"EXAMINATION OF EFFECTS OF REZONING ON THE TRANSPORT DEMAND IN NAIROBI HILL AREA"

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This Thesis is submitted in Partial Fulfillment of the Requirements for the Degree of Masters of Arts in Planning

UNIVERSITY OF NAIROBI

DATE: July 2004

Declaration

This Thesis is my original work and has not been presented in any University

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Acknowledgement

I wish to express my sincere gratitude to the Department of Urban and Regional planning for providing guidance, learning facilities and a conducive environment. Many regards go to my supervisor Dr. S. V. Obiero for his invaluable guidance and advice.

Further, I wish to thank the City Council of Nairobi Traffic/ Roads Department for the assistance they accorded to me during my fieldwork in form of information as well as their staff during traffic counts. In general I do thank all those people who contributed into making my report complete either directly or indirectly.

Many thanks go to my family for the opportunity to study and allocating funds towards my learning and most of all for the support and encouragement they continually provided to me all through my studies.

Dedicate to my husband George and children Isaac and Joan.

ABSTRACT

The Hill Area which is adjacent the CBD was a low-density residential area. Since the late 1960's when the Ministry of Works building was constructed within the Community Building area, was the only office development at the time. But from about the 1980's the character of the area has been changing rapidly from low-density residential development to high-rise office blocks. Such development however, had been taking place on the basis of the inadequate existing surveyed plots whose use was residential. Other than that, there had not been adequate guidelines for the development of the area. This pressured the Nairobi City Council Planning Department to form a liaison committee to look into the possibilities of re-zoning the area in order to harmonize development of the area. The committee findings rubber-stamped the change of user from residential to include commercial, office blocks and high-rise flats. The zoning plan was commissioned but for one thing, the plan had not dealt with the issue of transportation. It was in this light that the research embarked on the study to investigate the transportation demand of the area.

The study established that the area require public service vehicles for the community living and working there. There is also need for widening the road system and providing for terminal facilities for the motorised traffic. Due to the nature of the close proximity of the location of the area to the CBD, there is need for providing for facilities for the Non-Motorised Intermediate Means of Transport alongside the existing motorised facilities so as to avoid conflict between the two systems.

The study recommends that future rezoning should be carried out con-currently with the transport system planning. In the situation where this is not possible, the transportation planning should precede re-zoning. Also recommended is coordination between the concerned government departments so that planning is overall i.e. there is coordination between the land use planner transport planners as well traffic planner.

EXAMINATION OF EFFECTS OF REZONING ON THE TRANSPORT DEMAND IN NAIROBI HILL AREA

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Acronyms

ADT: - Average Daily Traffic

AADT: - Average Annual Daily Traffic

CBD: - Central Business District

EIA: - Environmental Impact Assessment

KR: - Kenya Railways

KRC: - Kenya Railways Corporation

KUTIP: - Kenya Urban Transport Infrastructure Programme

MT: - Motorised Transport

NCC: - Nairobi City Council

NMT: - Non-Motorised Transport

NMIMTS: - Non Motorised Intermediate Means of Transport

NUSG: - Nairobi Urban Study Group

RTB: - Road Transport Board

SSATP: - Sub Saharan Africa Transport Programme

TIA: - Traffic Impact Analysis

U.N: - United Nations

UNCED: - United Nations Conference on Environment and Development

UNCHS: - United Nations Centre for Human Settlements

1 CHAPTER 1: INTRODUCTION

1.1 Land Use Change and Transportation Demand

The City of Nairobi was established as the capital city of Kenya in 1905. Its residential patterns emerged by 1919. By 1963 the city boundaries were extended to the current size of 690 Km2. This gave the city adequate reserve land for future expansion. The population of Nairobi has increased from 350,000 in 1963 to 2.14 million in 1999 (Kenya, Republic of, CBS, 1999). It is expected that the population will be 3.47 million by 2009. These figures are an indication of the urbanisation rate of the Kenyan capital. Speculation on land in the recent past has been the key reason to the rising land values especially in the CBD. The building of single storey residential areas within the city boundaries has created the problem of urban sprawl, making trip distances longer and transport costs much higher. Nairobi's population is segregated by income, but with no clear zone boundaries. High and low income areas are sometimes only a few metres apart. Much of the development growth that took place since the 1990's in Nairobi was unplanned. Urban physical planning Master Plan that existed but development was largely unplanned (SSTAP, 2002). However this expired in 2003 without a current one to replace it. These among other reasons led to the rezoning of the Hill area.

Transportation occupies a high place in modern life. Advancement in all spheres of life has been to a large extent influenced by transportation. Transport planning is a science that seeks to study the problems that arise in providing transport facilities in an urban regional or national setting and to prepare a systematic basis for planning such facilities (Kadiyali, 1997). Human activities take place in adapted spaces linked by communications through channels. Any change in transportation planning is reflected in a number of impacts. Though motor vehicles have brought a revolution in our life and brought comfort, pleasure and convenience, they have created problems of congestion, lack of safety and degeneration of the environment. However, the objectives of the transport planner involves the organization of the transport system so that people and goods can be transported quickly, cheaply, safely and with the minimum adverse effects on people and the environment

In 1954, Mitchell et al stated that urban traffic was a function of land use. This statement paved the way for a new line of thinking in urban transportation and land use planning. Till then, transport planning was limited to the measurement of traffic using streets, identifying those sections where the present traffic had exceeded the capacity and undertaking improvement measures to remove bottlenecks and for the smooth flow of traffic.

Transport needs for an urban area are difficult to assess, and ease by which the transport is analysed will depend on the approach adopted. Traditional transport planners defined the major problem as vehicle movement and prescribed to the provision of additional highway space. However present day planners are centrally concerned with the problems of demand for transportation facilities, location and type of demand as well as changes in nature and magnitude of demand. They advocate for improvement of public transportation services. Human activities within an area define the nature of demand for transport while the transportation system itself represents a supply component (Grant, 1979).

The role of the professional adviser on transportation is to provide technical and procedural appraisal of the implications of the proposed development on transportation. The assessment of the impact of traffic from any proposed development should identify the potential transportation problems and benefits that would result from the development and any associated traffic management measures and highway alterations necessary to alleviate them. It is important for the transportation adviser to appreciate all material issues and blend the advice on transportation to ensure that development provides a balance of benefits to all interested and affected parties.

1.2 Statement of Research Issue

Land Use zoning is the practice of defining certain areas on a map to be reserved for specific land-uses. For example, an area might be zoned for residential development and any

application to develop a non-residential activity could be refused through development control. A zoning plan designates a set of admissible land uses for each plot of land in a city. In theory the purpose of zoning is to promote public health, safety, and welfare.

There are many types of zoning, each of which has got at least one purpose, which include nuisance zoning to separate incompatible land uses, fiscal zoning in cities, to exclude households that would not pay a share of their costs of local government and lastly, design zoning, which is a sort of macro-architecture through which planners arrange activities within the city to promote the efficient use of the city's infrastructure (Sullivan, 1990).

In the absence of zoning, landowners have the incentives to negotiate restrictions on land use. It seems the neighbourhood externalities are large enough to justify the costs of developing and enforcing restrictive covenants. This is the 'coarse' solution of externalities where by the parties affected by externalities negotiate a contract to resolve the externality problem. Also in the absence of zoning, most industrial firms cluster in the locations accessible to the transportation network, and most retailers cluster in the shopping centres and retail strips. Re-zoning is the activity of reviewing the already zoned area to a different use. The re-zoning may be through the proposals made by those who own the properties the authorities' in-charge of the specific area.

The Hill area has experienced rapid change in development since it's rezoning in 1993, some former residential houses were converted into hotels, restaurants or offices housing one or more firms, while some of the other old residential houses had since been demolished to give way to sky scrappers of office blocks. Open plots were also developed into large-scale offices or residential flats. Parallel with these there were noticeable informal structures especially along the road reserves, which operated as kiosks, hotels or open-air groceries. The evidence points to tremendous increase in the overall development in this area, and a larger number of workers in both formal and informal sectors had gone up while more people found themselves in the area as they looked for leisure and entertainment facilities offered there. Consequently, human and vehicular traffic increased a great deal in the area creating the need for a comprehensive overview of transportation in the Hill Area.

The area was re-zoned following the proposals by the City Council of Nairobi due to mainly pressure of development from the central business district. In Hill Area rapid changes of user were taking place without adequate planning guidelines from predominantly low-density residential use to high-rise office/commercial blocks and high-rise flats. Such changes required guidelines to facilitate harmonious development and to ensure provision of adequate infrastructure to support the development hence the need for rezoning (Town Planning Liaison Committee, 1993).

There are several emerging issues with regard to the transportation after rezoning of the study area. The area experienced poor accessibility due to increased number of vehicles and people generated from or attracted to the area. Accessibility to land use is analogous to the impedance concept of transport capacity, which can be described in terms of travel distance, time or direct cost of travel between two zones. In general the accessibility function needs to be extended to take accounts of multiple origins and destinations and it is plausible and practically convenient to weight the individual accessibility measures by the land use potential of the set origin and destination zones as appropriate. Accessibility in urban areas gives people considerable freedom of choice in deciding where they will live, work, shop and play. It also enables commercial activities to be optimally located for their production and distribution (Bruton, 1974).

Another issue was the problem of circulation. Movement around the area was characterised by delays due to congestion especially for the motorised traffic. These delays were worst at road intersections and at points where there was roadside parking. These in turn reduced traffic speeds and increased journey times, which in turn reduced accessibility. The road network in the area used to provide a by-pass facility for vehicles, which had no business in the CBD but wished to go to the Eastern side of the city, Industrial area or Mombasa road and its vicinity (Field Survey, 2003). The earlier smooth flow through the area as drivers used the hill area as a linkage to the industrial area of the city was no longer as clear as it used to be before the re-zoning

Previous studies have shown that various kinds of activities based on the land use generated different amounts and kinds of traffic. A change in land use will always have transportation implications, particularly with regard to its interaction with neighbouring land uses and its effect on the adjacent transport system (Bruton et al, 1983). Determining what is really needed includes the identification of immediate and urgent priorities, the demands and for transport imposed by further growth and development, and the growth potentials likely to result from the transport improvements. The process of making these judgements is frustrated by the lack of data, trained personnel and the understanding (Owen, 1964).

Parking is an integral part of the transportation system, which serves as terminal facility for storage of vehicles while stopped (Goodman et al, 1968). Terminal storage is inadequate in the study area, which causes traffic back-ups in streets and excessive hunting for parking spaces. This eventually affects the circulation system in the area.

The purpose of the research was to evaluate the extent to which the change in use had affected traffic and also identify the transportation demand in the Hill Area. The study also examined the travel patterns and documents the zoning process. Eventually the research came up with recommendations on the way forward based on the findings.

1.3 The Research Questions

The research questions were:

a. What are the development trends and land use changes in Nairobi Hill area?
b. What were the main transportation problems and benefits that had resulted from the change in user in the study area?
c. What was the traffic demand and supply of the study area?
d. What were the existing travel patterns and did the existing transport facilities serve the area of study adequately?

e. What were the challenges of public transport in the study area?

1.3.1 The Objectives of the Study

The main specific objectives of the study are: -

a. To document change of user process in the study area
b. To examine the existing travel patterns and further investigate the extent to which the existing transport facilities serve the area of study
c. To make appropriate policy recommendations as pertains to change of user schemes and associated transport needs

1.4 Methodology

1.4.1 Data Needs

In order to stimulate the process between land use and transportation needs, the demand of transport was generated in the form of trips generated and attracted by activities. There are various data types that were needed so as to attain this goal. These included income levels of the workers in the area, their residential areas (Household questionnaire-HH), and the journey to work, the mode mixture of their entire journey as well as the waiting time and the parking data.

From as early as in the 1950s, it was clear from the variety of research studies that characteristics of travel could be related to the intensity and spatial separations of the land use. For the purpose of developing traffic models and to understand clearly the physical impact of the transportation facilities, up to date land use data on an area wide basis was used. Typically, the following techniques were applied: - the land use survey, land use classification, vacant land use study and presentation and storage of land use data.

For this study, land use survey involved field studies carried out in order to identify the type of land use on all the parcels of the area. Two principal techniques are employable in this survey; these are the inspection method and inspection interview. The interview method was preferred. This was because the required data was easily obtainable on foot due to the size of the area of study. Though the inspection or "wind shield inspection" method is more commonly used it would have required that the researcher engage a car with a driver and an observer (Kadiyali, 1997). The inspection interview method may be used in areas of more intense land use, where some accurate estimates are needed of actual floor areas by type of usage. For these reasons, the former method was preferred to the latter.

In the process of differentiating the spatial arrangements and activity patterns of the urban area, it was necessary to arrange land use in some form of standard classification. There are several land use classification systems in current use that permit detailed differentiation of usage. It is recommended that in any study area one of the standardized classification procedures be used. For the purpose of environmental planner, only major categories of land use are classified. Therefore it might be necessary in most cases to group and the results of land use survey for analysis and presentation.

Table 1-1: Illustrative Major Urban Land Use Categories

Residence Low density Medium density High density	 Yellow Orange Brown
Retail business	Red
Transportation utilities communications blue	Ultra marines
Industry and related uses	Indigo blue
Wholesale and related uses	Purple
Public building and open spaces	Green
Institutionalised building and areas	Grey
Vacant non-urban land	Uncoloured

Source: Chapin, (1979)

In order to obtain the objectives of the study via the methodology, a data matrix as shown in Table 1-2 below was prepared. The matrix acted as a guide in selecting the type of data, source of data and the data collection method applied.

1.4.2 Research design

The research involved surveys, which investigated existing travel patterns as well as roads forming the transport network, including dimensions, types and condition of surface, capacity control devices and volume of traffic. Land use survey on the area wide basis was carried out for the study area. The cordon survey was applied to explore the origins and destinations of journey. Parking surveys were carried out in order to obtain the information necessary to provide an assessment of the parking situation in the area of study.

Table 1-2: Summary of Data Needs Matrix

Sector	Type of Data	Source of Data	Data Collection Method
Land Use	Land use types Land tenure system Plot sizes Intensity of use Type of development	Area development plan Documentation from the ministry of lands Maps of the area Approved plans for development/ field work Development plans/Field work	Document review Document review Maps from Lands office Field visits Documentation review/ field work
Transport System	Network of the area Hierarchy of roads Road condition/ reserves Authority in charge of roads-Footpaths Movement pattern -Modal split (motorized traffic (transport modes)/ NMT) -Origin-destination survey Parking facilities-Type and operation-Adequacy	Maps Ministry of public works & Housing (MoPW&H) Maps and field work Documentation (NCC, MoPW&H) Documentation and field work Maps/ field work Maps/ field work	Map interpretation Documentation review/ interviews to the officers in-charge Field work Household questionnaires(HH) Pedestrian/ workplace interviews Roads side interviews Maps/ fieldwork/ motorized-driver interviews Maps/ fieldwork
Area Physical Analysis	Physical features Topography	Maps/ field work Contour maps	Maps/ fieldwork Map interpretation
Population and income	Employment/ Expenditure Income Travel modes	Workers- HH/workers/pedestrians/ HH/workers/pedestrians/	Workers questionnaire HH/workers/pedestrians/ HH/workers/pedestrians/

Source: Author, 2003

1.4.3 Population and Sample Size

The simple random sampling was used in this study. This meant that for the roadside interviews for motorized drivers, were conducted at cordon points. The researcher interviewed every tenth vehicle and non-motorized transport that passed by. However, counting of all vehicles was continuous at the specified time. The volume of traffic was determined by the sample size within the specified counting period of the morning peak hours as well as the evening peak hours.

Other interview schedules involved office and informal workers, household questionnaires and the pedestrian questionnaires. These target groups will be sampled via a simple random sampling procedure of the offices as well as the informal businesses in the area. The workers will then be sampled from the selected offices and businesses.

1.4.4 Data Collection Procedure

Data collection was both from the primary and the secondary sources. The primary data collection was conducted by use of structured questionnaires and through field observations. Prior to commencing the fieldwork, the research assistants received some training on the project, about the vehicle classification and counting system, on how to conduct interviews and interview etiquette.

Land use survey was conducted in the entire study area and traffic counts conducted at specified cordon stations. The questionnaires were pre-tested before embarking on the final survey. Parking survey data was collected by simple inspection of the survey area. A typical parking survey requires an examination of the on-street accommodation and of all the off-street car parks and parking garages serving the traffic area of study. This survey would also include the fringe areas where persons park vehicles with destinations within the survey area.

The secondary and historical background data was attained from literature about the area of study and also use of Registry Index Maps (RIMs).

1.4.5 Data Analysis

The traffic count data was analysed as in-bound and out-bound. The data determined the volumetric flow of traffic to and from the study area and also determine the present traffic pattern in terms of total traffic volume made up of each type of traffic modes to determine the modal split of the total traffic. Further the data established the dimensions of the transport task

and the extent to which additional transport capacity or improved quality required. It was used to establish whether existing facilities can be made to perform more efficiently, whether additional capacity is needed, or whether the burden of estimated transport demands can be reduced to regulating traffic flows or otherwise reducing their impact.

The objective of the parking survey was to determine the logical point of departure in relation to indicating parking needs. This data was important so as to check if the legal requirement of one bay per one hundred square meters of office ratio is met (1 per 100 M^2). The parking supply surveys were concerned with obtaining detailed information regarding those on-streets and off-street features which influences the provision of parking space, the existing situation with regard to parking space, and how it was controlled. However the study could not conduct the parking study exercise as comprehensively due to the limitation of finances.

Data collected from field surveys was analysed using the SPSS programme to establish the frequencies and Excel especially where it involved graphs and pie charts generation.

1.5 Study Assumptions

The study assumes that the area will remain a high potential for office blocks and commercial activities as the CBD eases business pressure to its edge. The provision of adequate roads and parking capacity will ensure the efficiency of traffic flow hence the convenience of the Hill Area as a commercial area offering a high degree of accessibility.

Due to the close proximity to the CBD, Hill area will continue to act as a by-pass for the vehicles heading towards the southern and eastern part of the city without passing through the CBD In this case, the traffic of the area will continue to grow relative to the other parts of the surrounding areas.

1.6 Justification and significance of the study

Most studies of urban transportation have concentrated on the entire urban centres but not dealing with the specific critical need of a particular zone. This has arisen to many generalized issues, which do not most of the time address the core issues for any particular area. Therefore its application would always leave some gaps not addressed fully. The parameters measured in different areas may take on different values and priorities. Most of these urban regions could be addressing different land-uses, which could be compatible and others incompatible. Due to these differences it is therefore necessary that methods be developed to identify the transportation need, which will be applicable to the specific area. Further, a change in land-use will always have transportation implications, particularly the need to take into account its interactions with the neighbouring land-uses and its consequent effect on the adjacent transport system. The area of study has undergone some change in use and there is need to look at the area and its transportation demand as well its transportation supply.

The study is significant both scientifically and socially. From the 1963 Nairobi Master Plan it was estimated that the overall population of Nairobi was 350,000. The estimate of the population of Nairobi in year 2009 from the 1999 population census will be 3,467,946. Due to this high population growth rate it is evident that there will be more re-zoning in the city of Nairobi in-order to try and accommodate the rising demand for both land and resources. The Nairobi CBD is congested with office blocks and also a few old small buildings, which cannot accommodate the fast growing city economy. These buildings may not be easily reconstructed as the laws of leases govern them. This then means that the developers and office premises seekers have to look for an alternative, yet the area has to be in close proximity to the CBD as the CBD acts as the centre of most of the government administration offices.

Further, the living standards in Nairobi CBD have gone up and consequently leading to rising land values by the day. From the sale values of vacant prime land in the CBD as per this year (2003), some vacant land along Biashara Street of 0.1218 Acres of land was valued at Kshs.

26.5 million in September, while another vacant land along Parliament Road of 0.1722 Acres was valued at Kshs. 40 million in June 2003 (Valuation Office, Nairobi). The average value of land in the CBD is estimated at about just over Kshs. 200 million. In the Hill area vacant land valued along Elgon/ Upper Hill Roads of 0.347 Acres was worth Kshs. 17 million in April 2003, while some other vacant land along Kilimanjaro Road of 1 48 Acres was valued at 42 million in the year 2001 (Valuation Office, Nairobi). Therefore the value of land in the Hill area is just over Kshs. 40 million per acre. Going by these values, it clearly states that land in the CBD is about five times more expensive than in the area of study. These values all culminates and ends up emanating to the property in the form of rent among other expenses. This is also among the other factors causing the shifting of offices from the CBD to the Hill area.

1.7 The scope of the study

The Hill Area and its extensions is delineated as that area bounded by Uhuru Highway up to Bunyala Road roundabout, Nairobi-Kisumu Railway Line, Mbagathi Way, Valley Road, Ralph Bunche Road, Milimani Road, State House Road, Chiromo River and back to Uhuru Highway. This area is divided into six blocks with each having different land-use and development intensity as expressed by ground coverage and plot ratio parameters.

The study will be based on a section of the Hill Area as shown in Map 3-4. It has a proposed user of commercial/ office as well as high-rise flats and residential development. It is approximately 337.6 Ha in area. The physical boundary is Uhuru Highway, Bunyala Road, Nairobi-Kisumu Railway Line, Matumbato Road, Kenyatta Hospital, Valley Road, Haille Selasie Avenue back to Uhuru Highway. The section has been delineated based on the vastness of the Hill area and also on the comprehensiveness that is required in the field of transportation study.

1.8 Problems and Limitations

a. The collection of the field data especially the interviews was faced with the limitation of some respondents refusing to answer the questions on claims of lack of time. This was mainly significant especially with the motorised drivers.
b. The households' questionnaires were also cumbered by some similar problems as the homesteads have tight security and for one to get into an encounter with the owner it could take several days.

1.9 Definition of terms

Average Annual Daily Traffic (AADT); - The total yearly volume divided by the number of days in the year

Average Daily Traffic (ADT); - Total volume during a given period in whole days greater than one day and less than one year divided by the number of days in that time period

Development control: -the provision by which individuals can be prevented from doing certain things or in certain places and by implication encouraged to do other things or in other places.

Land Use zoning: -is the practice of defining certain areas on the map to be reserved for certain land-uses and not others. An area might be zoned as residential, for example in which case any application to develop a non-residential activity could be refused. This is acquired through development control.

Modal split/ choice: -Modal split is the division of the number of trips between zones into the number by each mode of travel that is, car, and public transport walking and so on

Modal split model. - analysis the proportion of trips that accrue to the various competing models of transportation.

Non Motorised Intermediate Means of Transport. - Broadly refers to low-cost transport innovations that increase the load carrying capacity beyond, head shoulder or back loading and /or increase travel speeds beyond walking. They include low engine capacity vehicles such as the motor-cycles and motor tri-cycles and side cars or trailers attached to these.

Non Motorised Transport:-. Includes- walking, head shoulder or back loading, the use of wheel-barrows, hand-carts, animal-carts, animal drawn carriages, bicycles and tricycles to transport passenger freight.

Traffic: - are all types of conveyances together with their load, either singly or as a whole, as well as pedestrians, while using any roadway for the purpose of transportation or travel

Traffic assignment model. - indicates which individual routing will be taken by a trip between its origin and destination.

Transport: - The conveying of goods or people from one place to another

Transportation: - Means of conveyance or travel from one place to another e.g. road, railway, waterways, air etc

Transportation Demand: - the transportation desire shown by consumers

Transport Mode: -The transport movement mode includes the (means) carriers and the channels of travel

Trip. -is a one-way movement by a person, usually more than five years old, for a particular purpose.

Trip distribution model: -describes how many trips originating in one particular zone end in each of the other zones.

Trip generation model: -indicate how many trips are generated in each zone for a particular journey purpose.

Urban land use: -is the spatial distribution of functions, its residential areas, its industrial, commercial, and retail business districts, and the spaces set aside for institutional and leisure-time functions Chapin (1972).

