TRANSPORTATION AS A MEDIUM FOR SPATIAL INTERACTION: A CASE STUDY OF KENYA'S RAILWAY NETWORK.

BY

STEPHEN AMBROSE LULALIRE ONGARO

DEPARTMENT OF GEOGRAPHY

UNIVERSITY OF NAIROBI

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QUOTES

"It is not uncommon thing for a line to open-up a country, but this line literally created a country".

Sir Charles Elliot, 1903.

(Kenya Railways Museum Annex)

"The degree of civilization enjoyed by a nation may be measured by the character of its transportation facilities."

Byers, M.L. 1908.

DEDICATION

I dedicate this thesis to the memory of my late grandfather, Topi Mutokaa

DECLARATION

This thesis is my original work and has, to the best of my knowledge, not been submitted for a degree in any other university.

STEPHEN AMBROSE LULALIRE ONGARO
(Master of Arts Candidate)

This thesis has been submitted for examination with our approval as University of Nairobi supervisors.

PROFESSOR REUBEN B. OGENDO
(University supervisor)

Mr. EVARISTUS M. IRANDU
(University supervisor)

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This work may have certain merits based on the assistance and guidance extended to me. Some of the ideas discussed herein are so entrenched in my thoughts that I may have unknowingly failed to acknowledge more authoritative scholars who discussed them before me. Such unacknowledged contribution comprise the ideas which loom large in my intellectual upbringing. Thus, when all is said and done, this work is mine and I am wholly responsible for all undetected errors that still exist in it. All praise is due to those who contributed towards its development.

ABSTRACT

This study is undertaken on a broad national scale and attempts to provide an insight into the relationship between railway transport and spatial integration. The overall objective of the study is to analyse the significance of railway transport in Kenya from a spatial perspective. It seeks to identify guidelines and measures upon which an institutionalised, comprehensive and long-lasting national transport policy may be formulated and effectively implemented.

Chapter one focuses attention on the conceptual basis of the study. A dynamic conceptual model comprising an open system that is responsive to changing social, economic, political, environmental and technological conditions is envisaged. The conceptualised system is assumed to be self-adjusting and continuously arrives at new equilibrium levels after a change in any of its components. Achieved equilibria represent the degree of progress towards the attainment of some desired level of national integration.

The second chapter discusses the conditions under which railway services are rendered in Kenya. The railway is identified as the oldest contemporary national mode of transportation in Kenya. It begun to experience competition in the 1930s when the construction of a national road network became noticeable while railway expansion was halted. It is concluded that colonial interests dominated the early days of railway transport in Kenya while geographical inertia, economic and political considerations now seem to have an upper hand in determining the availability and quality of railway services.

Chapter three outlines the methodology used to gather information, analyse data and interpret the results. Absolute and surrogate variables are analysed. Multiple regression and correlation

analyses form the basis of all data analyses. F and *t* tests are used to test the significance of obtained statistical results. Statistical outputs are related to theoretical expectations and field observations.

The fourth chapter attempts to establish the relationship between spatial interaction and railway transport in Kenya. It is suggested that Kenya's economy is strongly polarised along the railway network which outlines a national transport corridor designed during the colonial period. Geographical inertia is seen to be the main cause of the observed spatial polarisation of Kenya's economy.

Chapter five discusses the relationship between regional development and railway transport in Kenya. A strong spatial relationship has been found to exist between the location of major economic activities and the railway network. Most of the observed polarisation is either attributed to historical accidents or geographical inertia. The railway formed the initial development stimulus that resulted in the concentration of economic activities in certain parts of the country and initiated a geographical inertia that has strongly polarised Kenya's space economy. The railway network was designed to render external transport services and does not significantly affect most of the land through which it passes, especially wayside stations.

Chapter six examines the relationship between road and railway transport services. Kenya's railway network predates her road network. Roads were initially developed to complement the railway by rendering feeder and local distribution services. The extensive spread of roads, the ease with which they are constructed and up graded, and the numerical superiority of motor vehicles have given road transporters a competitive edge over the static railway network. The expansion of road transport has resulted in the inevitable conflict of interests between road and railway transport.

The seventh chapter provides a summary of findings, conclusions and recommendations emanating from the present study. The overall finding of this study is that railway transport is an integral part of Kenya's transport network. It is concluded that limited spread, unchecked road competition and lack of an all encompassing national transport policy appear to restrict the railway's ability to render effective transport services. This study recommends that Kenya should develop a clear national transport policy that seeks to harmonise the operations of its constituent parts and national interests in general.

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CHAPTER ONE

INTRODUCTION

1.1 STATEMENT OF THE RESEARCH PROBLEM

The analysis of interaction in space is a common theme of studies in human geography. A central issue in the analysis of an economy's spatial structure is how to determine suitable investment locations to prop-up less prosperous areas. An attempt is herein made to use spatial interaction as the basis for explaining man's effort to overcome the frictional effect of distance. Railway traffic is analysed with the view to understanding its spatial relationship to Kenya's economy. This approach is in accordance with White and Senior (1983:1) when they observe that "... the study of transportation is of great importance to geographers ... as an explanatory factor in the spatial patterns assumed by human activities which are basic to geography."

