embark on a road rehabilitation programme which should not only be concerned with the city centre traffic situation. The city authorities should for example construct ring roads and more crossroads linking various population centres to each other. Ring roads which do not pass through the city centre should be constructed to ensure that vehicles passing through the city do not necessarily have to pass through the city centre. Figure 11 provides an outline of the nature of such an outer ring road

in view of the future land use pattern in Nairobi.

In rehabilitating or constructing new roads the city authorities should ensure that the interests of pedestrians are considered by providing space besides the roads for pedestrian lanes to reduce the danger of accidents. This concern for the pedestrians is more so important in view of the fact that as the number of private automobiles in the CBD continues increasing, there will be need to restrict private automobiles from the CBD in the near future and to establish Pedestrian Cores in which some streets in the CBD will be transformed into pedestrian precincts. Other important traffic management improvements should include the construction of highways in major traffic flow zones, the construction of a network of one-way streets, integrated traffic signals, signs and road markings in the CBD, reserved bus lanes, and specialized roads to service high density residential, industrial and commercial districts.

6.2.2: The Future Role of Matatus.

The above recommendations point out to the fact that matatus are not responsible for the basic transportation problems which Nairobi faces. Instead they play a major role in increasing the transport options available to the travelling public in view of the excessive demand for public transport services. This study has specifically shown that they are mainly used because of their flexible services, their

frequency of service, and their speed. They also play a significant role in increasing the available sitting space to commuters and offer an essential competition to the public bus system. Apparently the need to reorganise their operations and ensure that they adhere to traffic regulations has been recognised but more needs to be done to ensure that their positive quality attributes are taken into consideration in planning for their future role. Since they are liable to greater increases in number, it is important that future effort should be geared towards creating alternative terminals for them outside the city centre. Such sites would provide more space for queuing and reduce congestion in the CBD. This study has shown that matatu services are offered in response to the demands hence there is a strong relationship between the distribution of their services and that of population distribution. It is therefore likely that they will continue increasing in numbers and offer services more so in areas which are increasingly being inhabited by the low income. In these areas commuters tend to use them mainly because there are more frequent and inclined to offer services even outside the normal official working hours. Since such trips have been identified especially amongst the low income residents of the city's suburbs, it is likely that matatus will continue on providing their services especially in these areas.

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APPENDICES

APPENDIX I: MATATU TRAFFIC CENSUS SURVEY INVENTORY.

1. OBSERVER'S NAME, ...

2. DATE, ...

3. TIME, From, ... To, ...

4. ROUTE/ZONE, ...

5. CBD TERMINAL, ...

6. Record the following details concerning each of the matatus counted.

VEHICLE REGISTRA. NUMBER.	BODY TYPE	OFFICIAL CARRYING CAPACITY	NO. OF PERSONS EMPLOYED IN THE VEHICLE

7. TOTAL NO. OF VEHICLES, ...

   (a) 25 Seator Category, ...

   (b) 18 Seator Category, ...

8. NORMAL CARRYING CAPACITY, ...

9. TOTAL NUMBER OF OPERATORS, ...

APPENDIX II; MATATU DAILY OPERATIONS SURVEY INVENTORY.

1.Observer's Name, ...

2.Date, ... Time, From,..... to, ...

3.City Centre Terminal, ...

4.Route/Zone,.....

5. Description of the terminal facilities and methods of acquiring commuters, ...
.....
.....

6. Record the following details for each vehicle used, whil making a trip from the city centre

Vehicle No.	Body Type	Departure Time.	Fares Ksh.	Approx. Passenger Capacity.	No.of Operators	Arrival Time.

7. For the same vehicle record the following details while makin the trip back from you destination;

Vehicle no.(same)	Duration of stay at residential terminal.	Approximate Passenger Capacity.	Time Taken for Trip back.

8. Name of residential terminal,.....
9. Description of method of acquiring commuters in th residential terminal, ...
.....
.....
.....,.....

10. Any other comment. (especially concerning the distributic of commuters along the route), ...
.....
.....
.....
.....
.....

APPENDIX III.

MATATU OWNERS AND OR OPERATORS SURVEY: SAMPLING DESIGN.