Vehicle: - any component of wheeled traffic

Volume: - the number of vehicles that pass a given section of a lane or a roadway during a time period of one hour or more.

Zoning: - basically the governmental regulation of the uses of land and buildings according to districts or zones

2 CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Throughout history transportation and land development have been closely bound. As people settled the cities and towns began to grow, new and more sophisticated modes of transport development. Faster and more flexible transportation, in turn, stimulated land development. In the early days, walking and movement by horse-drawn vehicles provided travel speeds of less than 4 meters per hour. Urban population densities were very high and land uses mixed. Except for the very wealthy who could afford private carriages, or the commuters who could come from nearby towns (after the availability of steam-powered commuter rail services), most of people lived in close proximity to the primary earners work location. Residences were often above some ground-floor commercial activity. The construction of an arterial street, or major reconstruction of an existing thoroughfare, modifies the accessibility of an area. This in turn leads to development and increased traffic demands, further roadway improvements are required, and a cycle of events occurs (Wells, 1975).

Much of the history of mankind and the urban society is the history of mutually supportive technology. Thus at one point of time the capability of transport technology has allowed human behaviour and society to develop in certain ways, as well as to constrain developments in other ways. Transportation systems serve and help mould the environment. Once the developments have taken place, man has been dependent on at least that level of technological capacity for the continuation of his way of life (Wilson, 1967).

The fundamental relationship between transportation linkage and land-use is the trip making patterns, volumes and modal distribution, which are largely a spatial distribution of land-use. Transportation can precede or follow development. As a land use if it precedes development it shapes the urban design pattern and the form of urban structure. There are also some cases where-by the latter precedes development.

The problem of movement are familiar so that there is little to emphasize the frustrations and irritations of traffic jams, the waste of fuel, the waste of time, the vast and essentially un-productive effort by police and others involved in many capacities in regulating traffic.

2.2 Land Use Control (Zoning) and Urban Transport Planning

Zoning is basically the governmental regulation of the uses of land and buildings according to districts or zones. It is a means of insuring that land uses within the community are properly situated in relation to one another, that adequate space is available for various types of developments, and that the density of development in each area is held at a level which can be properly served by governmental facilities and with permit light, air, and privacy for persons living and working within the community (Ministry of Lands and Settlement 2002).

Land use zoning originated in Germany in the first quarter of the 19th century. It subsequently became an aesthetic feature of town planning in Britain and Germany. By the time it was imported to the USA, it was primarily used as a means of maintaining income level homogeneity among residential areas and creating areas of exclusiveness (Dimitriou, 1992). The system was imported 'lock stock and barrel' to third world countries, where generally they do not use spatial isolation as a way of accommodating social prejudice.

To accomplish its purpose a city can zone with regard to land use age, lot area, population density, size of yards and open spaces, building set-backs, parking, signs and billboards. It can prohibit some uses as well as eliminate some existing ones. In addition to controlling industrial and commercial noises, fumes, smoke and particle emissions zoning can even control erection of structures in the air space approaches to airports. Zoning has become an infinitely sophisticated tool, with new approaches and techniques being developed all the time to meet new needs emerging in a complex society. Though zoning has been used as a 'preventive' device intended to deter community blight and deterioration by prescribing standards for uses

in given areas and thereby helps keeping blighting factors and keeping up property values in all areas, this concept is gradually changing. Zoning may now be used for the future rather than using it as a preventive tool.

The theory of zoning is to generate land use improvements by confining the specific classes of buildings and uses to certain localities without causing owner un-due hardship. Zoning that regulates the use of land, irrespective of its ownership, aims not primarily at protecting the value of property of particular individuals, but instead at promoting the welfare of the whole community. In some countries it may be appropriate to use a performance standard approach. In essence, performance standards allow a number of ways and means of satisfying objectives for land use rather than the traditional 'prescriptive' approach. In theory, the approach allows objectives for land use to be met within community priorities and capabilities over time Kadiyali, 1997).

The belief that the capability of a government to control land use is a prerequisite to effective urban transport planning is a view held by many planners, especially those from the UK and the Scandinavia. In effect, it represents a postulation that government policy can influence the pattern of urban development, which in turn is a major determinant to urban travel patterns.

a) Objectives of Development Control

The general objectives of development control include ensuring that development of physical development projects conform to physical development plan proposals and recommend enforcement actions in case of contraventions against plan proposal and/ or development standards. It also guards against injurious development to both man and physical environment by carefully assessing and processing all development applications. Further it is to ensure that planning standards, regulations and procedures are up to date from time to time in order to accommodate changes that might otherwise bring conflicts and to ensure that strong controls are exercised so that surrounding areas particularly to industrial zones do not suffer or deteriorate as various developers carry out their activities. Development control also aims at

ensuring that proper use of land and that planning powers are not made to sub serve other ends (Ministry of Lands and Settlement 2002).

b) Land Use Zoning

Zoning is the legal regulation of the use of land. It involves segregation of parcels of land or acres of town in a physical development plan and ascribes to the broad classifications of appropriate use for example, residential industrial educational commercial, etc. The regulation aims at protecting the public health, welfare needs and safety; include provisions for use of property and limitations upon the shape and bulk of the building that occupy the land. The zoning plan serves as a comprehensive guide for urban and regional development and is adopted and rendered effective as a legal ordinance.

2.2.1 Land Use and Zoning at the Wake County

The Zoning Ordinance's Zoning Map designates all land within the County's planning jurisdiction as within one of a number of general use zoning districts or one of a number of individualized conditional use zoning districts. It also designates some of this land as within one or more of several overlay-zoning districts. For each general use-zoning district, the Zoning Ordinance specifies permitted land uses and contains regulations controlling the intensity and design of new development.

Conditional use zoning districts are created only on request of landowners who are willing to subject future development of their land to more restrictive standards than would be applicable in the corresponding general use district - standards the landowner defines through volunteered conditions or plans (www.wakegov.com June,2003).

Where necessary to implement Current County policy or reflect changing County policy, the Board of Commissioners may, after review by the Planning Board, amend the Zoning Ordinance's map of zoning district boundaries. When major policy changes are to be implemented, the County itself will initiate a broad-based rezoning that may affect a large

number of parcels (e.g., the application of water supply watershed protection zoning classifications in 1984, 1988, and 1993). The County also considers rezoning in reaction to an individual property owner's petition to have the zoning classification applicable to his or her property changed - usually to a zoning classification that authorises a different type or intensity of development than allowed by the property's current zoning.

The Review Process is strongly recommended that any person seeking the rezoning of their property first contact Planning staff, who will explain the review process and potential issues, and provide the necessary forms and checklists. In the Review Criteria the Zoning Ordinance requires the review of a proposed rezoning - whether by the staff, the Planning Board, and the Board of Commissioners - to be based on consideration of whether the proposed rezoning is consistent with the Wake County. Land Use plans and otherwise advances the public health, safety, and general welfare.

The land use plan contains general goals and strategies pertaining to growth and development, and applies classifications that generally describe the range of land uses and development intensity proposed to occur on land within the County's planning and zoning jurisdiction. Because the Land Use Plan's provisions are explicit, the Plan is generally the principal guide to review of rezoning proposals. Such review, however, must look beyond the Land Use Plan and also consider whether the proposed rezoning, even if consistent with the Plan, advances the best interests of public health, safety, and general welfare. This very general criterion calls for consideration of a wide range of issues. The issues include, but are not limited to; the re-zoning's potential impacts on:

a. The natural environment - i.e., how development allowed by the proposed zoning might affect air quality, water quality (particularly within water supply watersheds and groundwater recharge areas), flooding, erosion, important natural areas, etc.;

b. Important natural resources - i.e., how development allowed by the proposed zoning might threaten or enhance the continued availability and efficient use of finite natural resources for agriculture, forestry, mining, etc.;

c. The transportation system - i.e., whether any additional traffic generated by development allowed by the proposed zoning can be safely and efficiently accommodated by area roads and other transportation facilities (and including how existing or proposed public transportation might be used or unduly burdened);

d. The provision of utilities and services - i.e., whether any additional demands for water supply, sewage disposal, electricity, refuse collection, fire and police protection, education, health care, recreation, etc. generated by development allowed by the proposed zoning can be safely and efficiently accommodated by public, community, or private utility and service systems (and including how the cost burdens on local government in providing such services might be affected);

e. The provision of affordable and convenient housing - i.e., how the proposed zoning might affect people's ability to find affordable housing reasonably accessible to their place of employment;

f. The local economy - i.e., how development allowed by the proposed zoning might affect employment opportunities and the general health of the local economy;

g. Important historic resources - i.e., how development allowed by the proposed zoning might threaten or enhance the continued existence and integrity of resources of historic, architectural, archaeological, or cultural significance;

h. Neighbouring development - i.e., how development allowed by the proposed zoning might affect living or working conditions in neighbouring areas (including whether development allowed by the proposed zoning might deter or enhance the appropriate development or conservation of neighbouring property); and

i. Community function, character, and attractiveness - i.e., how the proposed zoning might enhance the development of urban communities. Character that

contains the attractive and functional mix of land uses needed to meet the needs of future populations and avoid adverse impacts. , The conservation of rural countryside that contains important natural resources and provides open space transitions between urban areas, and the preservation of scenic areas and the general visual attractiveness of Wake County.

2.2.2 Land Use and Transport Interaction

Land use deals with the physical location of activities and services. There are three basic systems of particular relevance to urban spatial structure-activity systems, development systems and environmental systems. Activity systems concerns the way man and his institutions such as house hold, firms governments, and other institutional entities organize their affairs on a day to day basis in the pursuit of human needs and interact with one another in time and space. Their interactions involve a communications dimension, sometimes via the media but frequently also on a face-to-face basis made possible by transportation systems. So in a broad context, activity systems embody activity within places and trips between places as complementing behaviours. In a narrow context, movements and activities can be examined separately. In this respect it might be noted that movements are to transportation networks as activities are to the land use patterns, but neither pair can be dealt with without reference to the other. The principal agents are classified as follows: individuals and households, firms and institutions.

The second configuration, the land development system, focuses on processes that convert or reconvert space and adapt it to human use in the pursuit of the human activities. The principle agents include, predevelopment landowners, developers, consumers, financial intermediaries and public systems. Finally, we have the environmental systems whose principal agents include; biotic (the plant and animal community) and the a-biotic (water air and matter).

Traffic problems are often aggravated by newly constructed transport, infrastructure intended to improve accessibility but which leads to the displacement to the periphery of traditional means of transport, and economic and commercial activities especially of the informal sector). In this way, many of the everyday requirements of low-income urban inhabitants are pushed out of the central areas. Within a short period of time, the 'speed-up' of the interaction of land use and transport/ communication brought about the implementation of such projects has drastically altered the proportions of land use types within the central areas, so that housing land has been reduced, and land for purposes of new transport infrastructure, commerce and industry has been increased.

Land use planning should be inter alias, to its impact on travel demand and public transport operating conditions; land development control should be in tune with the needs of urban transport and be effective with appropriate legal instruments for its enforcement UNCHS: Habitat (1993). It is now well recognized that the process of urbanization and economic development are inextricably linked in developing countries, while transport is a necessary condition for and catalyst to, urban development. It is transport that enables the production and exchange of goods and services, which in turn contribute to the economic growth of the city. Urban transport makes it possible the expansion of cities and provides their inhabitants with access to employment, services shelter and other opportunities essential for their economic and social advancement. Development of the urban transport should be seen, therefore as an integral part of the urban development at large. But the prevailing approach to transport development in developing countries rarely reflects this perception. Under the twin pressure of rapid demographic growth and urbanization, developing countries concentrate more on the development of other development of the sectors of the economy that produce high rates of the retum on investment. Thus they tend to defer investing in the infrastructure system, which are capital intensive (Ibid).

2.2.3 Urban Transport Characteristic and Trends

Reports of urban transportation problems in the third world especially large cities have mushroomed in the last two decades. The severity of the problems encountered is in the part explained by the rise in number of automobiles, which has outstripped the growth in urban population. These problems are in the coming decade expected to become more serious-particularly in fast growing cities. Such trends are already apparent in some of the largest and most heavily populated third world countries, particularly in Brazil, China, Indonesia, India and Nigeria (Dimitriou, 1992).

While the economic performance of a country obviously influences city development, the demand for urban transport is also affected by city size and population density (Linn, 1983). Large settlements with lower peripheral population densities tend to increase trip lengths and encourage effort to raise travel speeds; transport fuel costs are thus increased. Poorly enforced (or non-existent) land use control regulations have further more permitted un-planned development in areas with inadequate urban transport facilities, thereby causing locational traffic congestion.

The provision and pricing of urban public transport services also plays an important role in urban development. The level of government subsidy, the capacity of public transport system vis-a vis the demand for its services, and the role of the informal transport sector, all have a great bearing on performance of a city's overall transport system.

The level of motorisation and cost of its accommodation are directly correlated with trends in per capita income. Thus, rising incomes share a positive correlation with other features such as increasing the fuel consumption, additional pollution more road accidents and further environmental disruption (Newman and Kenworthy, 1989).

2.2.4 Urban Transportation Systems

Transportation system can be defined as consisting of fixed features, the flow entities, and the control system that permit people and goods to overcome the friction of geographical space efficiently in order to participate in a timely manner in some desired activity (Papacostas et al, 2002, Papacostas, 1990). This definition identifies the functional components of a transportation system (i.e. the fixed facilities the flow entities, and the control system) and encapsulates the fact that transportation provides the connectivity that facilitates other societal interactions. Fixed facilities are physical components of the system that are fixed in space and constitute the network of links (e.g. roadway segments railway track and pipes) and nodes (e g. intersections, interchanges, transit terminals, harbours and airports) of the transportation system. Flow activities are the units that traverse the fixed facilities. They include vehicles railway road cars etc.

The word efficient stands for the balancing of a variety of conflicting requirements that society in general considers to be important. These requirements include but are not limited to cost considerations, convenience, protection of environmental quality, and protection of individual rights, which may have a variable priority, depending on the issue.

To talk of urban transport systems in many third world cities may seem to imply a greater degree of integration and coordination of the transport modes than in reality exists. Nevertheless, coordination among traditional and modern, as well as informal and formal transport operations, does take place, although with varying degrees of efficiency. The structure, mix and organisation of such working relationship are, however, more a product of the evolution of the city in question, and less an outcome of the city's management and investment programs. They generally reflect the transport needs (over time) of those who extensively use the system.

In any urban transport system different modes often compliment and compete with each other. They have different associated costs and benefits for the user, and are often associated with a variety of operators. The complimentary characteristics are those, which facilitate the inter-change of modes, so that a combination of transport means provides coverage of a given area and accommodates the needs of different markets. Competition exhibits the contest between modes for patronage of the same route and /or geographical area.

Many third world cities contain a rich mixture of traditional and modern modes of transport (White, 1990, Rao et al, 1990). In some places, they share the same routes and, although competing for road space, cater for different market segments of the public. The greater the spectrum of the income bracket accommodated, the more effective the transport system; and that diversity reflects the response of changing transport demands of different urban areas and groups. Many third world cities' officials however, do not consider diversity an asset. Instead, given a city's limited capacity to accommodate growing motorised traffic volumes, traditional and informal transport modes are often considered "obstacles" to the modernisation of the transport system.

2.2.5 Functions of the urban transport system

The function of a road is defined as the purpose for which it has been provided. In other words its purpose is what it is intended to be used for. A road can simultaneously have several functions. For example, access to houses, or primary arterial transit traffic of motor vehicles. The significance of the urban transport systems lies in the provision of linkages between points of residence and employment, their contribution to the economies of scale and specialization of the urban activities (particularly industrial and commercial activities).

Table 2-1: Functional Classification of Urban Roads

Type	Access	Transit	Public transport
Access road (Grid distance: 100-500M)	Access to buildings and plots	No MT transit Important for NMT transit (direct routes)	Not allowed
Local collector (500-2000M)	Access to buildings and plots, connected to access streets	MT transit to be discouraged strongly	Sometimes depending on road network
Collector/distributor (1000-5000M)	Access to buildings and plots, connected to access streets	Transit to, from and within city districts	Carries the main bus routes
Urban corridor (4000-10000M) Main carriageway	No plot access	City-wide transit, link to national highways No NMT	Carries the main bus routes
Service road	Access to plots, link to access streets	No MT Main NMT transit route	Not allowed

Source: Guidelines for pedestrian and Bicycle traffic in African Cities (2001)

Acknowledgement of the importance of urban transport to development has been a relatively recent affair. It was not until 1972, for example, that the World Bank became involved in the urban transport projects. However, with rising levels of urbanisation in the third world and with cities performing an increasingly recognized productive function in the development of this part of the globe, the influential role of urban transport has grown and is expected to grow further. Two particular aspects of urban transport systems development need to be considered. One is the relative importance of current urban development activities serviced by transport; the other is the compatibility of the urban development goals and policies with those assigned to the transport system.

One of the major problems facing the road sector in East Africa is the lack of clearly agreed classification for urban roads, which specifies the function, use and design standards of the various road classes. Without it, there are problems in planning road rehabilitation and in the management and maintenance of rehabilitated roads.

2.2.6 Urban Transport Related Costs

Like any other development, transportation system bears expenditure and revenue as well as social benefits and costs. But like many infrastructure expenditure for construction and maintaining the rolling stock by and large is the responsibility of the public sector. Transportation is taken as a public good. Revenue from transportation sector accrue to the public and private sectors in form of user goods and tariffs/ taxation licences etc. Even where revenue goes to the private sector like local government, this revenue is not necessarily used for transportation sector purposes. The treasury could revert it to other uses. Thus transportation infrastructure is goods that may not pay directly but are very fundamental for the economy to grow.

Transport is the most expensive among urban infrastructure system, in terms of costs of its development, operation and maintenance, which rise rapidly with the size of the city. Few cities in developing countries can afford the expenses required to meet the demand for transport infrastructure and service in full. Cities in particular cannot respond to the growth by motor vehicles in private use, which multiplies to the demand for travel way space. In most cities of developing countries traffic congestion is worse than in developed countries, but the cities have neither funds nor space to accommodate the massive motorization (UNCHS: Habitat 1993). Moreover, the development of transport often takes an unsuitable path. The growth of transport motor vehicles in individual use, and the simultaneous deterioration of public transport, increase the economic cost of transport and the social inequity in the distribution of transport costs and benefits and reduce the opportunities to eradicate urban poverty. They also speed up transport related degradation of the environment, including excessive use of energy and land.

For sustainable growth and social progress in large cities, consistent in inter-sectoral policies- framed in the context of human settlements management- are needed that can balance the demand for transport and the capacity of transport systems promoting- economically efficient and environmentally- compatible public transport. Increased efficiency in the use of available

transport assets, effective management of transport demand and consistent investment policies are also required to attain this objective. Equally important is the establishment of an appropriate institutional and regulatory framework for a financially sound urban transport sector.

The cost of urban transport varies according to the mode of transport used, each of which has its own associated capital, operating maintenance and foreign exchange costs. All costs are rising and in some cases considerably (Linn, 1983). Low-income urban communities through out the third world inevitably relies most heavily on the cheapest form of urban transport, namely the Non-Motorised Transport (NMT) movement and particularly walking (Rao et al, 1990). Such communities are expected to grow; so non-motorised travel- especially walking (and cycle driven modes particularly in Asia) will increase in importance for the urban poor. This is inevitable if alternative cheaper motorised public transport is not provided.

There has been calls towards the reversal of trends in the mode of transport in large cities in favor of mass transport, and for policies which would address the needs of the majority of the p[population on one hand and problems of the environment on the other. In spite of its importance to the attainment of social economic and environmental objectives in the urban development, the availability and quality of public transport are lagging far behind the demand in most cities. Two important factors that contribute to this situation are the paucity of funds for investing in public transport and the low ability of people to pay for services rendered. There are good reasons for investing in city transport. It is widely recognized that cities make an important contribution to the national economy, and clearly an efficient transport system supports the productivity and growth of the city. And with cities competing with one another in the global economy, effective transport must help in the development of competitive advantage. Transport can also contribute to the pro-poor policy in the very positive way, providing access to the opportunities, and enhancement to security (through reduced isolation), as well as providing job opportunities in the sector.

Urban rail transport systems, of which there are various kinds are usually confined to main traffic corridors and are not suitable for distributing passengers throughout secondary and tertiary transport networks. Extreme right of way light rail systems can, according to World Bank (1986) cope with peak hour volumes of 36,000 passengers per hour, while metro systems have been reported to achieve 60,000 passengers an hour in each direction. However (ibid) construction of light rail systems, with exclusive right of way, elevated systems or underground urban rail and metro structures require a high cost and thus these costs can only be warranted along high density corridors and in cities of particular sizes with significant proportions of populations who find the services offered affordable.

By and large, the costs of urban transport include the construction and maintenance of infrastructure, administration overheads, costs of factor inputs like fuel depreciation and site acquisition and most of the time repayment of loans and their interests. Most of the transportation finances are from the regular development or large budgetary allocation for the local authority. Finance could also come from borrowing loans and grants-multilateral or bilateral or from the private sector off-shore borrowing or locally.

2.3 Land Use and Transportation Planning

In conventional highway transport studies characteristic of the 1960s and 1970s, the future land use patterns assumed as a given, i.e. as an input and not an output, and the transport system is designed to cope with the travel patterns implied in that predetermined land use pattern. Redistribution effects on land use and travel behaviour that would be produced by the proposed transport system as given and estimates its influence on the distribution of the population and the economic activity, but does not then trace the travel pattern implications of that spatial distribution in order to test and revise the initial transportation system.

What is needed is a broadened focus on the combined impacts on transportation and decisions. Such a planning would strive to balance the travel generating characteristics of the land based

activity patterns with the movement capabilities of a multi modal transportation system and its development impacts. Ideally one can envision an approach known as spatial structure approach, which merges activity and urban development planning with multi-modal transportation planning. According to Chapin and Kaiser 1979, there are several perspectives about the relationship between land use and transportation on which to base coordination of their planning. These are transportation as a service system to support activity, land use as a variable policy input to transportation planning and transportation as a determinant of land use.

From the above three perspectives, transportation can be seen as a service, which enables people, firms and other organizations to carry on activities in separate locations. Land use is seen as an important determinant of demand for travel and therefore as partially determining the performance of transportation system. The various land use characteristics that have marked effects on travel demand and transportation system performance include type and location of development and the intensity of activity there, the design of access to activity centers and the design of circulation system transition schemes at the edges of and within these centers. Within the urban area transportation improvement alter accessibility and thereby land development or re-development potential and expand the land area available for urban development.

With these multiple perspectives in mind, coordination with the transportation planning should begin in the early stages of advance plan making i.e. the policy framework and land use plan stages (Hutchison, 1974).

2.3.1 Energy Issues

With motorization increasing, transportation becomes one of the main consumers of commercial energy, and it is almost fully dependent on non-renewable petroleum fuels. Although transport in developing countries accounts for only 18.6% at the energy consumed Worldwide by the transport sector, it is usually responsible for about 30.5% of national commercial energy consumption and often for more than 50% of problem consumption (United

Nations Centre for Human Settlement: Habitat 1994). This energy consumption not only puts a heavy burden on the countries economies and foreign exchange balances, but also an adverse impact on the environment, in particular large agglomerations.

2.3.2 Traffic Impact Analysis (TIA)

Traffic impact analysis is a specialised study of the impact a certain type and size of development will have on the surrounding transportation system. Depending on the size and type of development, the TIA may range from a cursory inspection of the site, the projected traffic volumes, and the adjacent streets to a full blown alternatives analysis that includes adjacent streets, regional thoroughfares, and transit systems.