TERMINALS	DESTINATION ROUTE	APPROX. NO. OF MATATUS.	SAMPLE SIZE	POSITIVE RESPONSE.
Munyu Rd. Ronald Ngala St. & opp. OTC	MAKADARA / MARINGO.	34	8	6
Tom Mboya St. opp. Raghvani Building.	DANDORA.	33	7	5
Hakati Car Park	KAMITI	19	4	3
Mfangano St. opp. Cafe de Paris.	KIBERA	24	5	5
Accra Road, Western Sector.	BURU BURU	16	4	4
	JERICHO	27	6	4
	EMBAKASI	10	2	2
Hakati Car Park opp. KBS Station	UMOJA	22	5	5
Temple Lane	KARIOBANGI	50	11	10
Accra Road Circular	EASTLEIGH	50	11	11
	MATHARE NORTH	25	6	5
Mfangano St. Bible Society House.	SOUTHLANDS	25	6	6
Latema Rd. opp. Odeon Cinema	PARKLANDS	20	4	3
Accra Road	KAWANGWARE	51	12	10
Mfangano St. North of Ronald Ngala St.	KANGEMI/WESTLANDS	54	12	3

	UTHIRU/KABETE	21	5	5
Moi Avenue opp. Khoja Mosque	KIELELESHWA	7	2	2
Gill House Area.	SOUTH B	48	11	11
	SOUTH C	16	4	4
	WEST/MADARAKA	16	4	4
	INDUSTRIAL AREA.	24	5	5
	UHURU/HARAMBEE	14	3	3
Railway Station	KAREN/NGONG	7	2	2
South B shopping centre	KIBERA-SOUTH B	9	2	2
General Post Office	NGUMMO/IDH	36	8	8
City Stadium	KARIOBANGI-JOGOO Rd.	7	2	2

TOTAL = 665

SAMPLE SIZE = 150

POSITIVE RESPONSES = 135

APPENDIX IV: QUESTIONNAIRE FOR MATATU OPERATORS AND/OR OWNERS.

Questionnaire No.....

Respondent's Code No.....

Interviewer's Name.....

1. INTRODUCTION.

I am a research assistant in a University of Nairobi M.A research project which is trying to understand the nature c matatu operations in Nairobi. The main reason for conducting thi study is that very little information exists concerning th important role which matatus play. It is my hope that with you cooperation we will obtain information which for the first tim will enable Kenyans as a whole to understand how important th matatu mode of public transport is, and how problems in thi industry can be solved. Before I ask you any question I wish t assure you that you are completely free to decide whether or nc you wish to be interviewed, and whether or not you wish to answe any particular question. I hope the whole interview will take n more than 20 minutes of your time.

II. GENERAL INFORMATION.

(To be filled by the interviewer before the interview).

1. Date of Interview.....

2. Place of Interview.....

III PERSONAL AND SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDEN

3. Local area (home area) of respondent,

DISTRICT (OR TOWN).....

LOCATION.....

4. Current residence of respondent.....

5. Age..... 6. Marital Status.....

7. Number of Dependents.....

8. Level of Education.....

9. Have you had any other training ?.....

10. If YES, Specify,.....

IV. OCCUPATIONAL PROFILE AND INCOME.

11. Do you do any work apart from owning and or operatin matatu/s ? YES..... NO.....

12. If YES, Specify your other occupation.....
.....

13. In what capacity do you work in this matatu ?

1.Owner operator,..... 2. Operator only,.....

14. If you are only an operator,specify your job,

1. Driver..... 2. Conductor,.....

3. Any of the two above,..... Specify how, ...
.....

15. If you are only an operator, state the terms under whic you are paid.....
.....
.....

16. Do you work on the same vehicle every day ?.....

17. If NO, specify how you carry out your operations, ...
.....
.....

18. If you are an owner-operator, Do you own any other

matatu/s, ...

19 If YES, specify the number, ...

20. Do you own this matatu/s alone or jointly with other partners. ? .....

21. If YES, then who are the other partners in thi bossiness ?

1. Family members,.....

2. Friends, ...

3. Both, ...

Others, Specify, ...

22. Specify the number of partners,.....

23. Did you buy this vehicle/s or did you get it/the through some other ways. ?

1. Bought it/them.....

2. Did not buy it/them,.....

3. Specify how you got it,.....

.....

24. Was the vehicle bought new or used ?.....

25. Did it undergo any conversion or purchased as it is ?..

.....

26. If it was converted where was this done ?.....

.....

27. State some of the major elements in it which underwent conversion.

1. .....

2, ...

3, ...

28.How many people have you "employed" in each of th matatu/s you own (or this one alone).....

29. Are they related to you in any way ? .....

30. If No, Specify how they happen to be employed in this matatu/s, ...

.....

31. For how many years have owned and or operated matatus ?

.....

32. If you have previously owned and or operated matatus ca you please state what happened to them/it,

1, ...

2, ...

3, ...

4, ...