The TIA should be an integral part of the development impact review process. It is specifically concerned with the generation, distribution, and assignment of traffic to and from a proposed roadway network, and what impact the existing and projected traffic on the roadway system will have on the proposed development. A complete impact analysis should be performed in each of the following situations:

i. All development, which can be expected to generate more traffic than some specified threshold. These may be 100 vehicles in the peak hour of the adjacent street or generator or for a lesser volume when review of the site plan indicates that such additional data are desired
ii. All applications for rezoning
iii. Any change in the use of the existing commercial or industrial site
iv Cases in which the original TIA is more than two years old or where increased land use intensity will result in an increase in traffic generation by more than 15% or a directional distribution in the traffic by more than 20%

The concerned authorities should decide on the interval at which to conduct the TIA based on the land use as well as the rate of development.

2.3.3 Environmental Impact Assessment

The issue of environment has continued to elicit a lot of concern in the last two decades especially since the U.N Conference on Human Environment (Stockholm Conference), 1972 and the subsequent U.N Conference on Environment and Development and Rio Declaration (UNCED), 1992, the World Summit on the Sustainable Development (South Africa), 2002 and the Habitat Agenda- to cite but a few. The over-riding concern is the sustainability of the development, having been realized that development encompasses much more than economic component, but traverses social, economic, political and environmental systems and institutions. It has been ascertained that many forms of development erode the environment, the base of the resources they are dependent on.

Conversely, environmental degradation does undermine economic development. For this then, environmental issues must be an integral component of sustainable development. Sustainable development is defined as development that meets the needs of the present without compromising the ability of the future generation to meet their own need (World Commission on the Environment and Development (Bundtland Commission) on its report "Our Common Future 1997)

Environmental impact assessment (EIA) refers to critical examination of the effects of a project on the environment before its implementation. Impact describes any negative and positive environmental influences caused by the project. EIA is applied on the principle that the effect on the environment of the projects needs to be established before it is implemented. The basic assumption is that is they if a proper EIA is carried out, then the safety of the environment can be properly managed during the projects implementation, commissioning, operations and decommissioning. The term environment is used in its broadest possible sense to embrace not only physical and biological systems but also socio-economic systems of their interrelationship

Environmental Implications of Transportation

Every transportation facility and service has some impact on urban activity system (Meyer, 1984). These impacts range from direct physical effects to the more indirect social and economic effects on surrounding neighbourhoods. The physical effects that merit physical attention are construction impacts on the ecology and impacts on air quality and noise of vehicles operating on the completed facility. Social impacts are mainly weakening and breaking of family and social ties due to the geographical separations.

In an article entitled 'Driving Ourselves to Death' by Mathew Nichols published in the UNHCS Habitat journal of 1998 Vol. 4 No. 2 he notes that by 1998 there were 600 million cars and trucks in the world. This number was growing by 35 million per year – more than one every second or 100,000 a day. While vehicle ownership is growing their manufacturer and use negatively affect the environment in many ways. Impact can be said to begin when a vehicle is manufactured, and with its scrap-page in a junkyard. However it also requires that land –be it farmland or wetland- is cleared for road, and that oil be extracted from fragile ecosystems, to be made fuel and transported to a local gas station.

Nevertheless full life cycle 'cradle-to grave' analyses of automobiles show that 90% of their total energy uses is due to fuel consumption during their use. Likewise most of the environmental impact of motor vehicles occurs when they are used, due to pollution in their exhausts, and pollution associated with supplying of fuel. Air pollution profoundly harms the quality of life in our communities and creates huge costs to the individuals businesses and governments for health care, impaired economic activity and increased property values. World wide more than 1.1 billion people live in urban areas with unhealthy air. And while there are numerous sources of airborne pollution, in most urban areas motor vehicles have become the single largest source of local air pollution. Motor vehicles are responsible for nearly 50% of the emissions of smog-precursors worldwide.

The main pollutants from automobile exhausts are: carbon dioxide, carbon monoxide nitrogen oxides, hydrocarbons suspended particles and lead. Identified health effects from air pollution include: increased incidence of pulmonary diseases such as asthma, and emphysema; cardiovascular diseases that lead to heart attacks and strokes; lung cancer; and mental retardation in children. Economic and environmental effects include damage to buildings food crops and forests.

A recent study by the Harvard School of Public Health in the United States provides new evidence that the high levels of smog result in increased emergency room visits and hospital admissions. The study showed that smog was linked with 15,000 hospital admissions and 50,000 emergency room visits in the 13 cities included in the study. Other long-term studies in the Czech republic, Jakarta (Indonesia), Poland and U S A suggest that air pollution is responsible for about 3 to percent of all deaths, primarily through respiratory and cardiovascular disease-about 30-60,000per year in the USA alone.

Many people discuss the great gains in producing "cleaner" cars, which produce far less air pollution per mile driven. In fact, today's cars are 70 –90 per cent cleaner than their 1970 counter parts. However these changes have nearly negated by huge increases in the number of miles driven annually by motor vehicles. The combination of increased driving and falling average fuel efficiency means that more fossil fuels are being burnt in motor vehicles than ever before. This therefore means that unless we can drive less and burn less fuel in aggregate, individually clean cars will simply not result in cleaner air.

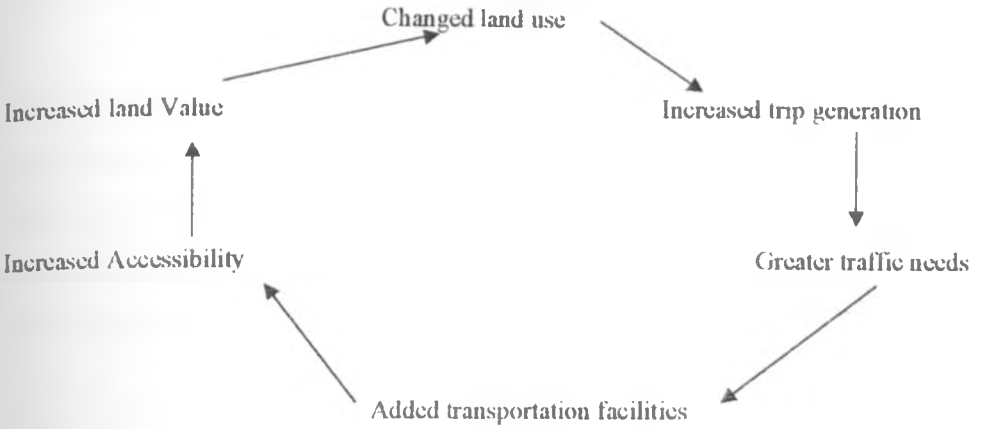
Another major health and environmental problem related to automobile emissions that is new to many people is that of global warming or climate change. Global warming refers to the increase in temperatures throughout the world that is already taking place as a result of "greenhouse effect" the trapping of increasing amounts of energy that reaches the earth from the sun. More sun is being trapped today primarily because of the increased amount of carbon dioxide and other "heat trapping" gases in the atmosphere. For example, atmospheric carbon dioxide has increased by 30% since the industrial revolution over 100years ago, largely due to

the burning of fossil fuels such as gas, coal and oil. The Intergovernmental Panel on Climate Change (IPCC) predicts that in a "business as usual" scenario, global temperatures will rise 2 to 6 degrees Fahrenheit. Over the next century it is expected that changing agricultural zones, disease areas and natural habitats, raising sea level and increasing the ferocity and frequency of extreme weather events such as hurricanes, droughts and floods. Thus climate change is likely to disturb various ecological systems, triggering off a host of mostly adverse effects on human health

How is all this related to transport? The answer is anything that burns fossil fuels will produce carbon dioxide and thus contribute to global warming. Every gallon of gasoline that is burned releases over 20 pounds of carbon dioxide. World wide, transportation is responsible for about 21% of the greenhouse gas emissions. If gasoline refining and processing as well as automobile manufacturing are considered, automobiles are responsible for even higher percentage of emission. Unfortunately there is no add-on," end of the tail pipe" technology that can reduce carbon dioxide emissions from vehicle exhaust. The amount of carbon dioxide is directly a result of the amount of carbon in the fuel and amount of fuel burned. Therefore we must vigorously pursue a combination of increased fuel efficiency, reduce vehicle travel and increased use of lower carbon-emissions alternative fuels. Other related costs of motor transport include- 885,000 people killed per year worldwide in traffic accidents, the loss of arable land and valuable wetlands to road construction, and the problem of tyre and battery disposal among others.

In general, the most striking problem in transportation plan design is not, however, the multiplicity of levels at which the solution must be considered. The chief difficulty lies in the fact that a transportation plan will affect its own environment when implemented. This change of the environment will modify the demand of the system, possibly invalidating the criteria and input used in the initial formulation of the plan.

Figure 2-1: The Land use Transportation Cycle



Source: Radnor J. P et al (1982)

The cyclic interaction of transportation facilities and land use is shown in figure 2-2. As mentioned earlier, land use has been found to be the prime determinant of trip generation activity. The level of trip generation activity and the generation of trips within the study area will determine the need for facilities. Provision of these facilities alters the accessibility of land itself, which in turn helps determine the value of the land. Land value being the determinant of land use, the planner is faced with a cycle in which alteration in any one element causes change both to all elements and to itself.

2.4 The Urban Transport Problems

The main transport problems in the third world cities are a historical culmination of several factors. First, the inheritance of an urban transport system predominantly designed to serve colonial economic, administrative and residential needs, developed and operated separately from the local transport system predominantly utilised by indigenous populations. Secondly, the subsequent abandonment of separate development after independence, thus making the whole city more accessible to the indigenous population, in turn dramatically changing demands made upon the city's transport system overnight. Finally, there is reliance upon

foreign technical assistance to tackle the resultant transport problems, involving too restrictive a scope of analyses and often a poor understanding of local conditions.

Though characteristic of urban transport problems differ from city to city features most closely associated with it include the destruction of existing (especially old) urban form structure; the penalising of the Non-Motorised Transport (NMT) community; a failure to incorporate the informal transport sector into urban plans; the dominance of transport user considerations; and use of past trends as a basis of 'blue print' planning.

2.5 Overview of Transport Planning

a) Transport planning in North America

Prior to the 1950's problems of urban movement were seen in terms of road traffic only, the transport planning consisted primarily of the application of crude growth factors to existing traffic flows to estimate future movement. In 1954, however a major breakthrough in the development of the transport planning process planning occurred with the publication of the classic work, Urban Traffic- A Function of Land use, by Mitchel et al. Following the analysis of land use data for Philadelphia, they established that different types of land use generate different and variable traffic flows, and went on to indicate how the interrelationship could be applied in operational terms. This approach brought about fundamental changes in the study and understanding of movement, and shifted the emphasis from the study of road traffic flows to the study of the land uses that give rise to the flows. It was successfully applied in large ad hoc studies such as the Detroit Area Traffic Study (1953), the Chicago Area Transportation Study (1955), and eventually the Pittsburgh Study (1958) and the Penn-Jersey Study (1959) (Bruton, 1974).

b) Transport Planning in Great Britain

Here the development and application of the transport planning process received its impetus in the late 1950s, when the ministry of transport encouraged the local authorities in the major conurbations to co-operate in producing the long term high way plans for their areas. The

objectives adopted for studies such as, the London Traffic Survey (1960) and the SELNEC Highway Plan (1962) were limited and purely traffic functional (Ibid).

Though the objectives were limited, the significance of developments in transport planning in the United States are realised in the early stages of the studies. Gradually amended objectives were incorporated which required land use and public transport analyses to be carried out as part of the process. Following the publication in 1963 of the Traffic in Towns Report, which established the need for comprehensive movement studies involving land use analysis, the then Ministries of Transport and Housing and Local Government issued a joint circular in 1964 advocating the use of land use-transportation studies to achieve a coordinated approach to land use and transport planning.

c) Transportation Planning and Management in South Africa

The Transportation Planning and Management Directorate is responsible for the development of strategy, programmes and plans to direct and manage both the private, business and public transport systems throughout the City of Johannesburg towards a common, long-term City vision. The Directorate is therefore responsible to ensure an effective and efficient transport system for all modes of transport for the city. This directorate is responsible for two functions, transportation planning and transportation management (www.igoli.gov May, 2004).

This sub-directorate formulates transportation policies, strategies and planning for the regulation of transport in the city. In terms of the National Land Transport Transitional Act, Act 22 of 2000, the City of Johannesburg is obliged to develop an Integrated Transport Plan (ITP). The ITP is a strategic policy or framework, which directs the City's transport vision and influences the City's capital budget on a longer-term basis. The ITP is formulated within the framework of the City's 2030 vision, supports the Spatial Development Framework and ultimately forming part of the Integrated Development Plan.

The ITP considers all modes of transport and formulates policies and strategies in line with the City's vision. It also identifies capital projects towards the City vision. This is achieved through

the development of a transport model that covers all modes of transport, inclusive of public passenger, private and freight. This sub-directorate monitors and oversees developments with regard to the provision of transportation infrastructure and operations to ensure that they occur within the overall plans and policies of the city. It also ensures that systems are in place to facilitate the implementation and ongoing operation and management of a fully functional transportation system within the city. The Sub-Directorate is also responsible for developing a framework within which the utilities, agencies and corporations related to transport should operate among others.

2.6 Urban Land use zoning in Kenya

The most common techniques for land use regulations and control are: building regulations, infrastructure regulations (on-and- off- site) and zoning. Underlying all the three is the question of standards: the correct application of standards will make a crucial impact on the effectiveness of land use regulations as a whole. Where existing standards are unsatisfactory, the choices are to do nothing, reduce standards to a level affordable by low income groups are or will be encouraged to locate.

Traditionally, zoning has been applied rigidly, involving single or limited-use of land parcels for housing, commercial, industrial, community and other activities and geared to the development of one parcel at a time. Recent improvements in zoning techniques include mixed-use zoning; a technique for incorporating integrated project components within a coherent plan that stimulates the type and scale of land uses; floating zoning, in which a district is described in the zoning ordinances but not located on the zoning map until the need arises (i.e. the city in effect sets a development performance standard for a district); and the condition zoning, under which the city bargains with a developer to certain social benefits such as park land to be provided in return for the permission to develop commercial land uses (i.e. 'planning gain'). Phased zoning is another technique whereby a permit is required before development

can occur. Such permission may be granted for example only when inadequate infrastructure to service the site is agreed to and installed by the city government.

In mixed-use zoning, for example, a commercial or industrial use may be permissible in proximity to residential uses, so long as it is a good neighbour. That's is to say, so long as it does not cause a nuisance by the emission of dust, smoke or fumes by strong lights, heavy traffic or other environmental impairment. However, the measurement of these environmental impacts must be made in respect of degree, duration and occasion and therefore depend for their effectiveness on system of monitoring.

The country's choices in the development control systems to implement land use regulations and standards are grouped under a 'policing' model or 'enabling' model. The policing model presupposes that all or nearly all land development projects from the individual plot level to large development projects require the developer to meet a detailed schedule of planning, environmental and building standards, obtain numerous permissions and often pay numerous fees, with the end objective of obtaining a building permit for construction. The model assumes the availability of skilled and plentiful staff to enforce the system. The policing model a responsibility not only on the development control department but on other government departments such as the city engineers, public health, water, drainage, sanitation, utilities and others, to carry out detailed analysis and processing of the application.

The alternative 'enabling' model of the development control assumes that the physical planning department or whichever department is responsible for land regulations, need a positive, innovative, relationship with the private sector and wishes to play a full role in promoting land development policies to support city development objectives. It also assumes that, staff shortages and other resource constraints will continue to afflict city governments in most developing countries, and further the controls on development can only be introduced incrementally as resources and, more important, political and social consensus permit.

Between 1976 and 1992, the system of planning in Kenya either retrogressed or remained stagnant without any new innovative improvements in the planning at the citywide scale. The use of informal Part-Development Plans (PDP) addressed only the development needs of a particular site (plot or area of a town) became most common. More emphasis also shifted to project oriented planning approaches. And the development control machinery virtually collapsed in the face of political interference (Maleche 2001). The government of Kenya does not have a land policy to date.

2.7 Zoning Procedures in Kenya

a. The zone change and amendment

Amendments to a zoning plan occur when property owners request a change for the classification of their property from one zoning district to another for the purposes of enhancing greater economic values from the use of their land. Such requests are only granted if the changes conform to the general structure plan of the area and are not detrimental to public facilities. The amendments may invade changes in terminology, inclusion or deletion of certain uses, changes in standards and changes in procedure. For an amendment of zoning change to become effective it requires public hearings and discussions. The Local Government Act and the Physical Planning Act provides that the private sector should be consulted during the preparation of transportation network. The public and the private sector may give forward their views to the city authority through writing.

The traffic and roads department of the NCC are some of the stakeholders in the zoning and re-zoning of urban areas. The chief engineer holds technical meetings with the chief planner on such issues. The department of transportation gets involved in the zoning and re-zoning at the initial stage as soon as the chief planner receives requests of such a process. Normally the road corridors in urban areas are fixed during land subdivision. The traffic and roads department explained that in a situation where there exists land development, the policy is that of widening the road free of cost. If this is not possible compulsory land acquisition is carried out.

b. Zoning Variance

A variance is a permission granted as a relief from some specific and unusual hardship imposed by strict interpretation of a zoning ordinance. This is a means to adjust property development standards of the ordinance which, by reason of specific location, topography, shape and size, are impossible to comply with the variance therefore permits a property owner to use the land at the same intensity allowed in the same zone and does not allow uses not permitted in the zone.

c. Conditional Use Permit

A conditional use is for the purpose of meeting a special need of the community based upon evidence that the proposed location will serve the special purpose. It is therefore a substitute for rezoning, but is designed to meet a special situation in the public interest. It only offers a degree of flexibility in adjusting to new demands within the framework of the ordinance. The ordinance should therefore clearly stipulate the circumstances and indicate areas under which conditional use permits may be granted as a protection to the investors.

d. Administrative Committees

It is desirable that each local authority should appoint an Administrative Committee for preparation, review and approval of zoning ordinances. The committees should include both public officials and laypersons for it to be effective

2.8 Transportation in Kenya

The principal traffic and transportation modes in the republic of Kenya are road, railway, water, air and pipeline transportation. However road transport accounts for 69% of the total freight and 96% of the total passenger transport (A Road Network Development Master Plan in the Republic of Kenya Vol. I Draft Report 1995 JICA Ministry of Public Works and Housing) making it therefore the prime mode among all other transportation modes. The roads in Kenya are categorized according to the services they offer. Table 2-2 shows the road classifications in Kenya.

Table 2-2: National Road Lengths by Road class

Category in Classes	1999 Bitumen	1999 Earth/ Gravel
A	2653.0	957.9
B	1304.4	1366.5
C	2561.7	5468.9
D	1138.8	10155.0
E	749.7	26321.5
F	219.5	11000.4
Total	8671.7	55270.2

Class A International Trunk roads
Class B National Trunk roads
Class C Primary roads
Class D Secondary roads
Class E Minor roads
Special purpose roads : Government access R, Settlement L, Rural access RR, Sugar S, Tea T, wheat W, roads etc.

Source: Central Bureau of Statistics Kenya Government

The international trunk roads link centres of international boundaries or terminating at international ports. The national trunk roads link the national important centres, such as the municipalities' and/ or district headquarters. The primary roads connect regional / provincial centres to each other or to higher classes roads. The secondary roads link important local centres to each other or to higher classes roads, while the Minor roads link local and market centres to higher-class roads. The latter range between 3to 5 kilometres.

It is therefore obvious that the road network in Kenya forms an important function for the economic growth as well as regional and local development. In order to arrive at a more considerable judgment to transportation needs, some general statistical guides can be useful where data is available. As an area grows there is a continued need for transport. Estimate of total transport demand from aggregate growth data provide a rough measure of future transport requirements, and easily identified urgent needs provide a way to get started.

The most important function of urban corridor roads is to provide for efficient transit traffic from one part of the city to another. Traditionally, the corridor is radial to the CBD, but increasingly the demand for efficient traffic movement between other parts of the expanding city, outside the CBD, necessitates corridors that have no relation to the CBD. A high density

of road link and a large number of intersections between different roads characterize an urban road network. Usually it is possible to make a choice between varieties of routes to go from one point to another. Table 2-3 shows summary characteristics of urban roads.

The primary distributors are sometimes referred to as arterial, major or urban freeway roads. They form the primary road network for an urban area as a whole. All external traffic movement to, from and within the urban area are channelled to the primary distributors, which are intended for free flow of traffic e g Haille Selasie Avenue in the case of the study area under discussion as in Map 3-4. The district distributors are also referred to as collector or minor roads. They form the link between the primary network and various neighbourhoods and localities. Local distributors or feeder roads distribute traffic within neighbourhoods and localities. They form a link between district distributors and access roads.

Table 2-3: Characteristics of Urban Roads

Class of Road / Characteristics	I Primary Distributor	II Secondary/District Distributor	III Local Distributor	IV Access Road/ Local Street
No. Of Lanes	4 or more	2 or more	2-4	2
Access from adjacent properties	No access	No access	Not preferable	Full access
Access from minor cross roads	No access	No access	At grade	-
Access from major cross streets	Grade separated	At grade Some grade separated	At grade	At grade
Frontage roads	Where needed	Where needed	Usually none	None
Median	Included	Included if 4 lanes	Preferable if 4 lanes	None
Side walk	None –if necessary route away from the road	If possible routed away from road	If possible routed away from road	Provided
Cycle path	None –if necessary route away from the road	If possible routed away from road	If possible routed away from road	Not provided –use roadway
Pedestrian and cycle crossing	Grade separated	Separated or cross walk	Separated or cross walk	Cross walk
Parallel curb parking	Eliminated	Eliminated	Restricted	Allowed
Shoulders	Included	Included	Seldom applicable	None

Source: Obiero S., 2003

Access roads give direct access to buildings and within neighbourhoods and localities. They include the cul-de-sac or dead end streets, which are meant to eliminate the through traffic in a

cluster of houses. The Loop Street or crescent are a variation of cul-de-sac but eliminates the necessity of dead end and therefore provides continuous circulation in a residential cluster and ensure easy accessibility to properties without road frontage. The service lane is also a form of the access roads This is a road parallel to main access road to buildings provided for parked loading and off-loading of goods. Service lanes should be separated/ screened from the main road using a buffer.

All roads have a hierarchical classification defining the minimum road size based on their level of importance. Table 2-4 shows the minimum road provision standards for the city of Nairobi.

Table 2-4: Minimum-Road Provision Standards in Nairobi

Road hierarchy	Road size
Major communication	60m
Important through-routes likely to require major treatment in the future	30-36m
Spine roads and roads in commercial or industrial areas	25m
Bus routes	18m
Local distributor roads (no vehicle plot access)	18m
Major access road exceeding 150m in length	15m
Access road (normal residential street) not exceeding 150 in length	12m
Minor access road (short cul-de-sac), not exceeding 60m	9m

Source: City Council of Nairobi, Works and Town Planning Committee – 1978

2.8.1 Transport Policy Management and Coordination

Policies are the measures and mechanisms which government adopt in order to achieve their goals and objectives. The purpose of urban transport policy is to establish the means by which government sets out to achieve its urban transport objectives in support of national and urban development aims. A strategy is a way in which the policies are packaged and delivered. When associated with a time frame, and detailed resource allocations, targets and outputs, the strategy becomes an action program.

In any type of planning, policy goals and strategies of a plan must be understood so that the plan can be implemented to satisfy the needs and the demand. Therefore the structural and functional relationship between the policy making, planning and implementation mechanism should be adequate and sound enough to facilitate the necessary action at various levels

In Kenya like many third world countries the weakest point is policy making. The British system as introduced in Kenya was routine and bureaucratic. In brief, major transportation policy issues should be concerned with the need to have an adequate system to deal with the system e g. accessibility, design provision of reliable service and so on. Further the policies should deal with the institutional arrangements at various levels to ensure smooth running of the sector. Other policies on resource matters such as financing revenues, manpower and promotion of growth and development should be in place. Policies on regulation for instance on Traffic Act, Speed limits safety and so on should be in place and enforceable. The issue of policy on distribution of benefits according to the various spatial, social economic should be very clear

The City of Nairobi has no explicit urban transportation policy. Regulations are largely limited to quality control. Urban transport is seen as a local authority issue. There are no restrictions (apart from those concerning vehicle safety) on entry to the public transport sector, and the government does not control fare levels (Transport Research Laboratory 2000). City transport is now seen as very clearly as a city responsibility, but it is still not treated as a single entity e g. roads are (by and large) planned and developed in isolation from transport services. The main role of central government, now that transport has largely become a city responsibility, is to frame laws, set standards and guidelines, and where appropriate, source funds and control budgets.

The laws and standards that influence transport are very wide-ranging (e g. traffic, employment, environmental, financing etc) as well as laws for creating specific bodies, which have a transport role (e g. road fund boards). And thus there is a wide range of sector ministries, which have some impact on the transport performance. Principally, the ministry of transport is

most likely to be concerned with the traffic law, while the ministry of local government has responsibility for urban development issues, including transport. The Road Transport Board (RTB) oversees the proper functioning of the private sector. All vehicles, other than personal cars, require a licence to operate from the RTB. The city council is responsible transport and environmental planning and development. The Nairobi city engineer controls transport through two units. The transport unit handles planning and traffic management, while the roads unit is responsible for infrastructure maintenance.

Although overall responsibility for the development of urban transport is vested on city level, progress is hampered by the lack of coordination and cooperation between the many organisations, which retain a vested interest. Furthermore transport has a low priority in the city affairs; its development has a low profile and little focus. Stakeholders (particularly users) have little or no influence.

2.8.2 Broad Overview of Transportation in Nairobi

Nairobi's transport and communication network was developed to links the city to the nearby countries. Intercontinental and international air links were established through Nairobi's airport and coupled with the regional road and railway routes to create the regions most important transport centre for all the modes.

Transport in Nairobi can be split into five components: private vehicles, buses, matatus, commuter trains, and taxis. Private vehicles are almost exclusively reserved for the middle- and upper-income groups because of the high cost of purchase and maintenance. The matatu is an African invention. Originally private taxis, they offer regular services with better frequencies than the bus service, thus providing a relatively quick means of transportation to the CBD and increasing the accessibility of many of the outlying areas (Aduwo, 1990; Obudho, 1993b). Recently, commuter trains were introduced by the Kenya Railway to help ease transportation to the suburbs and this service has been well received despite the high fares (Ibid). Taxis have

little impact on the mass transportation systems in Nairobi. Despite all these urban transportation systems, the majority of trips are still undertaken using non-motorized forms of transport, even over long distances.

The most prevalent mode of transport in Nairobi is the NMT. According to the survey conducted by the Nairobi study group in 1970, the average trip rate per hour for all trip purposes was 6.85 (Nairobi Metropolitan Growth Strategy Vol II, 1973). In 1985, it was estimated that the mobility in Nairobi was 1.75 trips per day per person (study of urban transport needs of Nairobi, 1986). In an article devoted to transportation planning in Nairobi, Mogridge, 1975 shows that although mobility increases with rising income, it quickly tends towards an asymptotic value. Going by this it was then assumed that the mobility rate would be an average of 1.80 trips per day per person in 1990 and 1.85 in 2000.

An estimate of global demand of entire city of Nairobi for public transport (buses/ matatus) was made for 1985 taking into accounts the estimated levels of parameters. For 1985, the population of Nairobi was estimated at 1.65 million inhabitants and the trip rate at 1.75 trips per day per person. As regards the modal split in favour of public transport it was estimated between 22-50 %.

2.8.3 Other Transportation Studies in the City of Nairobi

There has been much transportation planning but little implementation in the city of Nairobi. The first study, the Nairobi Metropolitan Growth Strategy, was done in 1973, and bus ways were proposed. Several other studies, notably the Transurb Consult Study of 1987 and 1990, study on the urban needs in Nairobi stage I in 1986, and stage II in 1990, by the World Bank, and the Nairobi Long Term Transport study in 1998 (SSTAP, 2002).

These studies have tended to focus on the increasingly unsatisfactory conditions for the journey to and from work, as manifested in the main junction congestion, slow journey times, high fares

etc. While most of the studies acknowledged the dominances of trips by walking and public transport, recommendations have tended to favour the latter, and by implication other motor users. The issue of affordability of public transport, its management in the increasingly decontrolled operating environment, and, as a consequence, the extension of services to the more remote communities, received little attention until the study in 1998. Similarly improved facilities for walking and the restoration of an environment that would reinstate cycling also received little attention until the 1998 report.

Few of the recommendations of these studies have yet been implemented, even those in the latest one of 1998. Lack of financial resources has been the main reason, but the failure of the NCC as both the political and administration organisation is also an obstacle. The result has been a steady deterioration in almost all transport infrastructures, and worsening congestion. Growth in population, economic activity and traffic has thus been superimposed on an infrastructure and transport services that receive little investment. Consequently much has deteriorated and continues to deteriorate

2.9 Theoretical/ Conceptual Framework

The provision of transport demand defies the use of simple design approach that can be applied to most engineering problems (Radnor et al, 1982). The formulation of transportation planning is not approached as easily. First the problem is not isolated and independent and second, urban transportation systems are themselves a small part of the overall regional and national transportation infrastructure. Proper overall transportation planning requires an examination of problems at various levels, because policy decisions at any one level may have severe effects on proposed plans. Looking at the following six categories of sectors as outlined below may identify the conceptualization of the transport demand.

a) Land use and Traffic Generation Activities

Land is a limited community resource. It will become even less available in future years as the urban population increases and as the population places gets increasingly varied demand upon it. Not only is land itself valuable, but the way it is used is critical, since certain combinations of land uses tend to be compatible and reinforcing, others less so, and still others non-compatible and conflicting. For these reasons, the land use survey, which attempts to identify and classify land uses in a systematic fashion, has been of great value to community planning. It should become even more valuable in the coming years. Scarce as the land become, there are various reasons why human activities cannot be located on the same sites. Some might be incompatible say residential and pollutant industry where they work. Therefore the two cannot be located together. During other times previous development may be a constraint to the current development. In this case the transport planner should be able through the analysis, plan for the required facilities considering the situation as it is.

Land use involves the distribution of population, employment, and economic and social activity centres. These provide the initial inputs for travel forecasting (Chapin et al, 1979). Emphasis should be put in the inter-relationship between the traffic and building in a town. According to (Buchanan, 1963) traffic takes place because of buildings and in fact all movements in a town have an origin and destination in a building. The pattern traced by traffic is thus closely related to the manner in which buildings are arranged.

Commuter flows are closely dependent upon the location and size of the work places and of the home areas. The main aim of trip generation model is to establish the final relationship between travel and use and social economic characteristics of an area. The rate of trip making within an area depends primarily on land use, which in conjunction with social economic information concerning residential and working populations is related to demands on the transportation system. Ultimately, the function of trip generation analysis is to establish meaningful relationship between land use and trip making activities so that changes in land use can be used to predict subsequent changes in transportation demand. The three characteristics

of land use, which are found to relate closely to trip generation, are the intensity, character and location of land use activities.

Intensity of land usually is expressed in such terms as dwelling units per acre, employees per acre and employees per 1000 square feet of retail floor space (Transurb consult et al 1994). Character of land use has reference to the social and economic makeup of the users of the land and includes measures such as family income and car ownership per capita. Location within an urban area has been found to be a variable that can express the combined effects of such variables as family size, stage in family life cycle, availability of parking, and index of street congestion. The main traffic generation activities emanate from the household whereby the family depending on its size and stage of development produces members either going to their places of work, to school, shopping or even leisure. The number of trips made depend highly on the level of income. The trip to work is very crucial as both the formal and informal workers as well as both high and low-income earners perform it. The difference is the modal split and the mode used. Other traffic generation activities may be to fulfil commercial obligations or at other times just for leisure.

b) Transportation Demand Factors

In the jargon of the economist, the demand for transportation is derived or indirect, that is people do not normally travel or move for the sake movement but to fulfil certain needs, such as going to school, to work, to shop, or to visit with friends (Papacostas et al,2002). By the same token workers do not get in the middle of the morning and evening rush hours because they enjoy traffic congestion, but because their work schedules requires it. Transportation planners are among the professionals concerned with accommodating these societal activities by providing efficient ways to satisfy the population's needs of mobility.

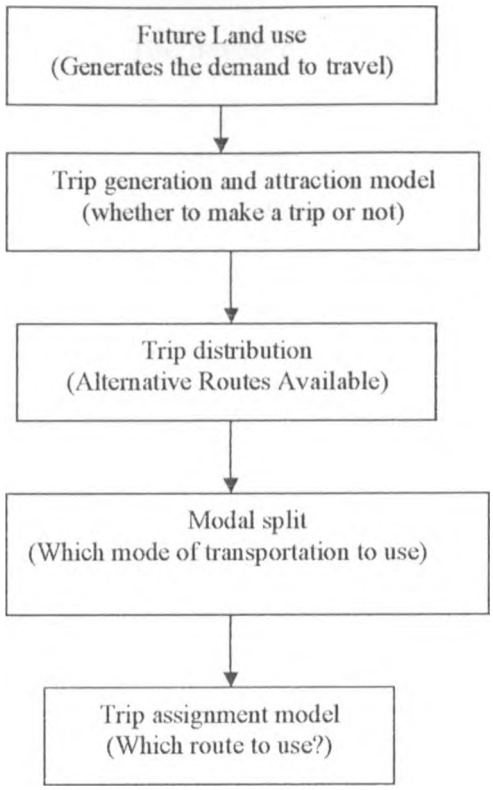
The transport demand factors depend on levels of income, the car ownership as well as the production system. The work pattern is another factor. The latter determines whether or not the roads will be congested only during the peak. The household characteristics affect the

transport depending on the family structure and the ages of school going children as well as the working group in the family. The last factor is the level of development of the transport system. It should to accommodate all the road users.

The urban transport process is based on a range of assumptions and principles. The most basic of these are that travel patterns are tangible, stable and predictable, and movement demands are directly related to the distribution and intensity of land uses, which are capable of being accurately determined for some future date. Although such assumptions can be subjected to critical academic debate, nevertheless they do at present provide a basis from which the planner can attempt to deal with the problems of movement and land use. Thus land use generates the need to travel, but the person making the trip decides on whether to make the trip or not to. There are alternative routes available as well as different modes of transportation. The trip is made once the decision is made on which route to use. This is a four-stage model, which is intended to correspond to the decision-making stages of the trip maker. These are referred to as the trip generation models and are summarised in figure 2-2 below.

Trip making procedures are the most basic to the whole forecasting process since they determine the overall scale and pattern of trip making in the study area. It is the stage at which land use planning data is in-put and at which travel choice behaviour is represented. Trip distribution model describes how many trips originate in one particular zone-end in each of the other zones.

Figure 2-2: The Traditional Transport Methodology



Source: Adopted from Hobbs et al (1981)

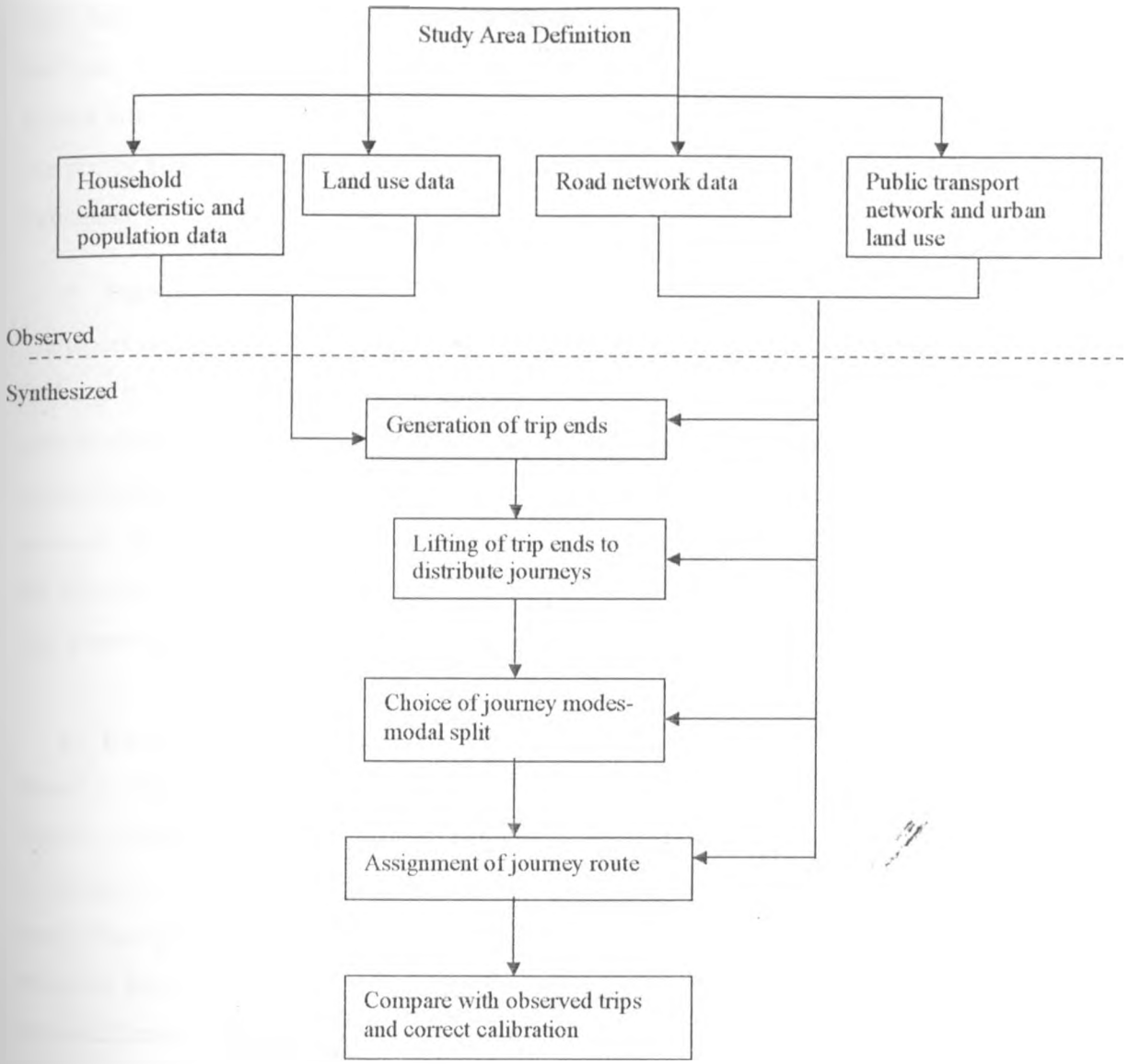
Modal split is used to plan for the dominant mode and the provision of more suitable routes, terminal facilities and reduction of traffic congestion. Traffic assignment model indicates which individual routing will be taken by a trip between its origin and destination. The fact that urban transport planning has not, in the eyes of the public, achieved many worthwhile results is due as much to the limited way in which the planning process has been applied to traffic function elements of the transport problem, as to the shortcomings of the fundamental assumptions.

c) Transportation System

The provision and operation of transportation system requires a continuous planning function to ensure that the mobility requirements of the community are supplied and maintained at a level found to be acceptable to its members at an economic, social, and environmental cost within its capabilities (Radnor et al, 1982). The output of the planning function should be in terms of what needs to be done, what alternative approaches can be used, how well these alternatives meet the community desires, and what steps need to be taken to implement the plans satisfactorily. Urban transportation studies design and surveys have further been improved from the traditional model to include road network data and the public transport network and use data as shown in Figure 2-3.

Modern transport planning emphasizes the total transportation system rather than one or more isolated facilities (Goodman et al, 1968). It concerns all modes of transport, which are economically feasible to a state, region or urban area. It considers all types of improvements, including traffic-engineering improvements such as more efficient signal systems, channelizing of traffic at intersections, better signs and off-street parking facilities; major construction of new arterials and transit facilities.

Figure 2-3: The Transportation Study Process-The Upper Part Simplified



Source: Wells (1975)

d) Traffic Generation

By the combination of the trip generation activities, the transport demand factors and the transportation system, traffic is generated i.e. the mode of travel, modal choice and mix and movement of traffic.

e) Problems of Transport System in the Urban Space

The land use system of any area can be evaluated through survey methods so as to determine their failure or success. The surveys conducted include the traffic count and parking and the land use survey. The Origin- Destination (O-D) Survey and the parking survey is used to collect information, which is then used to assist the in identifying the transport needs. The land use policy and the transport policy may be subjected to checks by comparing them with the set indicators.

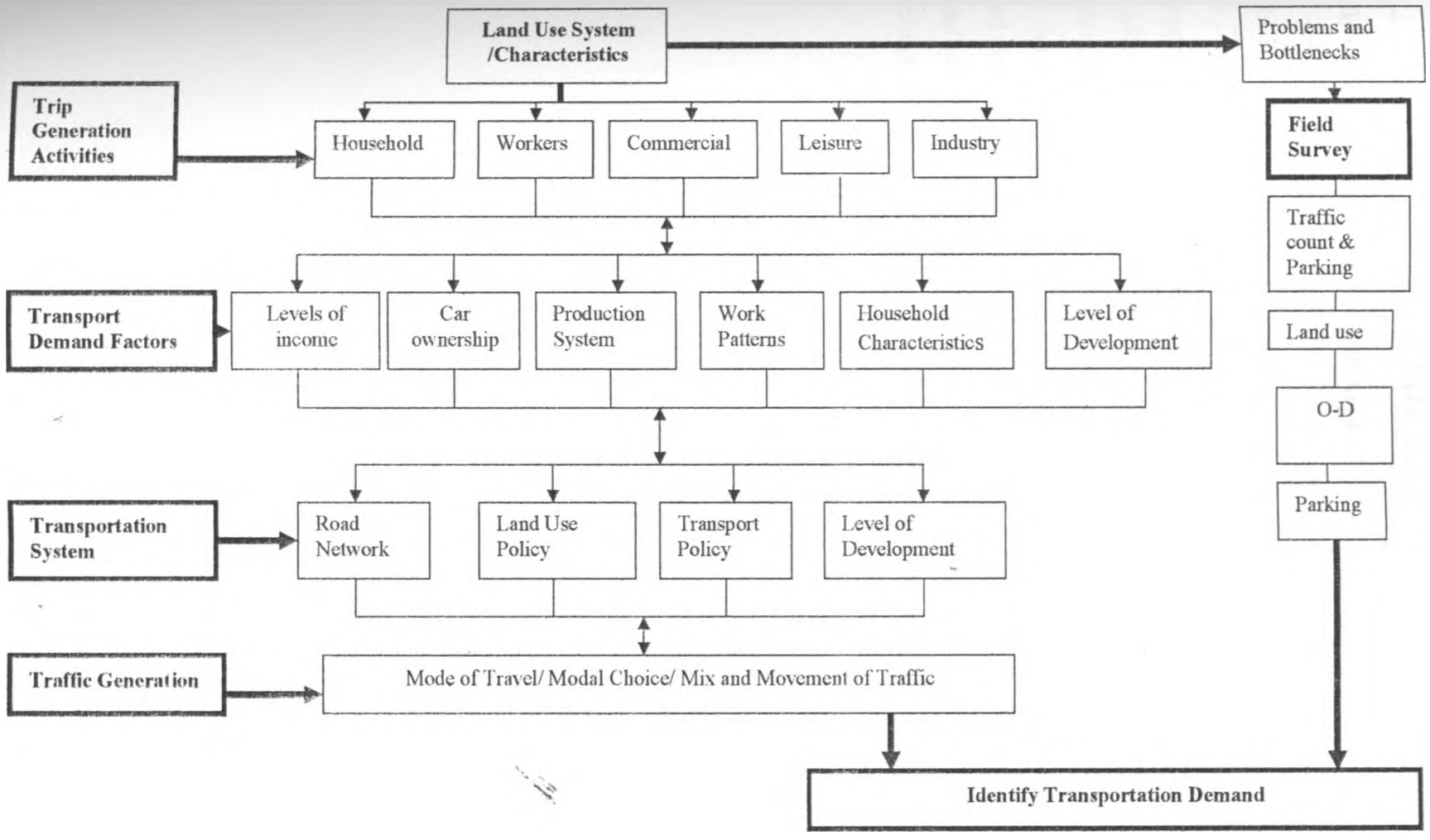
f) Parking

Transport is a derived demand. It provides service by allowing people to per-take in activities. Parking has an important role to play in providing this service, and therefore enhancing people's lives. Without appropriate parking, drivers cannot stop and store their vehicles before participating in activities. In this sense a parked vehicle can be seen as a need satisfied. City councils are very well aware that any parking policy is likely to balance city accessibility for the different categories of users and finally to act upon the distribution of activities among the city areas and even to promote their development.

g) Examination of the Transport Demand

Based on the above argument the study's theoretical/ conceptual framework is summarised in Figure 2-4 below. In order to examine the transport demand it was considered that the basis for al transportation planning was determined by the land use system/ characteristic, more so in this case where physical development had already been proposed. The research considered four transport factors that are affected by land use. These are the trip generation activities, transport demand factors, transport system and traffic generation (Papacostas et al, 2002).

Figure 2-4: Identification of transport Demand



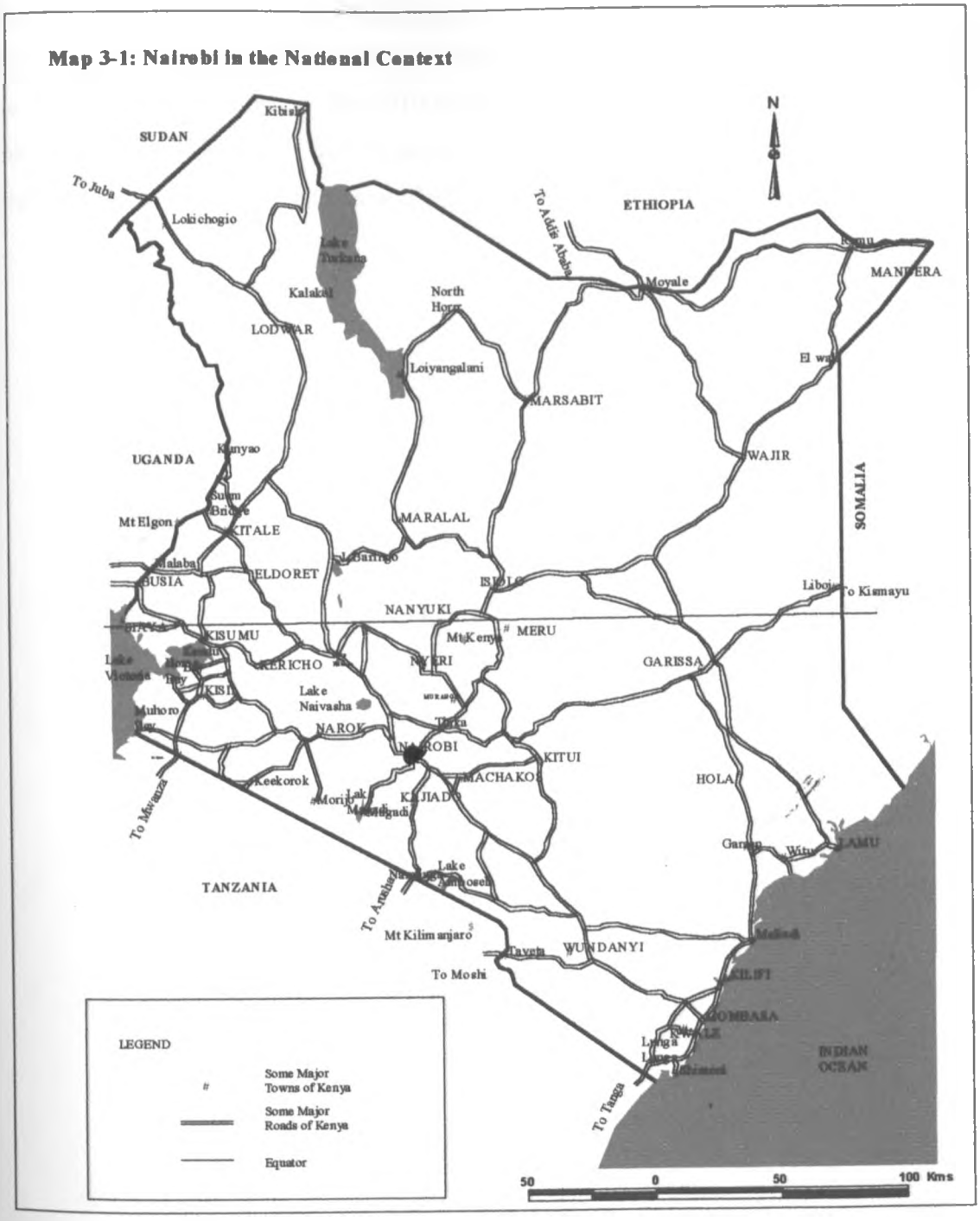
Source: Adopted from Mitchel et al. 1954; Goodman et al. 1968; Blunden. 1971; Radnor. 1982; Papacostas et al.2002

3 CHAPTER 3: THE STUDY AREA-HILL AREA

3.1 Historical Development of the Hill Area

The Hill area is at located at the fringes of the CBD of the city of Nairobi. Nairobi is the capital city of Kenya and serves as the seat of the government. It has served as one of Africa's most important centres for commerce, industry and tourism for many years. It has a history as the regional trade, communications and administrative centre for East Africa. The city is an internationally known tourist destination, supporting numerous wildlife parks and scenic areas in the region. The city hosts many international agencies, serving the eastern African region, and several United Nations bodies. It is situated along the great north road that links the landlocked Uganda, and other countries to the port of Mombasa. This road link passes right through the CBD. The map of Nairobi in its national context is shown in map 3-1 below.