33. May you please give me the following details concernin this matatu.

a) Route No. .....

b) Average No. of trips per day, ...

c) Approximate passenger capacity, ...

d) Normal hours fares per passengers, ...

e) Rush hours fares per passengers, ...

f) Approximate daily expenditure on petrol, ...

g) Monthly maintenance and other costs, ...

h) The fuel type, ...

V. <u>SERVICE PATTERNS AND OPERATIONS.</u>

34. Is this matatu affiliated to any association ? .....

35. If YES, Name the association and branch, ...

.....

36. If Not, does it comply with any formal regulation strictly. ? .....

.....

37. Is this matatu legally restricted to designated traffi routes and service zones or is it freer ranging ? .....

.....

38. If it is restricted to designated traffic routes an service zones specify the zone .....

39. Give reason/s why this designated route or zone wa chosen. (ie. the criteria used in choice of zone or route.

1, ...

2, ...

3, ...

4, ...

5, ...

40. Is this the same as that which is followed by the publi bus system ? YES..... NO .....

41. If this matatu is freer ranging; specify the routes or service zone;

1, ...

2, ...

3, ...

4, ...

42. State the criteria used in determining these routes,

1, ...

2, ...

3, ...

43. State the length of hours of daily operations,.....

44. Are there any shifts? .....

45. Does this matatu operate on;

Saturdays, YES.... NO, ...

Sundays, YES ..... NO.....

Public Holidays, YES..... NO,.....

46. Apart from transporting commuters within the city, does this vehicle perform any other tasks ? .....

47. If Yes, Specify, ...

.....

VI. PERCEPTIONS AND ATTITUDES.

49. What do you consider as some of the problems which you matatu owners/operators face ?

1,.....

2, ...

3,.....

4, ...

5, ...

50. Suggest possible solutions to these problems.

1, ...

2, ...

3, ...

4, ...

5, ...

51. Do you intend to remain in the matatu bossiness for th next five years ? YES..... NO..... I don't know .....

52. Reasons for your answer,

1, ...

2, ...

3, ...

4, ...

THANK YOU.

APPENDIX V: COMMUTERS INTERVIEW SURVEY QUESTIONNAIRE.

Questionnaire No.,.....

Respondent's Code No,.....

Interviewer's Name,.....

I. INTRODUCTION.

I am a research assistant in a University of Nairob research project which is trying to understand the problems an prospects of public transport in Nairobi. I wish to ask you th following questions concerning these problems and prospects Before I do so, I wish to assure you that you are completely fre to decide whether or not you wish to be interviewed, and whethe or not you wish to answer any particular question/s. I hope th whole exercise will not take no more than 15 minutes of you precious time.

II. GENERAL INFORMATION.(To be filled before the interview)

1. Date of interview,.....

2. Place of interview,.....

III. PERSONAL AND SOCIAL PROFILE OF THE RESPONDENT>

3. Residence of Respondent,.....

4. Age,..... 5. Marital Status,.....

6. Sex,..... 7. Occupation,.....

8. If employed Specify where,.....

IV. COMMUTING PATTERNS AND TRENDS.

9. Do you have a car, motorbike or bicycle? Specify which,.....

10. Where do you travel to daily (especially during th weekdays) ? From,..... To,.....

11. State the major reason why you make this trip ?

.....

12. What kind of transport do you mostly use ?

a) Buses,.....

b) Matatus,.....

c) Walking,.....

d) Private Automobile,.....

e) the Railway Commuter Services,.....

f) Institutional Automobile,.....

13. Approximately how many times in a week do you use the buses. ?..... (or how many times last week did you use buses) ?

14. Approximately how many times in a week do you us matatus ?..... (or how many times did yo use matatus last week)?

15. Give reasons why you use matatus/buses more than th buses/matatus in a week.?

.....

.....

.....

.....

.....

16. Which of the following factors do you consider most i your choice and use of a particular mode of publi transport? (Rank these factors in order of preference)

a) Regularity (Reliability), ...

b) Comfort, (sitting and or luggage space),.....

c) Safety, ...

d) Frequency of Service, ...

e) Speed, ...

f) Relative cost, ...

g) Others, Specify,..... .....

17. How would you compare matatus and buses in terms of the following quality attributes? (Choose the mode of transport you consider as relatively better in the provision of each of the quality attributes or answer both if you are indifferent.)

18. Listed below are some of the major problems faced by public transport services users in Nairobi. Rank them in order of the ones you consider as affecting most or least. (if you are not affected by any of them, give all of them the same ranks or if you consider two or three etc. of them as having the same effect, then give them the same rank.

a) increasing walking distances, ...

b) long waiting hrs. .....

c) severe struggles while getting on and off the PSV's .....

d) insecurity and pickpocketing, ...

e) traffic jams, ...

f) accidents, ...

g) vehicle breakdowns, ...

h) an atmosphere of bad tempers, ...

i) touting by the manambas, ...

19. List down some of the problems you associate with the matatu mode of public transport in Nairobi.

.....

.....

.....

.....

.....

.....

.....

20. Which of the following measure would you most consider as the most appropriate way of dealing with the matatus.

a) Banning them all together,.....

b) Reorganising their operations so that they can provide better services without Police harrashment, c) Continuous strict supervision of their operation by the Police force.....

d) Any other suggestions, Specify, ...

.....

.....

.....

.....

.....

APPENDIX VI; COMMUTERS SAMPLE SURVEY RESPONSES.

MATATU USERS ZONE.	POPULATION SIZE	POPULATION DENSITY	SAMPLE SIZE	POSITIVE RESPONSE
Kangemi/Uthiru	115,100	10,464	34	30
Waithaka/Riruta	192,000	14,769	57	55
Kilimani	45,211	1,884	13	10
Karen/Langata	61,000	824	18	18
Kibera	79,717	6,643	23	20
Nrb. South/West	29,026	2,642	8	8
Embakasi	35,146	567	10	10
Dandora/Kariobangi	171,854	988	51	50
Eastlands 1	178,934	36,076	53	50
Eastlands 2	144,305	14,911	43	40
Parklands/Ngara	34,092	8,523	10	10
Ruaraka/Kahawa	229,000	3,693	63	60
Spring Valley/Karura	43,100	730	12	10

TOTAL POPULATION = 1,358,435 (Commuters' Size, = 675,000)

SAMPLE SIZE = 400 = 0.04 % of the population.

POSITIVE RESPONSE = 371.

APPENDIX VII:

POPULATION AND INCOME DISTRIBUTION IN SELECTED MATAT ZONES/ROUTES IN NAIROBI. (Based on Estimates)

ZONE/ROUTE	ESTIMATED 1987 POPULATION (in thousands)	ESTIMATED MEAN AVERAGE ANNUAL INCOME (in pounds)
Makadara/Maringo	36.0	1200
Buru Buru	28.0	3000
Embakasi	35.0	1500
Uhuru/Harambee	22.6	2100
Dandora	110.0	1080
Kariobangi South	29.0	1140
Kieleleshwa	8.5	3600
Uthiru	45.0	1500
Kangemi	87.0	1500
Eastleigh	112.0	1800
Kamiti	78.0	2100
Mathare	90.0	600
Kariobangi	85.0	1080
Kawangware	131.0	1080
Kibera	97.0	900
Ngummo/IDH	56.0	2600
South C	12.0	3600
Southlands	16.5	4200
Ngong/Karen	8.0	4600
West/Madaraka	8.9	3600
Parklands	22.0	3200
South B	25.5	3200
Umoja	54.0	1300
Jericho	86.0	1600

APPENDIX VIII:

MATATU MEAN TRAVEL TIMES, FARES, AND DISTANCES COVERED FOR TH MAJOR ZONES/ROUTES IN NAIROBI AREA.

ROUTES	DISTANCES COVERED.	AVERAGE FARES CHARGED.	AVERAGE TRAVEL TIMES.	FARE PER KM.	MEAN NO. OF TRIPS.
1.Makadara/ Maringo	6.0	2.00	17.4	0.3	25.9
2. Buru Buru	10.0	3.50	25.0	0.35	17.5
3. Embakasi	15.0	4.00	45.6	0.26	12.5
4. Uhuru/ Harrambee	9.0	2.50	22.3	0.27	14.3
5. Dandora	17.0	3.00	50.9	0.18	16.7
6. Kariobangi/ Jogoo rd.	11.0	2.50	28.5	0.23	10.7
7. Kieleleshwa	9.5	3.50	23.6	0.39	10.7
8. Uthiru	16.0	3.50	56.8	0.22	17.8
9. Kangemi	12.0	3.00	30.8	0.25	13.9
10. Eastleigh	6.0	2.00	15.0	0.33	14.5
11. Kamiti	17.5	4.50	64.7	0.26	13.2
12. Mathare	7.5	2.50	16.9	0.33	18.0
13. Kariobangi	12.5	3.00	36.3	0.24	15.0
14. Kawangware	13.0	3.50	34.1	0.27	15.7
15. Kibera	9.0	2.50	18.2	0.28	17.7
16. Ngummo/IDH	6.0	2.50	14.6	0.42	16.7
17. South C	6.5	3.00	16.7	0.46	14.1
18. Southlands	12.0	3.50	35.6	0.29	15.0
19. Ngong/Karen	19.0	4.50	61.4	0.24	10.7