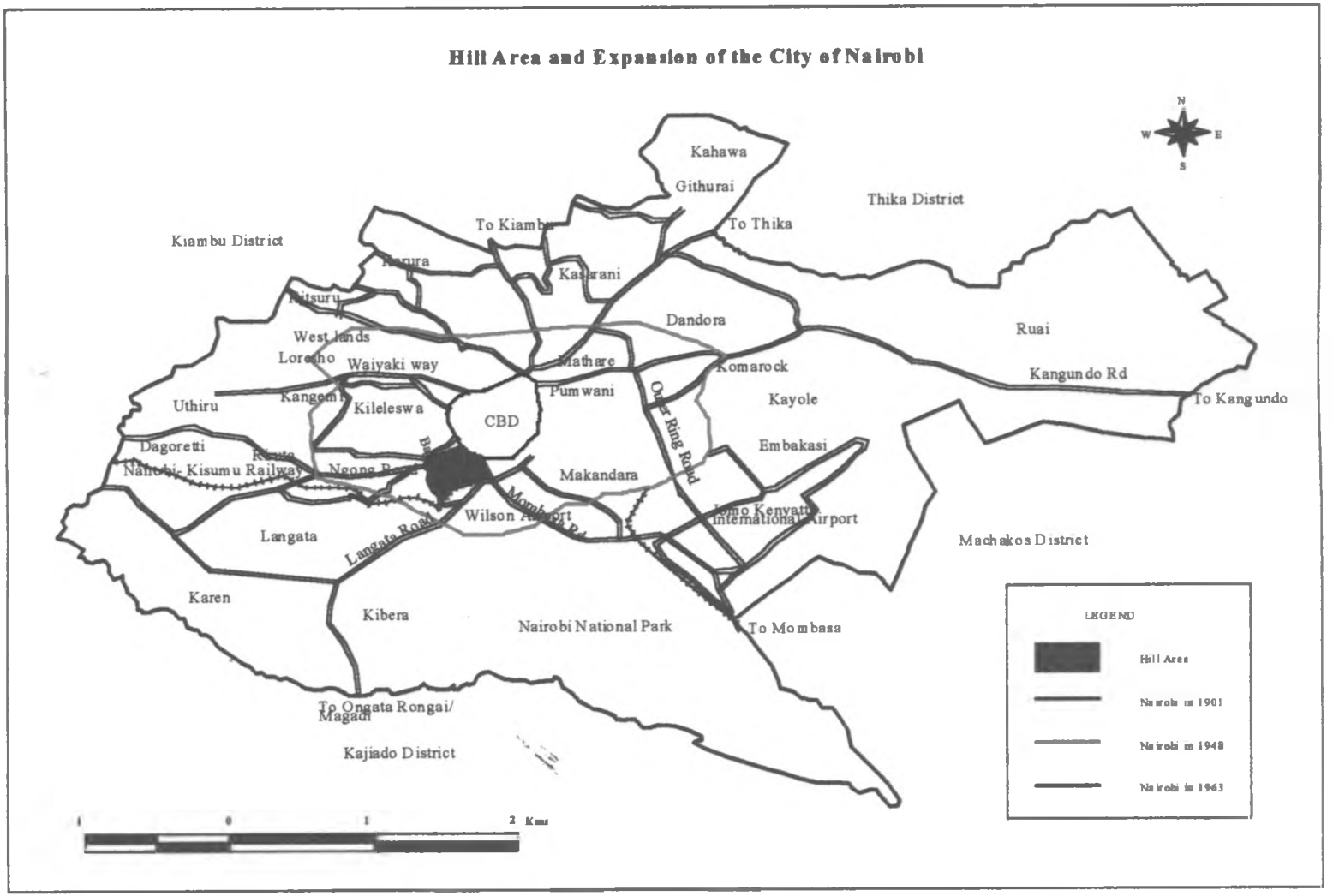
Map 3-1: Map of Nairobi in the National context



Source: Survey of Kenya

The origin of Nairobi is associated with a watering point for the Maasai people. Due to this availability of water, Nairobi turned into a railway depot for workers constructing the Kenya Uganda railway in 1899(Okoth P. F and Otieno P 2000). The first depots were located around Kiambu, but later moved around the present day Moi Avenue to enjoy the proximity of the water sources. In July 1899, the railway headquarters moved from Mombasa to Nairobi. In August the same year, the provincial headquarters for the Ukambani province were transferred from Machakos to Nairobi. In 1905 Nairobi became the capital city of Kenya. By 1919 when it became a municipal with corporate rights, a clear residential pattern had emerged. The city became a municipality and boundaries were altered to include Muthaiga, Eastleigh, Pangani, Kilimani, Parklands and Upper Hill Area as indicated in Map 3-2

Map 3-2: Hill Area in the context of Nairobi



Source: Survey of Kenya

By 1969, transportation studies had made good progress. This led to the financial support from the Kenya government. The city council had turned to Colin Buchanan and Partners as its transportation consultant. In working out terms of reference, the scope of their concern was extended to the more complex questions of urban growth so that the other necessary studies, to which the council was committed with the World Bank and UN agencies, could proceed with confidence. Following the independence in 1963, the boundaries of the city were enlarged from the 'Old City' area of 90 square Kilometres to embrace the area of 690 square kilometres. This included the Nairobi's peri-urban settlement and certain other important features such as Game Park, Embakasi, airport and large areas of ranching land in the east. The boundary extension aimed at giving the city adequate reserve land for future expansion. The growth of the city boundaries is summarised in Map 3-2 above.

1.1 The Land Ownership and Development

There are three categories of land ownership in the planning area: - government land, Kenya Railways Corporation land, and Private land (lease-holds). The hill Area is currently characterized by mixed development of residential and high-rise office blocks.

Accommodated in this area are also public and social facilities. There are two hospitals, Kenyatta National Hospital and Nairobi Hospital, three recreational areas i.e. Nairobi Club, Public Service club and the Railway Club. In addition, there is one primary school and one secondary school. Uhuru and Central Parks are also located here.

1.2 Land Use Proposals and Layout

In 1979, the Hill Area was zoned as an extension of the Central Business District (CBD) where the proposed land uses are commercial, residential and office development. The minimum plot size were proposed as 0.04 Ha with maximum ground coverage of 0.50 and proposed plot ratio of 2.0.

Due to the preference for office blocks shown by developers in the Hill Area and the particular problems posed by the NSSF building extension, which exceeded the permitted plot ratio of 2.0, and considering that some areas were rapidly responding to these changes while others, remaining residential were slowly thereby resulting in mixed development (office/ residential) it was necessary, therefore to re-

classify the Hill Area into smaller blocks. It was after development trends were observed that the study area was classified into six blocks as indicated in Map 3-3, each with a different land-use and development intensity as expressed by Ground Coverage and Plot Ratio parameters. The area encompasses almost all the land uses in the urban setting. It includes recreational land uses like the Railway Golf club, amongst others exclusive for members only. There are hotel and restaurants of which some have been formerly residential apartments.

The area has a secondary school, primary and nursery school and also neighbouring the Kenyatta General Hospital, which is the biggest public hospital in Kenya. In addition to this are the up-coming office blocks among the residential houses. Residential user was initially low density with large plots between 0.2 Ha to 1 Ha or more accommodating a single dwelling house and domestic quarters usually sited in the middle of the plot as shown in Map 3-3. Some buildings are old and dilapidated but some are still in goods condition and they accommodate senior public servants. It is on the basis of the availability of land that the allocation for the office development has been done thus paving way for the change of user and re-development to the intensive use of the high-rise office user, both Government and Private otherwise there is also change of user for the affected areas so as to accommodate the proposed use. Some of the residential houses are quickly being converted into offices save the few, which are being deserted or demolished in readiness for the sky crapping office blocks. The area also has some religious centres in Hill area.

The area of study is divided into blocks with each having a proposed user. Block I was proposed for office development with an area of about 109 ha gross. The ground coverage is 0.6 and a plot ratio of 3.0. Assuming 30 % i.e. 33 ha will be used for roads, footpaths and incidental open spaces, then a gross development area of 76 ha can be realised with a total gross of 2,280.000 M^2. Considering employment generation per person at 30 M^2 then potential employment levels of 76,000 can be reached. Block II was proposed for office/ commercial development, with an approximate area of 44 Ha. The ground coverage is 0.6 with a plot ratio of 2.5. 30 % or 13.2 Ha of the area would be used for circulation i.e. roads footpaths, incidental open spaces etc. This leaves about 31% for gross development. Using the plot ratio of 2.5, the total gross development area is 77.5 Ha i.e. 775,000 M^2. Considering 30 M^2 per person, maximum potential employment level for the block is about 25,800, with a car generation potential of about 9,688 cars. Block III was proposed for office development and high-rise flats. It has an area of 34 ha, a ground coverage of 0.6 and a plot ratio of 2.0. Assuming 30% or 10 ha for roads footpaths and incidental open space, the developable land is 23 ha thus the gross developable land is 46 ha i.e. 460,000

M^2. The employment potential of Hill Area considering 30 M^2 of office space per employee will be about 15.300 people and a car generation of 5,750 cars.

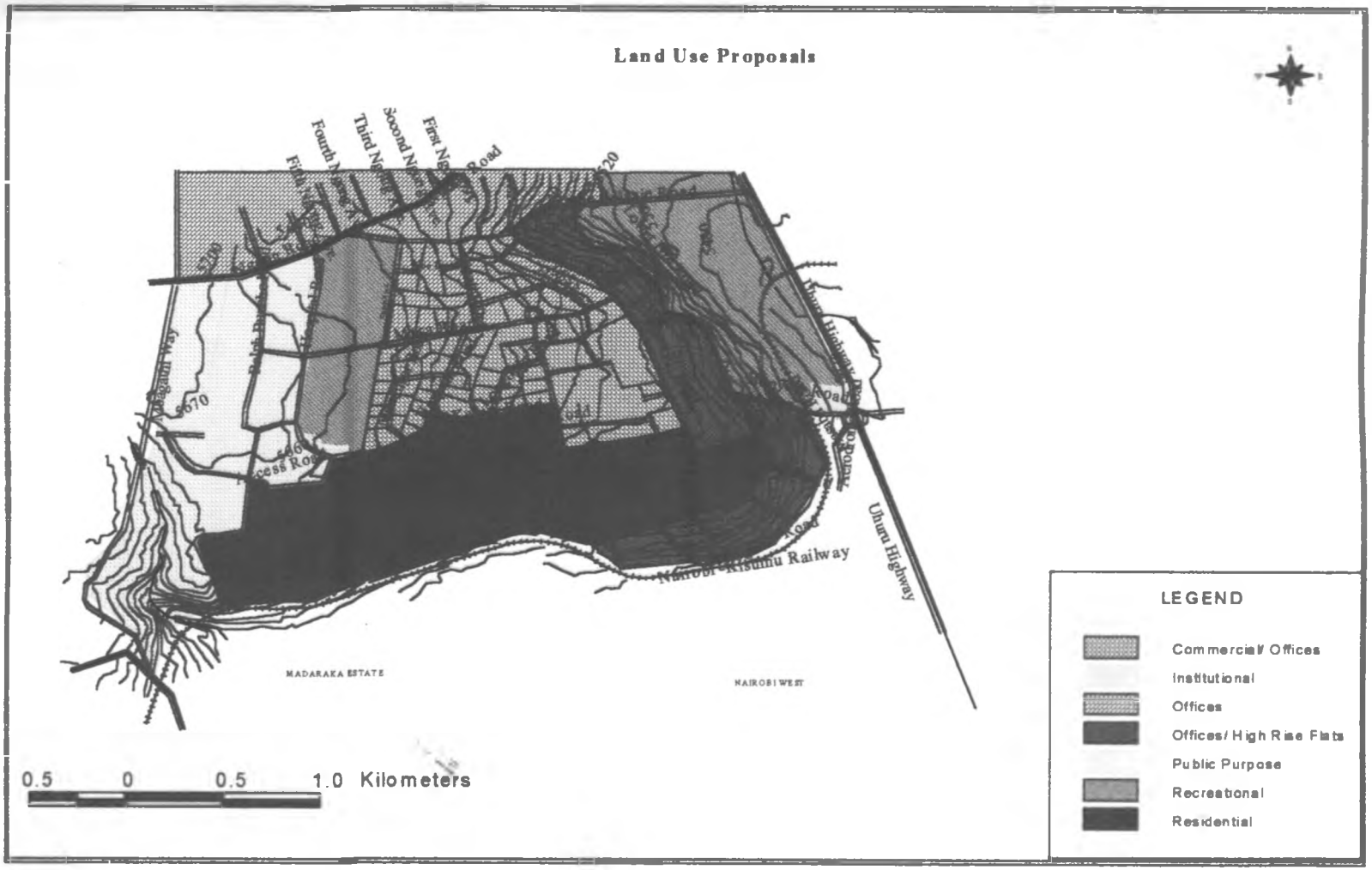
Block IV has an area of 52.8 Ha and was proposed for residential use. The ground coverage is 0.35 with a plot ratio of 1.5. The development potential is 30% or 16 Ha for roads, footpaths and other incidental open spaces, thus the gross developable land is 37 Ha. Considering the plot ratio of 1.5, then the total gross developable area is about55.5 Ha i.e. 555,000 M2. Assuming a standard flat of 110m2, then total maximum units expected are about 5,045. Taking a household size of six, then the expected population is about 30,270 people. The maximum number of cars expected is 7,560,considering 1.5 car parking space per family. Block V was proposed for institutional and is currently the Kenyatta National Hospital with an area of 97.9 Ha. Assuming 30% or about 29 Ha for circulation and incidental open spaces, area left for development is about 69 Ha; the total population expected is about 14,160 people and residential car generation of 3,540 cars.

ıble 3-1: Land Use Proposals

Block No.	Proposed development	Gross area Ha	Ground coverage	Plot ratio	Circulation Ha	Gross development area Ha	Employment potential (persons)	Car generation
I	Offices	109	0.6	3.033	33	228	76,000	28,500
II	Commercial/ offices	44	0.6	2.5	13.2	77.5	25,800	9,688
III	Offices/ High-rise flats	34	0.6	2.0	10	46	15,300	5,750
IV	Residential	52.8	0.35	1.5	16	55.5	30,270	7,560
V	Institutional (KNH)	97.8	29	—	—	69	14,160	3,540

Source: City Council of Nairobi. Nairobi Town Planning Liaison Committee, 1993

Map 3-3: Land Use Zoning Proposals (Blocks I-V) of Hill Area



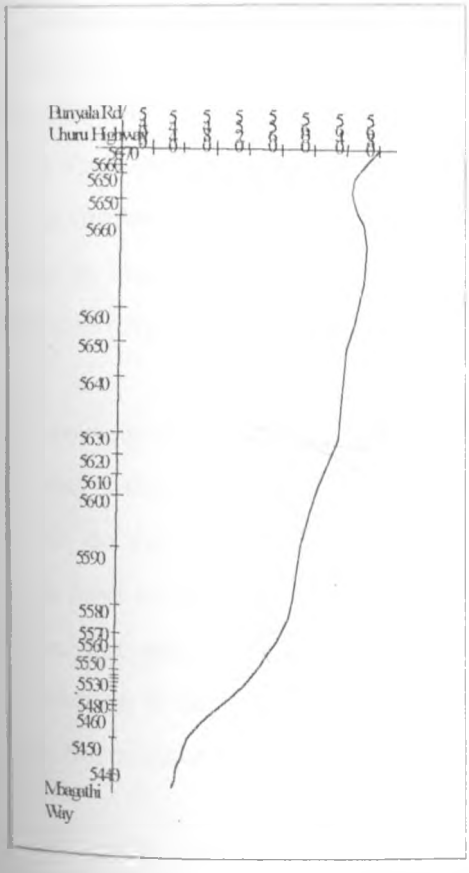
Source: Survey of Kenya

Physical Features and Slope Analysis

The land in the Nairobi region falls from the edge of the edge of the Rift Valley in the west at the elevation of 2300M to 1500M to the east of the city, with the centre itself at 1,700M. To the north west of the city, adjacent to the Rift valley, is an area of rich well-drained red soil. To the north and Northeast Southeast flowing streams dissect the high and evenly sloping land, which forms a series of steep sided parallel valleys and ridges. South and east of Nairobi are poorly drained black cotton clays. The northern and western areas have a high rainfall, while the east and south have a low rainfall.

The Hill area is sloppy and may not be appropriate for the (NMT) especially for those moving from the side of the CBD towards the Hill area. The gradient rises from 5440M to 5670M above sea level. The undulation of the area along the North-South direction are summarised in the cross-section in Figure

Figure 3-1: North-South Cross-section (Bunyala Rd to Nbagathi Way



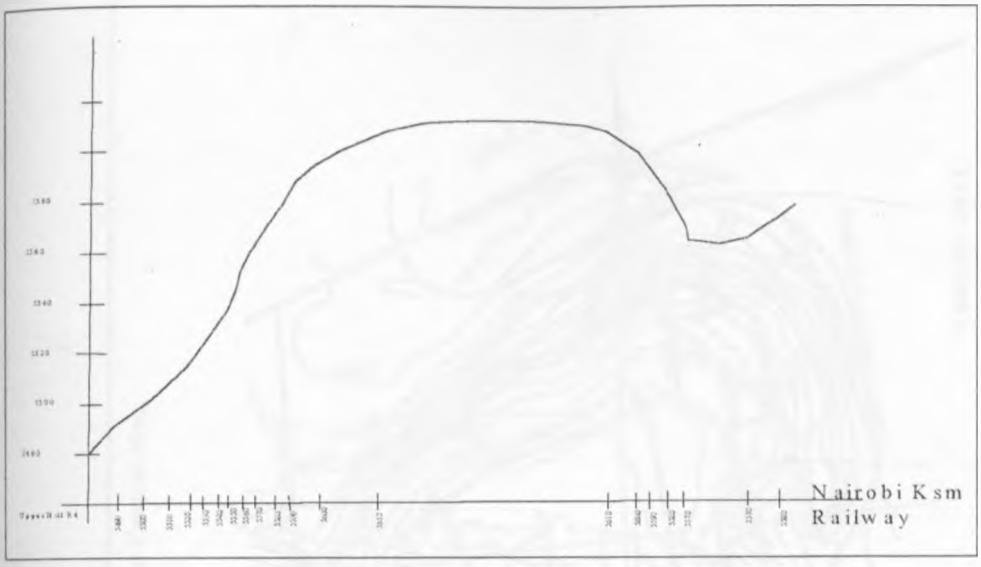
Source: Prepared by Author, 2004 from Survey of Kenya Map

This Cross- section is taken in an orthogonal direction from Bunyala Road and Uhuru Highway junction to the south of the Hill Area through to Mbagathi Way to the north. These points are illustrated in Map 3-4 below. The topography starts with a fall before rising steadily and then gradually fall towards the northern side of the area.

Viewing the area from the East-West direction another Cross-Section was prepared in order to appreciate the nature of the terrain. The section shown in Figure 3-2 was taken from Upper Hill Rd- Haille Selasie

junction and ran orthogonal to the Nairobi-Kisumu railway. A complete contour map is shown in Map: 3-4.

Figure 3-2: East-West Cross-Section (Upper Hill Rd to Nairobi- Kisumu Railway

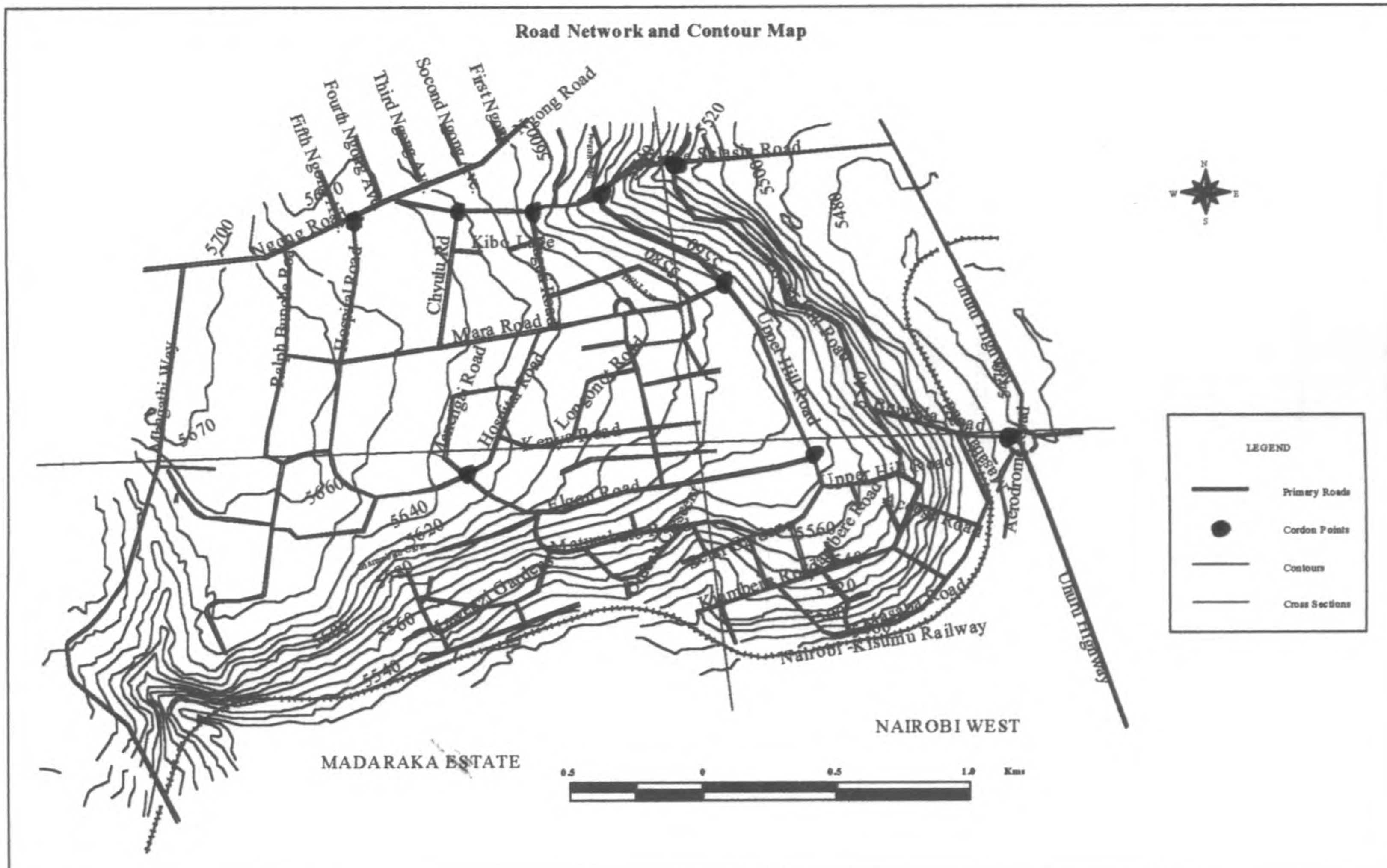


Source: Prepared by Author, 2004 from Survey of Kenya Map

A contour line is an imaginary line on the surface of the earth connecting all the parts that are of equal height above some reference plane or level datum surface, usually mean sea level. A contour line on the map is similar in shape to the contours on the ground but is drawn to the scale of the map. The contour lines also indicate the shapes of the various landforms that make up the earth's surface. With a little study one may visualize the terrain from a well-drawn contour map as accurately as if he were on site.