20.West/Madaraka	5.5	3.00	12.3	0.54	12.5
21. Parklands	5.0	2.50	8.5	0.50	25.0
22. South B	7.0	2.50	14.9	0.36	15.6
23.Industrial Area	6.0	2.50	11.3	0.42	20.8
24. Umoja	12.5	3.50	38.1	0.28	14.7
25. South B/ Kibera.	9.5	2.50	22.5	0.26	16.7
26. Jericho	7.5	2.50	15.0	0.33	22.2

APPENDIX IX:

MATATU PROFITABILITY INDICES FOR VARIOUS ROUTES/ZONES.

ROUTES	AT	AF	AP	PI	PID
1. Makadara/ Maringo	25.9	2.00	36	1864.80	3.10
2. Buru Buru	17.2	3.50	34	2046.80	2.04
3. Embakasi	12.5	4.00	26	1300.00	0.86
4.Uhuru/Harambee	14.3	2.50	37	1322.75	1.47
5. Dandora	16.7	3.00	40	2004.00	1.17
6.Kariobangi/ Jogoo Rd.	10.7	2.50	30	802.50	0.72
7. Kieleleshwa	10.7	3.50	37	1385.65	1.45
8. Uthiru	17.8	3.50	35	2180.50	1.441
9. Kangemi	13.9	3.00	23	959.10	0.799
10. Eastleigh	14.5	2.00	36	1044.00	1.740
11. Kamiti	13.2	4.50	28	1663.20	0.175
12. Mathare	18.0	2.50	23	1035.00	1.380
13. Kariobangi	15.0	3.00	39	1755.00	1.404
14. Kawangware	15.7	3.50	35	1923.25	1.479
15. Kibera	17.7	2.50	40	1770.00	1.967
16. Ngummo/IDH	16.7	2.50	40	1670.00	2.783
17. South C	14.1	3.00	22	930.60	1.432
18. Ngong/Karen	10.7	4.50	40	1926.00	1.014
19. Southlands	15.0	3.50	27	1417.50	1.181
20.West/Madaraka	12.5	3.00	23	862.50	1.563
21. Parklands	25.0	2.50	22	1375.00	3.250

22. South B	15.6	2.50	26	1014.00	1.44
23. Industrial Area	20.8	2.50	28	1456.00	2.427
24. Umoja	14.7	3.50	24	1234.80	0.988
25. South B/ Kibera	16.7	2.50	32	1336.00	1.406
26. Jericho	22.2	2.50	35	1942.50	2.590

N/B. AT = the average number of trips made by each vehicle in that route per day.

AP = the average number of passengers transported by each matatu per trip. (average carrying capacity).

AF = average fare charged by each matatu for every passenger

PI = the profitability index for each route (AT * AP * AF)

$$PID = \frac{\text{profitability index for each route}}{\text{the distance covered in each route}}$$

APPENDIX X:

MATATU FREQUENCY OF SERVICE SURVEY RESULTS.

(a) CITY STADIUM (JOGOO RD.) CORDON.

ROUTE No.	DESTINATION.	OFF-PEAK NO. OF MATATUS PER HR.	PEAK NO. OF MATATUS PER HR.
10.	Makadara/Maringo (Eastlands)	42	54
58.	Buru Buru	11	16
33.	Embakasi/Donholm	5	10
23.	Outer Ring/Uhuru	8	14
35.	Umoja	13	22
36.	Dandora	28	33
26.	City Stadium/Kariobangi	5	7

(b) UNIVERSITY WAY-UHURU HIGHWAY CORDON.

48.	Kieleleshwa/Lavington	3	7
22.	Kangemi/Uthiru	17	21
23.	Westlands/Kangemi.	50	54

(c) PARKROAD (NGARA) CORDON.

9/6.	Eastleigh	47	50
145.	Ruiru	14	26
44.	Kamiti/Kahawa West.	16	19

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(d) JUJA ROAD CORDON.

30.	Mathare North	22	25
14.etc	Kariobangi	48	52
17.	Njiru.	2	4

(e) KENYATTA AVENUE/COMMUNITY CORDON.

46.	Kawangware	47	51
8.	Kibera.	20	24
33/41	IDH/Ngummo	24	36

(f) UHURU HIGHWAY-SOUTHLANDS CORDON.

11.	South B	43	48
12.	South C	9	16
14/24/15.	Otiende/Langata	15	25
125.	Ongata Rongai	9	14
111.	Ngong/Karen	3	7
*	West/Madaraka	8	16

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