Each contour closes on itself either within the limits of the map or beyond the limits of the map. Close contours indicate summits or depression/ hollows in the ground. Contours never cross each other. Neither do they split or branch. On a plane surface the contours are straight parallel lines. Uniform slopes have equally spaced contours. The slope of the ground along any line drawn on the map is the interval between two adjacent contours divided by the distance between them as scaled from the map. The fraction is usually expressed as a percentage, in which case it is usually called the rate of grade. The closer the contour lines the higher the grade. The grade ranges to over 30%.

Map 3-4: Contour Map and Road Network of the Hill Area



Source: Survey of Kenya.

Infrastructure

3.3.1 The Transportation Network

The Hill area has a good network of roads as shown in Map 3-4 above. It serves as the alternative link between the Ngong road and the Industrial area of Nairobi. Traffic heading towards the eastern side of Nairobi area and have no business in the CBD normally prefer this route so as to escape entering the CBD. The same also applies the reverse side. The area experiences a high traffic, as the roads have remained the same almost 10 years after re-zoning. The roads have small reserves without any provision for footpaths or on street parking. The carriageways are more or less 7M wide.

The Hill area borders Madaraka estate to the South. The Nairobi-Kisumu railway line creates the buffer between the two areas. However this railway line does not serve Hill area directly.

3.3.2 Parking

The Hill area had no problems in relation to parking. This was because the residents who owned vehicles parked their vehicles within their premises. The area consisted of individual homesteads with each enjoying an in-built parking as well as a compound to go with it. In this case there was no foreseeable crisis in the area of parking. However the re-zoning altered this and the issue of parking had to be addressed. The roads are narrow and on street parking would only obstruct other road users. Consequently, it is a requirement for the developers to include some roadside or in-build parking space for their developments before the relevant authorities can approve them.

3.3.3 The Sewerage Service

The sewers that serve the Nairobi area were designed and constructed between 1945 and 1977, according to the NCC department of Water and Sewerage. The Hill Area is well covered by trunk sewer, which runs down all the way to Nairobi West at which point they join the southern outfall trunk sewer, which runs, along the Ngong River. Since the sewers were laid, a lot had taken place in terms of population density and plot sizes. However, this had not really put a strain on the existing facilities by the time the re-zoning took effect in 1992.

The sewer lines most of the time tends to follow the transportation network but at times the sewer and storm water may run separately. This could be due to some factors like the geology of the land. The water and sewerage department is not involved at all with land use zoning. The department handles problems as they emerge (The Department of Water and Sewerage, NCC). For instance, the most recent trunk sewer was laid in 1967. By considering the increased density of development of the Hill Area especially after re-zoning the facilities would require revision

1.4 The Water Supply

The major source of water of the study area is the Kabete Water Works (KWW) via the Hill Tank reservoir. The flow is by gravity. As early as during the time of the area re-zoning the water supply services in the area were not adequate to sustain the substantial expansion in the development of the increased number of domestic and/ or commercial properties in the short term. The water demand in the area already exceeded the available supply. In the long term, there was a major expansion of water distribution network within the area's zone source supply and when completed, there would be considerable improved water supply thereon to meet increased domestic and commercial developments thereon. This period was to prevail from the end 1994 to the 2008-2010 depending upon the population of Nairobi.

1.5 Drainage

The hydrology of Nairobi is controlled by the nature of the various volcanic lava flows and configuration of the old land surface and the basement system. The river drainage and ground water table gradient closely follow the easterly direction of the lava flows. The main streams and rivers draining the Kikuyu highlands towards Nairobi area are perennual. The Kikuyu springs feed the Nairobi River while the Mbagathi springs in Ololua forest feed Mbagathi River, which becomes the Ngong River. A number of buried channels containing ground water occur beneath the Nairobi city centre. These channels represent the old river courses of the Nairobi river tributaries.

The Hill area is naturally well drained as indicated in Map 3-3 and Section 3.2. However, due to the changed human development system of the ma-made drainage system has been developed to serve these land uses. The system consists of both open and closed drains.

4 CHAPTER 4: TRANSPORTATION AND LAND USE ANALYSIS

4.1 Land Use Characteristics

From the Survey it was established that the land in the Hill area is leasehold. This has come about through the government allocation of the land, which it previously owned to private developers. The area still had mixed land use as some of the residential plots were rezoned for other purposed depending on their location in relation to the new zoning blocks (see Map 3-3). The area still had mixed land use. This was because the rezoning did not require automatic compliance to the new land uses, but the owners were only obliged to comply with the new zoning regulations as from the time the rezoning laws were established and as to when their leases expired.

The current trend of the nature of development is slowly facing out the residential houses in those areas where it was meant for commercial and office blocks. Some of the residential houses have undergone some renovation and have been converted directly from residential to offices while others are quickly being converted into commercial places like Hotels and restaurants. Other than the parastatal owned residential estates, there are only a few small private estates in other isolated areas. Other land uses in the area include the public purpose like the Nairobi South Radio station and bordering Kenyatta National Hospital on the west. In addition, there is a police station and some religious centres. The area also has many places for recreation, of which are either 'members only' clubs e.g. Railway Golf Club and The Civil Servants Club or open to the public. Hill Area has also land designated for educational purposes, which include a secondary school and a primary school (See Map 3-2).

4.2 Transportation Characteristics

The provision of adequate roads and parking requirement will ensure the efficiency of traffic flow hence the convenience of the Hill Area offering a high degree of accessibility. The

change in zoning therefore meant complete reconstruction and widening of existing roads. It also would require the provision of off/ on street parking, footpaths, street lighting, street signs and traffic lights. Of critical importance during the stage of planning would be the availability and adequacy of the road reserves widths and parking requirement.

Transportation takes up 30% of the land in this area. The Hill area is mainly dominated by private car transportation system. The area is set well close to the CBD but there are no means of public transport which the people dealing with the Hill area can utilize to the interior of the area. Most of the time, the only means of transport is that serving the Kenyatta General Hospital. The other public passenger vehicles are those passing through the Haille Selasie Avenue and the Uhuru Highway. These serve only the people at the fringes of the area. These are the only people who felt that the area is adequately served by passenger public transport. However, the public transport along the Haille Selasie Avenue does not have a designated bus stop on which to alight or pick passengers. They only do this illegally. It then means that if the traffic rules were followed to the point, then the people of Hill Area utilizing this mode would not have any alternative left other than walking.

4.3 Transport and Land Use Interrelationships

According to Meyer et al (1984), trip making patterns, volumes and modal distribution are largely a function of land use. Likewise, the pattern of land use is influenced by the level of accessibility provided by the transportation system from one activity area to another. Development of land for a particular land use results in generation of new trips originating from or attracted to the particular area or both. During the time of the study, the Hill Area had undergone substantial change some of the residential plots had been demolished and reconstructed as office blocks. Some were under construction while others were just converted directly into offices or commercial uses.

From the study, transport in the Hill Area had not changed from its initial system that was meant for a low density residential zone. Development of the area had increased demand for travel and adequate transportation facilities. Improvement of transportation system would make the area more accessible. Increased accessibility would improve land values in turn influence the location decisions of individuals and firms and consequently making the rezoning proposal attainable.

4.4 Transport and Population Relationships

There has been a significant change in the population of Nairobi since the country's independence in 1963. The population then was as indicated in Figure 4-1. In the past population growth was due to rural urban migration, but natural growth is now the main important factor. The city is approximately 696 Km^2 in area with a density of 3079 persons per Km^2

Table 4-1: The Population of Nairobi since 1963

Year	1963	1969	1979	1989	1999	2009[x]	2019[x]
Population	350,000	509,286	828,000	1,325,000	2,137,000	3,467,946	5,611,137

[x] Author's Projections
Source: Kenya Population Census CBS

Nairobi's population in the day is much higher than in the night. In the day, it serves the neighboring districts of Thika, Kiambu, Murang'a, Kajiado and Machakos. Many people from these districts come to Nairobi on a daily basis to work, school, for business and so on. This has some direct impacts on the city like heavy traffic flows during peak hours, supply of services cannot meet day time demands, traffic management demands outstrip the resources, inadequate infrastructure and sanitation facilities etc.

The study has established that there was increased development in the Hill Area as individuals and firms got established there or transferred to the area. This is clearly indicated in Map 3-3. Further, from the interviews carried out in the area the respondents within the area asked their places of residence were giving varying answers of places all over within the neighbouring districts. Therefore the Hill Area experienced the increased population of the CBD by extension.

4.5 Energy Issues in Hill Area

The land uses in the Hill area basically relies on the electricity from the national main grid line. A few people are using solar energy. However, its production is low and the conversion efficiency very low. It is relatively cheap and can be used to heat water directly. Other sources of energy are the LPG gas for cooking and sometimes paraffin for standby lighting in cases of power blackouts, mostly for the low-income groups in the area otherwise the large office blocks have some standby generators for that emergency.

4.5.1 Environmental pollution in Hill Area

In 1999, parliament passed the Environment Management and Coordination Act, which came into force in January 2000. The act provides an appropriate and legal institution framework for management of the environment and sustainable use of natural resources. As a first step in the reduction of vehicular pollution, the ministry of energy, in liaison with the Kenya Bureau of Standards, effected a new standard on unleaded gasoline in 1999.

No comprehensive study has been done in Hill Area or in Nairobi City as a whole to get the pollutant levels, but indications (congestion, poor roads, old vehicle fleet, etc) are that vehicular emissions are high.

4.6 Data Analysis and Discussion

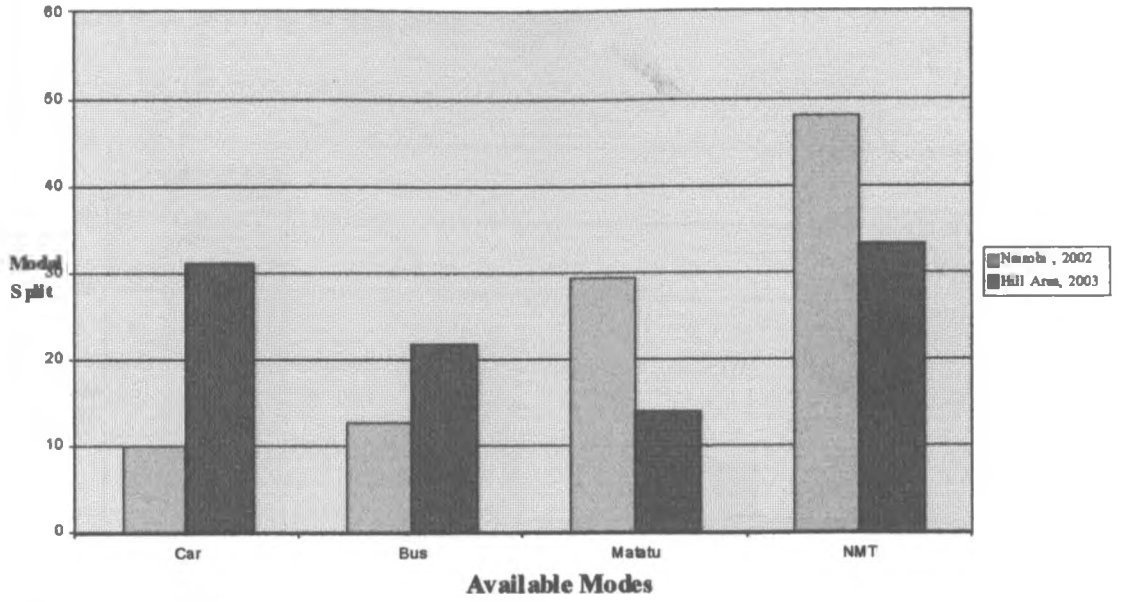
4.6.1 Transportation Analysis

One of the objectives of the research was to examine the travel patterns and further investigate the extent to which the existing transport facilities serve the study area. In order to satisfy this objective the field data was analysed and synthesized from the various responses that the interviewees had over the various items under investigation.

(a) Travel Patterns in Hill area

According to the proposals laid out during the re-zoning plan the study area would accommodate a population of 161,530 persons by the time all the proposals were put in place. This population included people working and residing there as well as those attracted to the area by the services the area would be able to provide, both commercial and leisure. From the study it was established that a total of 33.3% people walk, 45.6% use public transport, while 31% use cars. Out of these 21.8% use the bus while only 13.8% use Matatus as shown in Table 4-2. According to a study conducted in 2002 for the entire city of Nairobi, the mode split 47% walk, 1% use NMT, 42% use public transport while, and 10% use cars. Out of this ratio using public transport, 30% use big bus while 70% use minibuses. The taxi users are negligible (SSATP, 2002).

Figure 4-1: Modal Split for the City of Nairobi versus the Hill Area



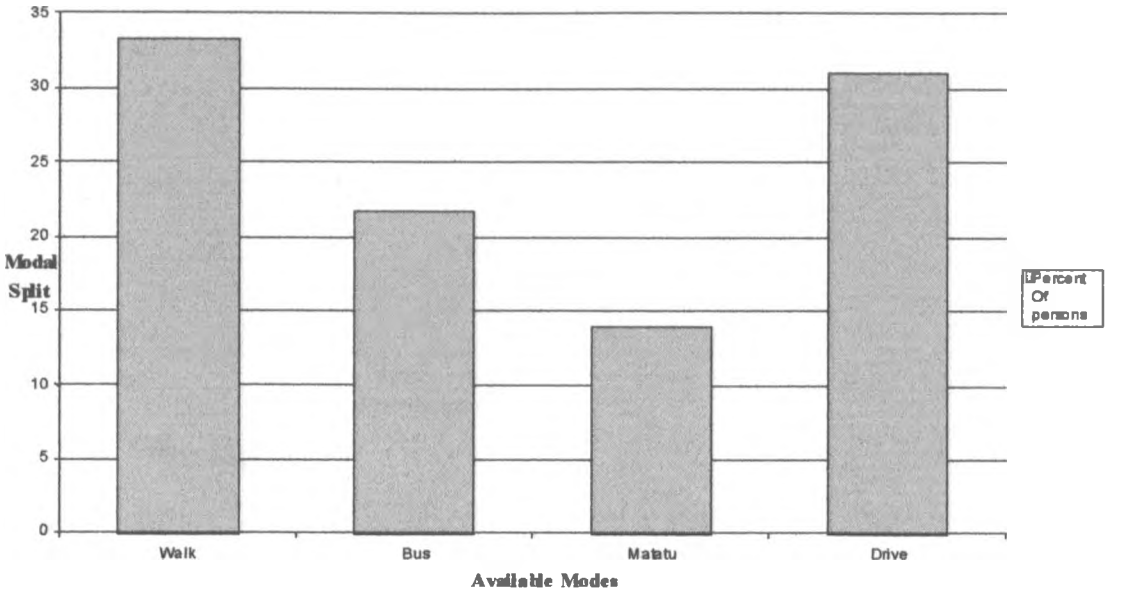
Source: SSATP Working Paper No. 70 and Field Survey 2003

These two studies could be used to deduce some facts about the study area. More people seemed to prefer to use private cars to the study area. The Matatu usage had also reduced tremendously owing to some factors, which were revealed through the interviews conducted in the area of study. Were all the conditions of the studies uniform i.e. were all the public transport facilities readily available? Why the drastic prevalence in the use of private cars?

Further, according to UNHCS Habitat (1998) Vol. 4 No. 2 report, the urban poor of Nairobi cannot even afford public transport much less a private vehicle or bicycle, and spend almost four hours a day walking to and from their place of work. As illustrated below in table 4-2, a more in-depth analysis was conducted in order to understand whether the reason behind the large number of people walking was based on the same reason as was reported by UNHCS i.e. poverty. The number of people walking to Hill area comprised over 33% of the entire commuters to the area. This figure only included the people solely walking. Those who alighted from a public vehicle and ended up walking for almost half a kilometre or more to

Considering the U.N report and contrasting it with the increased usage of the personal vehicles is clear indication that poverty was not a factor for the modal choice in this case scenario.

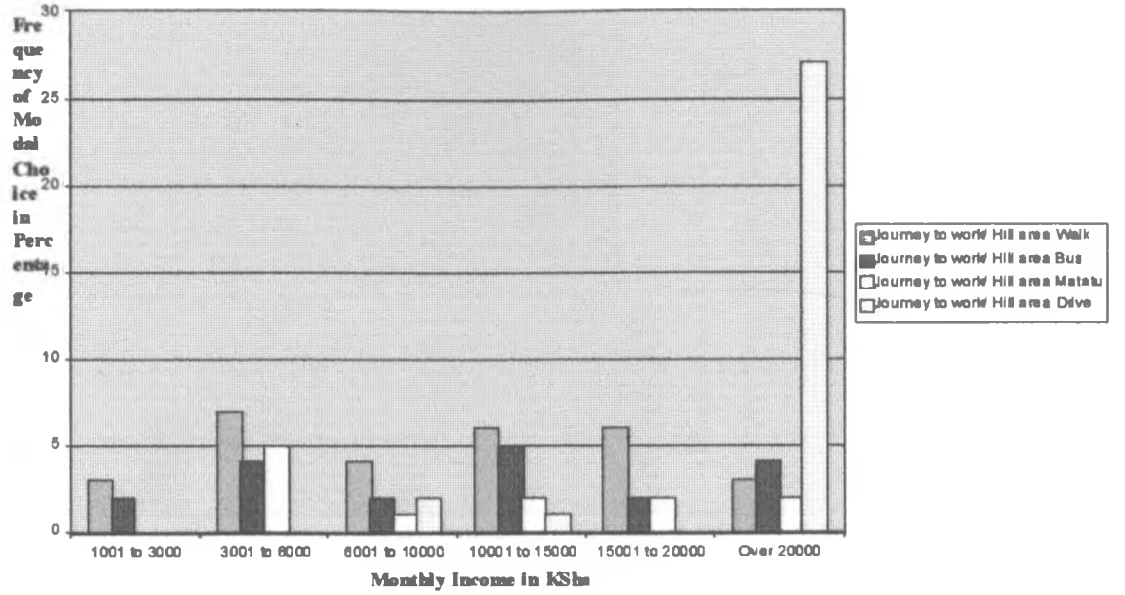
Figure 4-2: Journey to Hill Area



Source: Field Survey 2003

Though the terrain from the CBD, which is the main circulation point to other parts of the city, is not quite friendly for walking, we still found out that some people preferred walking as an alternative to go to work. To find out if there were other factors other than the levels of income, the correlation between the monthly income and the mode of transport used to work or to the Hill area (in the case of those who reside there) was run. Figure 4-3 below shows that the mode used is distributed all through the levels of income.

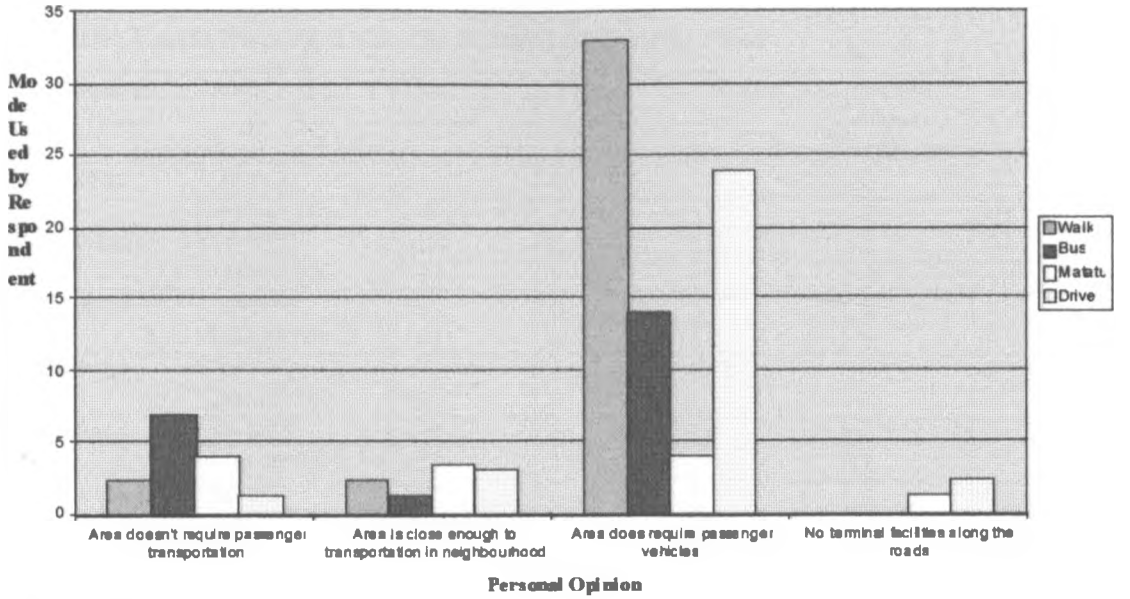
Figure 4-3: Relationships between Monthly Income and the Modal Choice



Source: Field Survey 2003

The current trend of planning is for the community to participate in the activities through direct involvement in the project as well as through giving their personal views and opinions in relation to the issues under investigation i.e. the bottom-up approach. The information provided may be of necessity and gives some guidance towards the issue. According to the figures in Table 4-5, 14.94% of the respondents stated that the area did not require passenger transportation, while 10.34% thought Hill area was close enough to CBD and therefore did not require additional transportation of its own. However 71.22% indicated that the area required public transport and the remaining 3.45% insisted that the area would require terminal facilities for the public transport to be viable in the area. Figure 4-4 shows the travel patterns of the respondents in the area.

Figure 4-4: Personal Opinion on Availability of Passenger Vehicles



Source: Field Survey 2003

(b) Existing Transport and their Service

Table 4-2 shows the traffic count survey analysis for the Hill Area. The counts were carried out during the peak hours in the morning from 7:00Hrs to 9:30Hrs and later in the afternoon from 16:00Hrs to 18:00 Hrs. From the data we find that 94.9% of all the vehicles through the study area are private cars and vans. Owing to the amount of data that the researcher was able to gather from the field, the analysis of the data was quite limited. It was only possible to compute the inbound and outbound vehicles that were observed during the single day that the traffic counts and motorised drivers interviews were conducted.

Further, the table shows the summaries of the traffic counts. However, though the table shows only the data for the roads along the periphery of the study area, traffic counts were conducted for all the road junctions in the area, which would capture the movement of any vehicle in the area. The limitation to the analysis occurred from the failure of conducting the traffic counts for seven days with at least two of the days with 24 hours count. These being the requirements

for computing ADT and AADT, the capacities of the roads in the study area were not determined in this study.

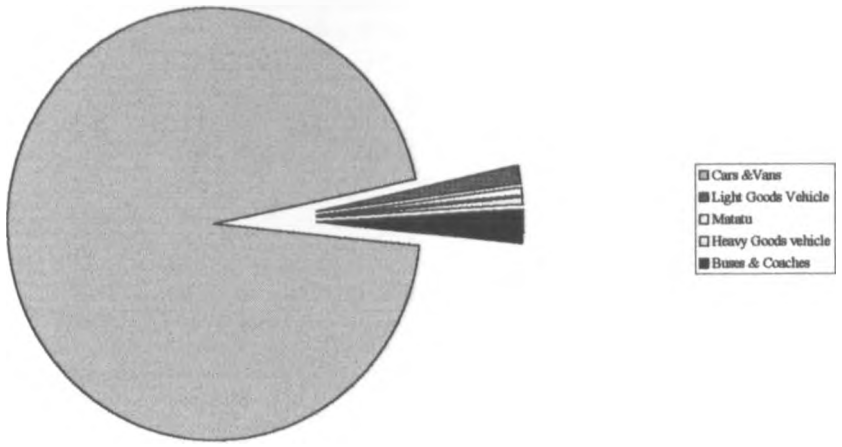
Table 4-2: Traffic Count Survey Analysis- Pattern of Traffic Flow

Census point Description	Direction	Time	Cars &Vans	Light Goods Vehicle	Matatu	Heavy Goods vehicle	Buses & Coaches	Total
Bunyala Road[x]	Inbound	7:00-9:30	742	6	4	0	0	748
		16:00-18:00	387	1	0	1	0	389
	Outbound	7:00-9:30	698	6	0	2	0	706
		16:00-18:00	572	9	0	4	1	586
Lower Hill Road[x]	Inbound	7:00-9:30	94	0	0	4	0	98
		16:00-18:00	101	6	0	0	0	107
	Outbound	7:00-9:30	187	10	12	0	0	197
		16:00-18:00	367	9	2	1	0	377
Upper Hill Road[x]	Inbound	7:00-9:30	492	6	0	6	0	504
		16:00-18:00	423	15	0	1	0	439
	Outbound	7:00-9:30	662	1	1	4	0	667
		16:00-18:00	355	9	0	4	0	368
Ragati Road[x]	Inbound	7:00-9:30	212	0	2	5	0	217
		16:00-18:00	111	1	0	0	0	112
	Outbound	7:00-9:30	50	0	0	1	0	51
		16:00-18:00	40	0	4	0	0	40
Chyulu Road	Inbound	7:00-9:30	5	1	0	0	0	6
		16:00-18:00	27	0	3	0	0	27
	Outbound	7:00-9:30	8	0	0	0	4	12
		16:00-18:00	12	1	0	0	0	13
Hospital Road	Inbound	7:00-9:30	602	4	1	5	66	677
		16:00-18:00	443	3	0	4	31	481
	Outbound	7:00-9:30	676	24	3	8	101	809
		16:00-18:00	663	7	20	1	4	675
TOTAL			7929	119	52	51	207	8358
Total %			94.9	1.4	0.6	0.6	2.5	100

Source: [x] Extrapolation from NCC Transportation Unit 1995 and 1997 Traffic Counts and Field Survey, 2003

The Matatus take 0.6% while the buses and coaches take 2.5% of the total number of vehicles through the area. Matatus only used the area as a transit place to ease congested en-route other destinations. This therefore meant that they could not offer any transport services to the area. They only used this route only when need to escape from congestion arise. The summary of the traffic distribution in the Hill Area is shown in Figure 4-5. The morning peak hours ranged from 7:00 t0 9:30 am while the evening peak hours were 4:00 to 6:00 pm.

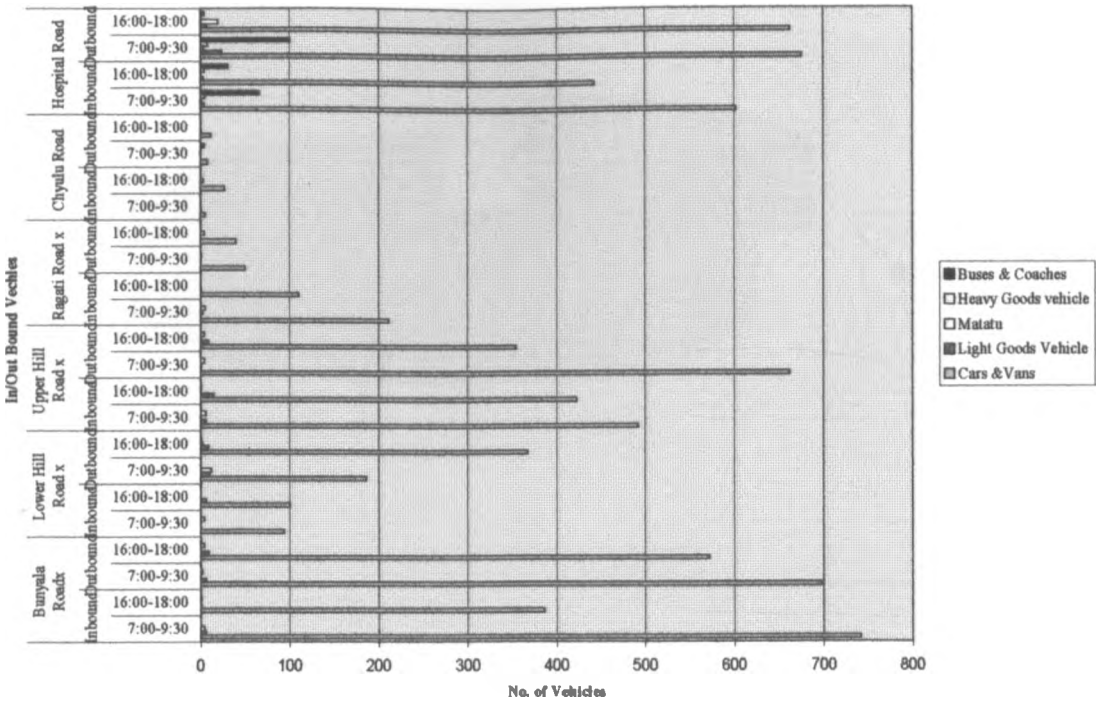
Figure 4-5: Distribution o f Traffic in Hill Area



Source: Field Survey 2003

The pattern of traffic flow is summarised in Figure 4-6 below. The study observed that along Bunyala road, during the morning peak hours the inbound vehicles were almost the same as the outbound vehicles whereas, in the evening for every two vehicles that entered the area through this point three vehicles left. At the Lower hill road the ratio of inbound to outbound vehicles in the morning was 1:2 wile it was 1:3 in the evening at Upper hill road the ratio was 2:3 in the morning as compared to the close to 1:1 ratio for the evening. For Ragati road the morning peak hours experienced a ratio of 4:1 and 3:1 respectively. Though the ratios are varying greatly this latter road was not busy as indicated in the table 4-2 above. Chyulu road had very low volume of vehicle, most likely due to it dilapidated nature. At hospital road the ratios of inbounds to outbound vehicles in the morning were 1:1 and 2:3 in the evening.

Figure 4-6: Pattern of Traffic Flow in Hill Area

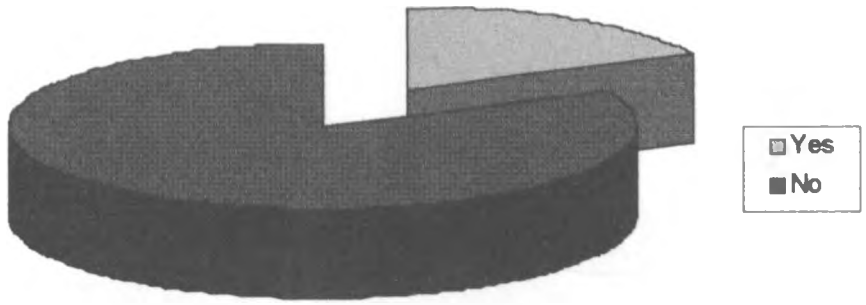


Source: Field Survey 2003

The study further wished to find out if the consumers of the transportation services were contented with the available services. From the field survey, 81.6% felt that the public transport system for the Hill area was inadequate. 16% indicated that the transport facilities are sufficient. Most of the people going to the Hill Area, other than those using private cars, have to walk at the stage of their journey within the Hill area.

This is indicated more clearly from the responses of the people interviewed in the area as shown in figure 4-7.

Figure 4-7: Personal Opinion on Transportation Adequacy in Hill Area

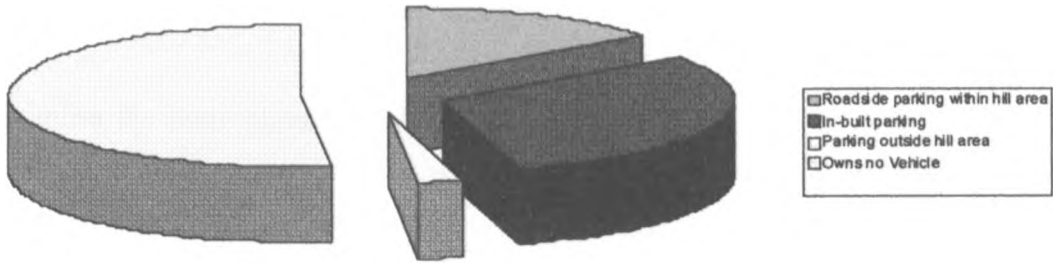


Source: Field Survey 2003

4.6.2 Parking

In order to supply adequate car parking spaces both basement parking and surface on site parking were a must for office and commercial development. This assumed that parking requirements as provided in the building code will be adhered to. To meet the demand of parking some spaces would be earmarked for off-street parking to take care of the long term parking requirements. Due to land constraints it would not be possible to obtain the necessary land needed for surface parking (public car parks). It was recommended that the commissioner of lands reserve the sites for public car parks. It was also recommended that the city commission (Department of City Planning and Architecture) ensured that developers provided adequate on-site parking space in giving planning and building permission.

Figure 4-8: Parking Availability in Hill Area



Source: Field Survey 2003

The field survey indicated that the Hill area did not have a public parking. This should be provided in Hill Area within residential areas, commercial zones and social facilities, recreation and sports areas. The available parking was mostly inbuilt but a few new developments were incorporating roadside parking adjacent to their buildings during construction. From the field survey, only 2% of the drivers indicated that they parked outside the Hill area not due to lack of parking space, but due to varied personal reasons. The area had adequate parking owing to the fact that most of the buildings provided for in-built parking and besides the residences in the area also offered parking especially for those working and living within the area.

The issue of parking should be addressed according to the zoning proposals. Any new development was required to provide parking for the generated traffic both within the premise as well as outside along the adjacent road stretch. However the latter should be treated with caution so that the developers do not convert all road reserve land meant for road extension into parking alone as they tried to utilize their plots entirely for commercial purposes. According to

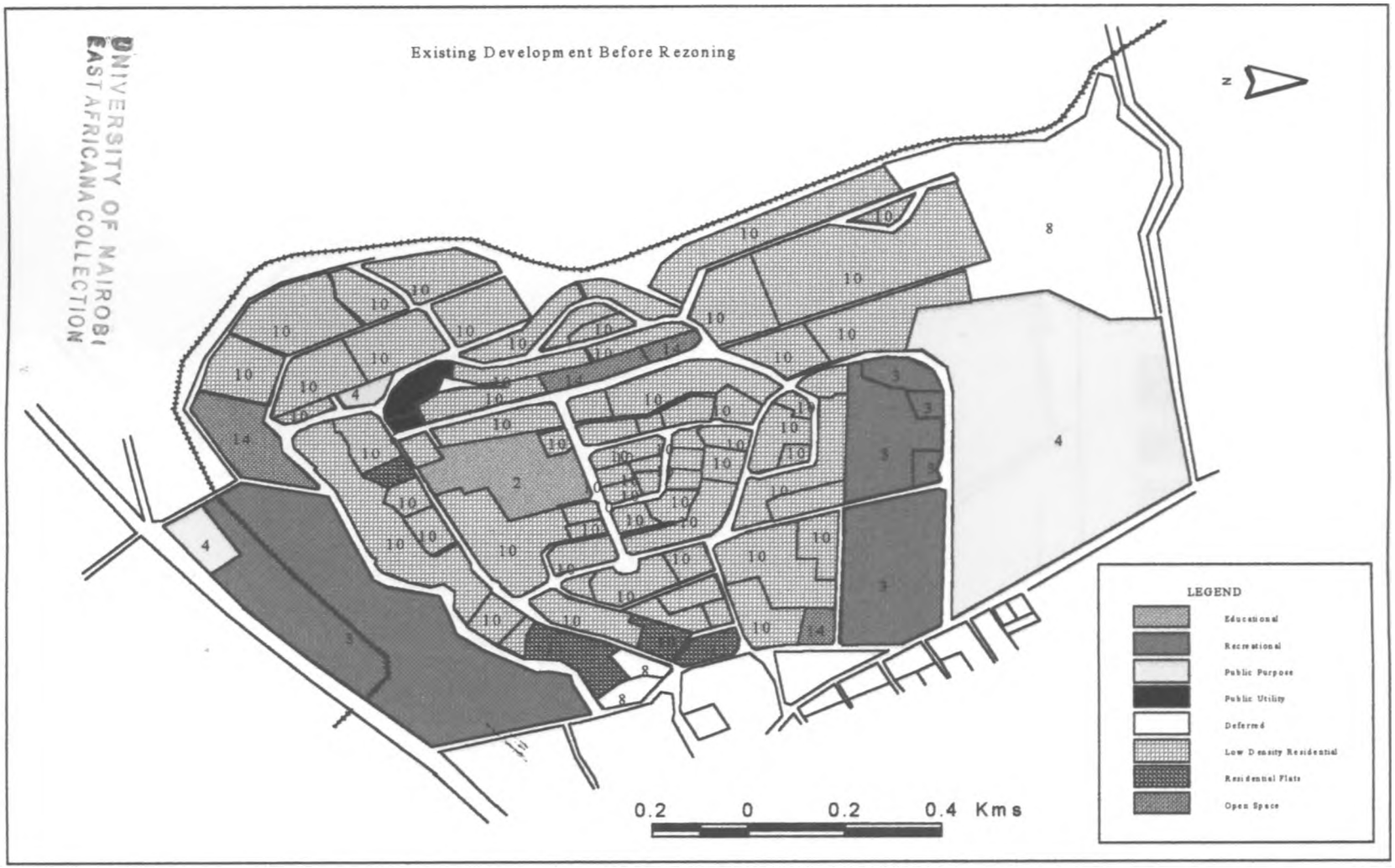
the zoning proposals the Hill area at full capacity would attract about 22,478 cars while the areas proposed to remain as residential would generate about 7,560 cars.

4.7 Documentation of change of user process in Hill Area

To accomplish the study objectives, the researcher documented the change of user process in the Hill area. This was attained by use of the following Maps 4-1and 4-2. Map 4-1 represents the Hill Area before rezoning. The area was dominated by low residential with some few residential houses converted into offices. The land meant for public purpose like the hospital and police was unaffected by the rezoning. The areas meant for recreation remained as such.

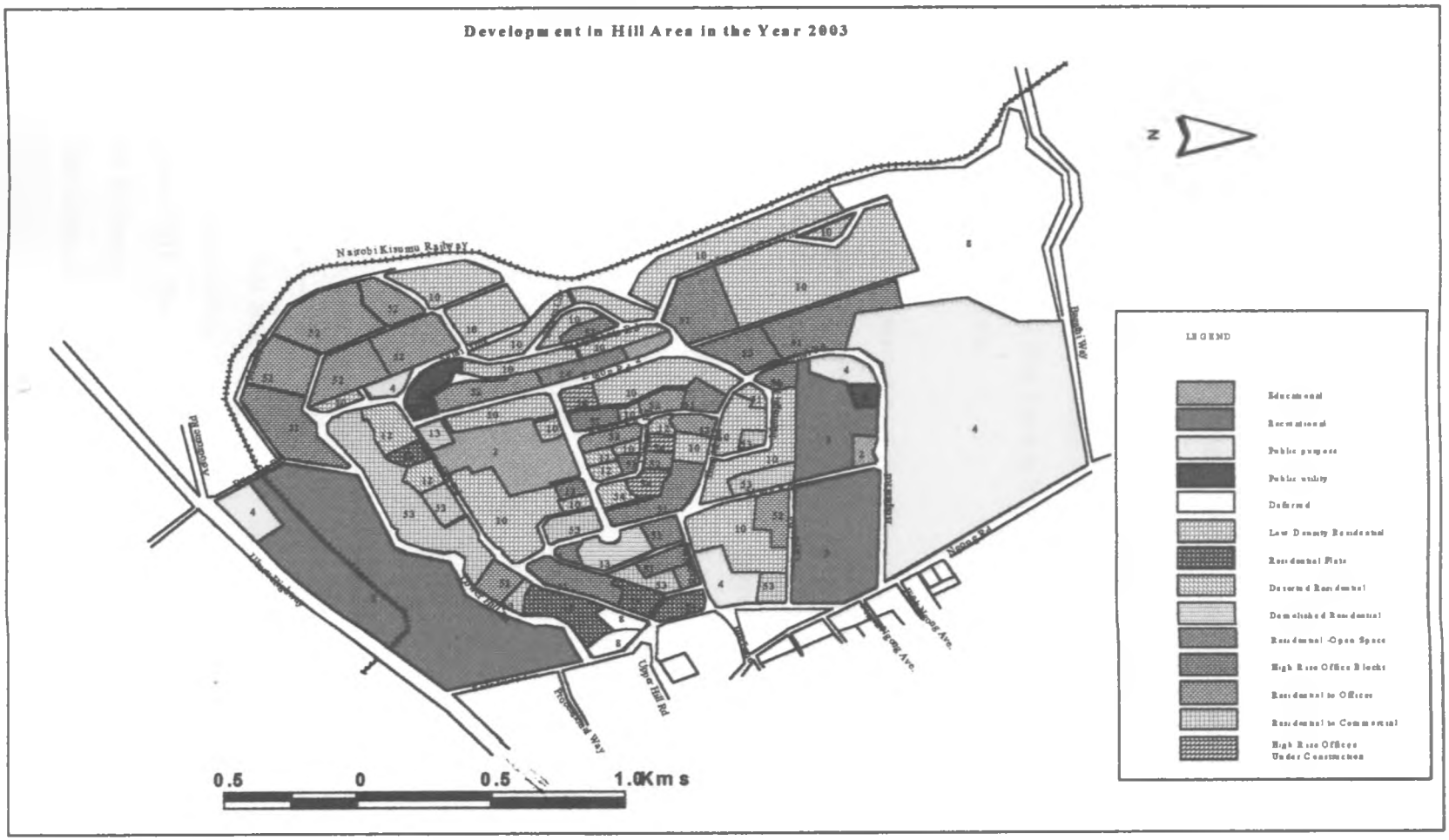
The development that emerged after rezoning is marked in Map 4-2. The changes varied from demolitions of the earlier residential houses to the desired one by the developer according to the zoning proposals to renovations of the old building to commercial places and desertion of some residences in readiness for redevelopment. As noted from Map 4-2 some part of the recreational land has been carved out to give way to a education institution. Also public purpose land next to the recreational area along Hospital road has also been etched to give way to a public utility site.

Map 4-1: Existing Development before Rezoning in Hill Area



Source: Survey of Kenya

Map 4-2: Change of User Process in Hill Area



Source: Survey of Kenya

5 CHAPTER 5: RECOMMENDATIONS AND CONCLUSION

5.1 Synthesis of Land Use Issues

In large urban areas, the medium term planning of future transport system is usually based on transportation study sometimes called a land use transportation study because of its fundamental reliance on the relationship between land use and travel demand The medium term –oriented transportation study is customarily developed on the basis of a single future land use forecast. It is generally accepted that there is little traffic significant scope for variation in such a forecast within such a time scale.

The committee responsible for the rezoning of the Hill Area made recommendations that the roads in the Hill area be widened. There were also some accompanying general proposals for road widening. The city engineer was then required to carry out the details of the directional flow of traffic including pedestrian movement and reserved the right to verify existing conditions and/ or imposition of additional conditions as to road widths, traffic flow and service way leaves as it deemed proper and necessary in securing traffic circulation and management. All these issues touch on land directly. It implied that in cases where the land for construction or roads was inadequate the people who owned land abutting the road would be required to compulsorily donate some land to enable completion of the road.

5.2 Synthesis of Transportation and Parking Issues

Transportation network in the Hill area is sufficient. All properties are well served by access and the area is also well connected to the major Haille selassie Avenue to the north, which starts all the way from the CBD. The only access on the eastern side to the Hill area is through Bunyala Road to Uhuru Highway. The main reasons for this could be attributed to the Nairobi-Kisumu railway line that passes all the way through the southern boundary of the area of study.

However, there were proposed footpaths crossing over the railway line joining the Hill area to the neighbouring Mandaraka estate. Some of the pedestrians interviewed lived in Mandaraka estate as well as Nairobi west and at times walked through the useable footpath at the railway crossing as they went to work at Hill area. Only one path was in use. It appeared eroded and badly gullied during the time of the field survey.

On the western side there is no access whatsoever which could join the area to Mbagathi road thus easing some of the through traffic from Uhuru Highway to the western side of the study area. This meant that the Hill area was sought of closed up. Some of the people interviewed indicated that there used to be a footpath through Kenyatta Hospital land to the Hill Area, but this was closed owing to security reasons. The only alternative left for those walking from the western side of the Hill Aarea was to follow the main road i.e. Mbagathi Way via Ngong Road. This was because on the southern side there is the railway line, which acted as a buffer; on the western side is the hospital, which occupied the entire frontage to Mbagathi way. The only alternative to access this end would be to carry out a study on the possibilities of constructing a road passing at the boundary of Mawenzi gardens and the hospitals quarters and enjoining Mbagathi road on the other side.

There were vehicles that drove through the study area as a by-pass. This meant that their destination was not within the area but for some reason they wished to circumvent the CBD most probably to avoid the usual city congestion as have been established by other studies. These vehicles were already showing signs of undergoing through delays at the current situation. Yet the Hill area has not even gone through its entire development as shown in the map – showing the extent of implementation of the rezoning. In this case, it is clear indication that the area has a lot more expected vehicles than just the ones attracted or generated within the area.

The number of vehicles which entered and left the Hill area through the major entry points i.e. Bunyala road and Hospital road as the study established (See Figure 4-6) were approximately the same. This coupled with the motorized driver interviews clearly established that most

vehicles were on transit through the area. For the minor entry points, i.e. Lower hill and Upper hill road, we noted that the inbound vehicles were almost half the outbound vehicles. This therefore meant that these roads were preferred by vehicles not destined to the area of study. For Ragati road most vehicles were inbound but very few exited from this point. This could be attributed to the road being the entry point to the Delegation of the Commission of European Union building and the British American headquarters, bearing in mind that during the period of the study there was high security alert for the British and American linked properties. The few vehicles noted along this routed were mostly destined to these buildings as the other drivers avoided security screening.

The Hill area was designed with major access roads as this was a low density residential area. Major access roads exceed 150metres in length and have a width of 15metres. They have full access to adjacent property with a side walk provided together with a pedestrian and cycle crossing provided as a cross walk. Parallel curb parking is allowed and the road has no shoulders. From the study we established that the Hill area did not have any side walk while the road reserve was taken up by informal businesses like green groceries or food kiosks. Further, we noted that most vehicles were on transit and mostly the area through Bunyala road and others via Hospital road. These two roads are connected to each other by Elgon road and a small stretch of Upper hill road. Based on this argument, these roads were acting as through roads.

This being the case, the hierarchy of these roads should be elevated to secondary distributor. A secondary distributor road classification has two or more lanes with no access from both adjacent property and minor roads. They are 30-36metres. The side walk is routed away from the road and pedestrian and cycle crossing separated or by cross walk. Parallel curb parking is eliminated and the roads have shoulders.

The research established that there was need for providing public service vehicles to the Hill area. This was not possible without provision of facilities for these public vehicles, which would include widening of the roads as well as provision of terminal facilities. There are some

public vehicles sited during the course of the survey. These vehicles only operate during the peak hours to only selected points like the British- American building and another plying from KNH through the Hill area to Lower Hill road near Bunyala road. The operators of these vehicles were reluctant to be interviewed and they claimed that they were doing the business against the NCC. The fares they charge are far higher than the same paid for same distance from CBD to other similar distances.

One of the factors that inhibit the introduction of the public passenger transport is the lack of terminal facilities for the public passenger vehicles. The one existing at the terminus of Kenyatta general hospital is exclusively for the use by the former Kenya Bus now renamed Bus Track. Public transport can contribute substantially to the productivity and sustainability of large cities. However at the current stage it is an industry that looks for help from other sectors. Appropriate land use management can ease the pressure of travel demand on public transport, by reducing the need for travel, and it can lead to a more efficient use of public transport capacity by providing the balance in the distribution of traffic generators. The management of public transport system at large can mitigate the conflict between public and individual transport in the use of available travel way space, while fiscal policies can create new source of revenue for public transport development

5.3 Summary

The re-zoning of the Hill area has seen the area undergo a tremendous growth. High buildings have been put up especially for the places that are proposed for office and commercial blocks. Residential houses falling in this latter area have been deserted or converted into offices, if not demolished ready for over-whole reconstruction. The area is busy with traffic during the peak hour in the morning as well in the evening. The main vehicles within the area are private cars, and the public service vehicles are rare to find other than the Bus track buses destined for Kenyatta hospital and back

It has emerged that there is need to come up with a public transport system for the hill area. It has been proven that most people have to revert to walking at one stage of their journey due to the fact that the public transport facilities are situated at locations not conveniently set to serve the area's interior. As a matter of fact the areas topography is not conducive for walking especially when moving towards the western side from the CBD. However, pedestrialization is also required for the movement within the area. The issue of transportation ought to be addressed and it should be geared towards taking the necessary measure to provide to the residents and workers of the Hill area satisfactorily.

5.4 Recommendations

a. Introduction

Land use planning is living in the future today. Land use planners are seers. It is therefore recommended that there should be comprehensive plans to guide the city development. If these were in place most issues relating to provision of public facilities like the community facilities or transportation would be carted for in the plans. These plans should be up to date reflecting the future and never to be overtaken by time. The existing Nairobi Metropolitan growth strategy has lived its life and was not replaced by another plan for the city. Planning alone will not solve the problems of transportation. There should also be effective development control. Most land reserved for future road extension has been taken over by informal businesses, which operate right next to the carriage way. This is both risky for the road users as well as those operating and being served in the business. Further, they consume all the land that could be used by the NMT. The only way to derive significant improvements in the performance of urban transport sector is to recognize the way in which urban transport is planned and developed. Once this has been achieved, technical interventions have a greater chance of achieving a positive impact on the urban transport sector

b. Integrate Land Use Planning and Transport Planning

Land use planning and development especially in the urban areas and road transport are not currently integrated. This is due to poor coordination of responsibilities for administration planning and regulation of various aspects of land use, infrastructure and operations. Most of local authorities lack planning departments while those that have are understaffed. This situation has led to spatially dislocated settlements, urban sprawl and long travel distances. It is recommended that in order to support passenger transport, land use development proposals must be subject to a land use and road passenger transport policy. Most effective plans can only be achieved through integrated planning of land use, transport infrastructure and transport operations.

Zoning and re-zoning should go hand in hand with transport planning and implementation. At times when transportation facilities are not provided concurrently with the development, then the research recommends that transport facilities should be provided prior. If this is not done the transport infrastructure may be overtaken by other issues, though it is clear that transportation is a great contributor to positive growth of the economy. The zoning and re-zoning is incomplete without incorporating the transportation aspect in the plan. It is recommended that in order to have a smooth transition of re-zoning the complete exercise should be well coordinated so that the plans are not left incomplete long after some of the development proposals have already been implemented. The re-zoning could only be considered successful once all the necessities are provided to the area under consideration. The policies should be clear that re-zoning could only take effect when all the necessary procedures and plans are complete.

c. Coordination Between Different Actors

i. The Ministry of Transport and Communication is in charge of formulation of national transport policies (planning, design and management), vehicle licensing and transport service regulations. There is a fragmented and uncoordinated legal and institutional framework for regulation, coordination, development and management of roads passenger transport services. The

Transport Licensing Board (TLB) is the body mandated to license all public service vehicles and act as the industry regulator but does not include road passenger transport services demand regulation in accordance to transportation plans. This body does not however regulate the routes, which the vehicles would operate. The current licensing framework is based on applications, while the supervision of the licence operators is left to the police whose core function does not include the area of operation priority. Kenya Bus Service (KBS) now known as Bus track originally operated under a city franchise under which they provided scheduled services with fares controlled by the city council. The city council undertook to provide and maintain the infrastructure. However in recent years KBS did not renew the franchise (which had in any ease largely lost any significant value), as from 1973 there was direct competition from the Matatus, and from 1986(until 1992) with Nyayo Bus. Matatus are not subject to any formal kind of regulation after deregulation of bus services in 1994.

Vehicle operators were organized into route associations, which attempted to limit new entrants to routes. There is a quasi control of fares by the authorities, though individual drivers may vary fares with time of day, or month. The authorities also try to impose some control on routing and in particular parking in the central areas. This ends up leaving out some regions without any public service vehicles, as the vehicle owners would locate their vehicles to the most competitive and more profit making routes. From this research it is recommended that vehicles should have designated routes so that no area is left out.In this regard it is recommended that the transport authorities introducing a system of route tendering may attain the above. Vehicle owners would be required to tender for the routes through which their vehicles would ply. If a particular route though may seem more competitive due to the large number of commuters then the transport authorities should decide on the number of

vehicles to allocate to the route through a system of balloting. This would ensure that all areas are well served by public transport services.

ii. The Ministry of Transport and Communication has had relatively little involvement in the roads sector since 1984 when the roads department was moved to Ministry of Public Works. Further, the responsibility of urban transport planning and management is the responsibility of the Local Authorities through the various City, municipal and town councils. There should therefore be coordination and cooperation between the many organisations, which retain a vested interest. Transport should have a high priority in the city affairs; its development should have a high profile and be more focussed. The stakeholders (users) should have influence in the sector.

In addition, there should be more effective coordination among the various departments of the city council. For instance, though the council is the same one responsible for the provision of infrastructure and urban roads, it is also mandated with the authority to license all kinds of businesses. In this case one department deals with trade licenses while the other is responsible for roads and traffic. But we find legally licensed businesses operating on the road reserves, which infringes directly on the safety of all citizens using these facilities.

d. Integrate NMT into the Transport System

Over the years, the road development has focused attention mainly on roads for motorised transport although this has not been matched with increased access to motorised transport mode. The NMIMTS are not fully recognized by law to qualify the government's technical or financial support (GoK 2004). This means that the NMIMT infrastructure and attention is mainly focused on MT and its infrastructure. It is recommended that the NMIMT should be included in national transportation policy. This would encourage the development of NMIMT's along with other transport modes in order to increase accessibility and mobility. If

these were put into place they would go a long way in solving the crisis for area such as the Hill Area, which have an unfriendly terrain for the NMT.

e. Facilitate Use of Available Alternative Modes of Transport

Finally, one of the boundaries of the Hill Area comprise of the Nairobi Kisumu Railway. Railway transport in Kenya comprises an interface of inter-modal transport for both passengers and freight. Passenger services are currently limited to domestic market. The KR operations are governed by the KRC Act and are subject to the provisions provided for in the State Corporations Act. The guidelines provided for from time to time on the operations of the state corporations by the government influence the management and operations of the railways. However it is recommended that there should be a policy which will enable the KR to respond to the market demands and also allow participation of other player in the railway transport business. In this regard the KR may also consider offering passenger transport to areas within the city through which the lines pass. This would also include the Hill area in which there are no public transport means especially in those areas next to the railway.

5.5 Areas of further research

The present research recommends that further research on zoning and rezoning process. The research has verified that transportation plays a major role towards the economical accessibility of an area. However due to the close proximity of the study area to the CBD, it is not clear as to whether people would still be attracted better to any other areas away from the city centre but with good accessibility. There should be relative comparison between the rate of economic growth of an area rezoned with transportation factor put into consideration and another rezoned but transportation left to take its own course.

5.6 Conclusion

The Hill area has undergone re-zoning and the proposed development has already commenced. The study was carried out in a section of the Hill Area which acted as a representative of the entire zone. The major reason for the choice of the area was that having looked at the development trend of the City of Nairobi, more of the rezoning were on the way. The study concentrated on the transportation demand of the area after rezoning.

This study was conducted through field survey, questionnaires, traffic counts and some interviews to some city planning officials. Conclusions were drawn from analysis of data collected. It was established that the area has undergone through substantial changes as indicated in Map 4-2. It was also noted that though the new scheme of plan has been followed most of the development has been through change of user process without necessarily changing the face of the area. In this case the area has yet to take some time before it meets its carrying capacity of development. However, it was noted that there were already some problems in transportation flows. On the other hand, there was low accessibility especially by the public passenger vehicles due to narrow roads originally meant for low density residential area and also lack of terminal facilities. The population living and interacting with the area lacked public means of transport and most of them reverted to walking along the harsh terrain especially for those approaching the area from the CBD direction as shown in Map 3-4.

The study recommends that transportation planning be integrated into rezoning plans and in places where this is not possible, transportation planning should precede rezoning. Further, it has shown that there is need to ensure accessibility of the area all the people interacting with the area. The area requires public passenger transport, but this can only be possible if there are facilities to accommodate them. In this light it is therefore recommended that there should be close coordination between the land use planner and the transportation planner.

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APPENDICES

TRAFFIC COUNT SCHEDULE

INTERSECTION:			LOCATION (Sketch)		
STATION:		Entry from:			
DATE:		Exit to:			
ENUMERATOR:					
TIME	Cars & Vans	Light Goods Vehicles	Heavy Goods Vehicles	Buses & Coaches	Total
7:15					
7:30					
7:45					
8:00					
8:15					
8:30					
8:45					
9:00					
Total					
16:15					
16:30					
16:45					
17:00					
17:15					
17:30					
17:45					
18:00					
Total					

QUESTIONNAIRES

Workers (Office and Informal Sectors) Questionnaire

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

M. A. PLANNING YEAR II 2003

A Study on the Relationship Between Re-zoning of Land Use and Transport Needs in Nairobi Hill Area by Karoki, E. M.

Interview Schedule for Workers (Office and Informal Sectors)

Note: This information is confidential and will be used for academic purposes only

Interviewer: _____ Date_____ Questionnaire No._____

a) Name (Optional) _____

b) Sex: 1. Male 2. Female

c) Marital status: 1. Single 2. Married
3. Divorced 4. Other (specify)

d) Residence (State Town / Estate) _____/_____

a) Describe your journey to work
1. Walk 2. Bus 3. Matatu 4. Drive

a) Do you own a vehicle?
1. Yes 2. No

b) Do you drive to work?
1. Yes 2. No 3.At times [If Yes Go to (f)]

c) Why not?
1. Traffic congestion 2. Fuel cost
3. Poor road surface 4. Other (indicate) _____

d) If you don't drive a car from the place of residence, describe your journey to Hill area

i. Home to Bus stop
1. Walking 2. Riding 3. Driving

ii Duration to bus stop:
1. Less than 10 min 2. 11-20 min
3. 20-30 mm 4. Over 30 mn

iii. Waiting at stage:
1. Less than 10 min 2. 11-20 min
3. 20-30 min 4. Over 30 min

iv. Mode used:
1. Bus 2. Matatu 3. Taxi
4. Private lift 5. Non-Motorised Transport (NMT)

v. Length of the trip
1. Less than 10 mn 2. 11-20 min
3. 20-30 min 4. Over 30 min

e) Number of times vehicles/modes changed to Hill Area?

f) Where do you park your vehicle (hill area or elsewhere)?
1. Road side parking within Hill area
2. In-built Parking
3. Reserved public parking
4. Elsewhere (indicate)

If you park elsewhere, give reason _____

g) Is there public means of transport, which serve this area?

1. Yes 2. No

h) Do you feel the area's transportation system is adequate?

1. Yes 2. No

i) If No in (h), what is your opinion about it?

1. Area doesn't require public transport
2. Area is close enough to transport facilities serving neighbouring areas
3. Other (state)

j) How much do you spend on transportation per month in KSh?

1. Less than 1,000
2. 1,001 to 3,000
3. 3001 to 6,000
4. Over 6,001

e) Monthly Income (KSh)

1. 1,001 to 3,000
2. 3001 to 6,000
3. 6,001 to 10,000
4. 10,001 to 15,000
5. 15,001 to 20,000
6. Over 20,000

Household Questionnaire

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

M. A. PLANNING YEAR II 2003

A Study on the Relationship Between Re-zoning of Land Use and Transport Needs in Nairobi Hill Area by Karoki, E. M.

Household Questionnaire

Note: This information is confidential and will be used for academic purposes only

Interviewer: _____ Date_____ Questionnaire No._____

a) Name (Optional) _____

b) Sex: 1. Male 2. Female

c) Marital status:

1. Single
2. Married
3. Divorced
4. Other

d) How long have you lived in Hill area Area?

e) Where do you work?

f) Describe your journey to work/CBD

1. Walk 2. Bus 3. Matatu 4. Drive

a) Do you own a vehicle?

1. Yes 2. No

b) Do you drive to work?

1. Yes 2. No 3. At times [If Yes Go to (f)]

c) Why not?

1. Traffic congestion 2. Fuel cost

3. Poor road surface 4. Other (indicate) _____

d) If you don't drive a car from the place of residence, describe your journey to Hill area

i. Home to Bus stop

1. Walking 2. Riding 3. Driving

ii Duration to bus stop:

1. Less than 10 min 2. 11-20 min

3. 20-30 min 4. Over 30 mn

iii. Waiting at stage:

1. Less than 10 min 2. 11-20 min

3. 20-30 min 4. Over 30 min

iv. Mode used:

1. Bus 2. Matatu 3. Taxi

4. Private lift 5. Non-Motorised Transport (NMT)

v. Length of the trip

1. Less than 10 min 2. 11-20 min

3. 21-30 min 4. Over 31 min

f i) Where do you park your vehicle (hill area or elsewhere)?

1. Road side parking within Hill area

2. In-built Parking

3. Reserved public parking

4. Elsewhere (indicate)

ii) Give reason for parking elsewhere _____

g) Is there public means of transport, which serve this area?

1. Yes 2. No

h) Do you feel the area's transportation system is adequate?

1. Yes 2. No

i) If No in (h), what is your opinion about it?

1. Area doesn't require public transport
2. Area is close enough to transport facilities serving neighbouring areas
3. Other (state)

j) How much do you spend on transportation per month in KSh?

1. Less than 1,000 2. 1,001 to 3,000
3. 3001 to 6,000 4. Over 6001

a) Do you own this house?

1. Yes 2. No

b) If not please indicate the terms of occupation

1.Government house 2.Rental
3.Leasehold 4. Other (indicate)

c) Are you aware that the area has been re-zoned into commercial and office blocks only?

1. Yes 2. No

d) How did you come to learn about it?_____

e) Monthly Income (KSh)

1. 1,001 to 3,000 2. 3001 to 6,000
3. 6,001 to 10,000 4. 10,001 to 15,000
5. 15,001 to 20,000 6. Over 20,000

Motorized Traffic Drivers

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

M. A. PLANNING YEAR II 2003

A Study on the Relationship Between Re-zoning of Land Use and Transport Needs in Nairobi Hill Area by Ka

Interview Schedule for Motorized Traffic drivers

Note: This information is confidential and will be used for academic purposes only

Interviewer: _____ Date_____ Questionnaire No._____

a) Name (Optional) _____

b) Sex: 1. Male 2. Female

c) Marital status:
1. Single 2. Married
3. Divorced 4. Other (Specify)

d) Residence (State Town / Estate) _____/_____

e) What is the destination of your journey?_____

f) What is the purpose of the trip?
a) Official b) Private
c) Work place d) Other (specify)

a) Describe your journey to work
1. Walk 2. Bus 3. Matatu 4. Drive

a) Do you own this vehicle?
1. Yes 2. No

b) Do you drive to work?
1. Yes 2. No 3.At times [If Yes Go to (f)]

c) Why not?
1. Traffic congestion 2. Fuel cost
3. Poor road surface 4. Other (indicate) _____

d) If you don't drive a car from the place of residence, describe your journey to Hill area

i. Home to Bus stop
1. Walking 2. Riding 3. Driving 4. Other

ii Duration to bus stop:
1. Less than 10 min 2. 11-20 min
3. 20-30 min 4. Over 30 min

iii. Waiting at stage:
1. Less than 10 min 2. 11-20 min
3. 20-30 min 4. Over 30 min

iv. Mode used:
1. Bus 2. Matatu 3. Taxi
4. Private lift 5. Non-Motorised Transport (NMT)

v. Length of the trip
1. Less than 10 min 2. 11-20 min

3. 20-30 min 4. Over 30 min

e) Number of times vehicles/modes changed to Hill Area? ☐

f i) Where do you park the vehicle (hill area or elsewhere)? ☐

1. Road side parking within Hill area
2. In-built Parking
3. Reserved public parking
4. Elsewhere (indicate)

ii) Give reason for parking elsewhere _____ ☐

g) Is there public means of transport, which serve this area? ☐

1. Yes 2. No

h) Do you feel the area's transportation system is adequate? ☐

1. Yes 2. No

i) If No in (h), what is your opinion about it? ☐

1. Area doesn't require public transport
2. Area is close enough to transport facilities serving neighbouring areas
3. Other (state)

j) How much do you spend on transportation per month in KSh? ☐

1. Less than 1,000 2. 1,001 to 3,000
3. 3001 to 6,000 4. Over 6,001

e) Monthly Income (KSh) ☐

1. 1,001 to 3,000 2. 3001 to 6,000
3. 6,001 to 10,000 4. 10,001 to 15,000
5. 15,001 to 20,000 6. Over 20,000

Pedestrian Questionnaire

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

M. A. PLANNING YEAR II 2003

A Study on the Relationship Between Re-zoning of Land Use and Transport Needs in Nairobi Hill Area by Karoki, E. M.

Interview Schedule for Pedestrians

Note: This information is confidential and will be used for academic purposes only

Interviewer: _____ Date_____ Questionnaire No._____

a) Name (Optional) _____

b) Sex: 1. Male 2. Female

c) Marital status:
1. Single 2. Married 3. Divorced 4. Other

d) Residence (State Town / Estate) _____/_____

e) What is the destination of your journey? _____

f) What is the purpose of the trip?
a) Official b) Private
c) Work place d) Other (specify)

a) Describe your journey to work
1. Walk 2. Bus 3. Matatu 4. Other

a) Do you own a vehicle?
1. Yes 2. No

b) Do you drive to work?
1. Yes 2. No 3.At times [If Yes Go to (f)]

c) Why not? 1. Traffic congestion 2. Fuel cost
3. Poor road surface 4. Other (indicate) _____

d) If you don't drive a car from the place of residence, describe your journey to Hill area
i. Home to Bus stop
1. Walking 2. Riding 3. Driving 4. Other
ii Duration to bus stop:

1. Less than 10 min 2. 11-20 min
3. 20-30 min 4. Over 30 min

iii. Waiting at stage:

1. Less than 10 min 2. 11-20 min
3. 20-30 min 4. Over 30 min

iv. Mode used:

1. Bus 2. Matatu 3. Taxi
4. Private lift 5. Non-Motorised Transport (NMT)

v. Length of the trip

1. Less than 10 min 2. 11-20 min
3. 20-30 min 4. Over 30 min

e) Number of times vehicles/modes changed to Hill Area? _____

f i) Where do you park the vehicle (Hill area or elsewhere)? Give reason

1. Road side parking within Hill area 2. In-built Parking
3. Reserved public parking 4. Elsewhere (indicate)

ii) Give reason _____

g) Are there public passenger vehicles, which serve this area?

1. Yes 2. No

h) Do you feel the area's transportation system is adequate?

1. Yes 2. No

i) If No in (h), what is your opinion about it?

1. Area doesn't require public transport
2. Area is close enough to transport facilities serving neighbouring areas
3. Other (state)

j) How much do you spend on transportation per month in KSh?

1. Less than 1,000 2. 1,001 to 3,000
3. 3001 to 6,000 4. Over 6,001

e) Monthly Income (KSh)

1. 1,001 to 3,000 2. 3001 to 6,000
3. 6.001 to 10,000 4. 10,001 to 15,000
5. 15,001 to 20,000 6. Over 20,000

INTERVIEW SCHEDULES

Interview Schedule to City Engineer (Traffic/ Roads Department)

UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
M.A PLANNING YEAR II, 2003

Interview for the study on the relationship between re-zoning of land use and transport needs in the Nairobi Hill Area by Eunice M. Karoki

Interview Schedule to City Engineer (Traffic/ Roads Department)

Note: The information is confidential and will be used for academic purposes only.

Date of Interview_____Schedule_____(2)_____

1. What is the involvement of your department in the zoning and rezoning of urban regions?
2. At what stage does your department get involved in the zoning and re-zoning of an area?
3. In a situation where there do exist land development, and the survey on transportation shows that you would require more land in order to provide for transportation adequately, how do you provide for such a case? Please explain
4. Do you consider other factors other than the field survey and design requirements to determine the route in an area?
5. Is the private sector consulted during the preparation of transportation network of an area?
6. Do you involve private developers in the issue of transportation planning?
7. If you do, is there any role played by the developers?
8. How do you incorporate public participation in your activities?

Interview Schedule to City Engineer (Water and Sewerage Department

UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
M.A PLANNING YEAR II, 2003

Interview for the study on the relationship between re-zoning of land use and transport needs in the Nairobi Hill Area by Eunice M. Karoki

Interview Schedule to City Engineer (Water and Sewerage Department)

Note: The information is confidential and will be used for academic purposes only.

Date of Interview_____Schedule_____(1)_____

1. What is the involvement of your department in the zoning and rezoning of urban regions?
2. At what stage does your department get involved in the zoning and re-zoning of an area?
3. In a situation where there do exist a sewerage system, if a rezoning is then effected increasing the density of land use, how does your department accommodate such scenario? Please explain
4. Is the sewer reticulation in any way related to the transportation network of an area?
5. Can a re-routing of the road network affect the already laid sewer lines?
6. What are the main factors of consideration in designing the routing of a sewer line other than the land carrying capacity?

Interview Schedule to City Planning Department

UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING
M.A PLANNING YEAR II, 2003

Interview for the study on the relationship between re-zoning of land use and transport needs in the Nairobi Hill Area by Eunice M. Karoki

Interview Schedule to City Planning Department

Note: The information is confidential and will be used for academic purposes only.

Date of Interview_____Schedule_____(1)_____

1. What criteria are applied in the zoning and rezoning of urban regions?
2. Are these regulations uniform in all situations?
3. Are the policies used based on existing land uses? Please explain
4. How do the market forces affect the zoning of an area?
5. Is the private sector consulted in the formulation of zone policies?
6. Do you involve developers in the issue of zoning and rezoning?
7. Is there any role played by the developers during the process of zoning and rezoning?
8. How do you incorporate public participation in your activities?