Transportation facilitates the exploitation of natural and human resources through the movement of people, information and commodities. It is a key factor that affects the distribution pattern of human activities in time and space. A n efficient transport system facilitates the effective implementation of national economic obligations. Transport improvements provide a suitable base for restructuring national economies. The uneven distribution of human and natural resources in Kenya accentuates the significance of transportation in spreading development impulses.

This study attempts to assess the relationship between the availability of railway services and regional development in Kenya. It inquires into the measures that can be taken so as to provide adequate mobility levels and support national development programmes. The spatial structure of Kenya's economy is compared to the morphology, function and lay out of the railway.

Transport improvements often change the spatial dimension of existing economic systems by increasing the general level of intra- and inter-regional interaction. This process has far reaching implications on regional economic development. Areas peripheral to the main concentration of economic activity may be isolated as their degree of integration within the system diminishes.

New modes of transportation have led to a large shift of traffic and therefore revenue from the railways (Nelson, 1959). The monopoly in transportation that was enjoyed by the railway during the first half of the twentieth century has gradually diminished as other modes of transportation were introduced to the domestic transport scene. Apart from the construction of sidings, there has been no railway construction work in Kenya since 1931. The government has focused attention on increasing the length and quality of rural access roads and thus appears to have neglected the expansion and development of railway transport in general.

This study is based on three basic questions, namely:

i) Is there a significant relationship between Kenya's railway network and economic concentration?

ii) Is the railway a significant national mode of transportation?

iii) What is the significance of the distance-decay function to Kenya's railway traffic?

The study is based on the premise that transport networks originate and develop from the need to facilitate, with greater ease, the movement of people, commodities and messages (Ongaro, 1989).

1.2 LITERATURE REVIEW

This section outlines the theoretical and empirical bases of this study. Previous research findings are discussed with a view to establishing their strengths, shortcomings and gaps. Valuable observations have been reinforced so as to strengthen the basis of this study. Weaknesses are assessed with a view to highlighting areas in which the present study could make new contributions and where possible, fill in the identified gaps.

THEORETICAL BASES

Baransky (1959) discusses the Soviet approach to geographic evaluation and concludes that geographical phenomena should not be evaluated in metaphysical terms or isolated from world events. Geography must be approached in a dialectical manner by linking its elements to the state of technology, production conditions and the entire socio-historical situation of a particular country at a particular stage in its development. Such a holistic approach to research in geography is desirable but exceeds the scope of the temporal and monetary limitations of this study.

Hay (1973) suggests that the quantitative-qualitative approach to studies in transport geography is dehumanised in its academic form. In an applied form, it becomes a device used by planners to preserve systems that are basically inhuman. He favours the analysis of interconnections between a transport system and its related socio-economic conditions. Such a research framework is likely to produce comprehensive findings. This study is guided by such a research framework.

Ullman (1956) attempts to establish a broad based theoretical approach to transport studies. He postulates a three factor typology that seeks to account for variations in spatial linkages between places, namely; complementarity, transferability and intervening opportunity.

The complementarity concept is based on the spatial variation in the availability of resources and reflects the spirit of the principle of comparative advantage that is held by economists. Resources are not available everywhere in uniform quantities. Areas tend to produce a surplus of what they have in abundance and exchange it for what they lack. As a result, a series of complementary locations causes spatial interaction by facilitating trade in their respective commodities.

Transferability refers to the effective ability to move or interact in space. It is affected by the quality of the medium of transportation and the type of commodity being moved. The concept suggests that interaction tends to be highest where least effort is used. This concept acknowledges the fact that interaction depends on available infrastructure and the commodity being moved.

The concept of intervening opportunity is based on the relative location of the places generating traffic. The concept suggests that interaction tends to be highest when the interacting pair of places are close and there is no nearby substitute. The influence of intervening opportunities on traffic density is not easy to measure. Accurate estimates of the amount of traffic diverted as a result of intervening opportunity are difficult to make. The concept of intervening opportunities appears to be paradoxical and reflects a negative factor of spatial interaction in a positive manner. Careful analysis reveals that a series of intervening opportunities can in a step-wise manner lead to the emergence of traffic serving far-flung areas.

The gravity model is a simplistic device whose structure parallels certain real life conditions. It is often assumed to equal reality and therefore truly explanatory (Hurst, 1974). The model provides a fundamental theoretical base for analysing movement but is no longer widely used. It creates a deterministic framework in which movement is always to the nearest area, based on a thoroughly rational behaviour and minimised external influences. Thus, its structure comprise utopian conditions which do not by themselves govern spatial interaction in real life.

The gravity model does not state why variations in spatial interaction occur. It is herein used as a device for analysing the relationship between traffic flow volumes and the distance covered as a guide for identifying factors which may account for the current structure of Kenya's railway network.

Kohl, J.G. (1850)[1] develops a transport network with a series of branch routes that serve settlements in an ideal city region (figure 2a). Almost a century later, Christaller (1933) discusses the traffic principle of his central place theory and develops the model in figure 2b. Kohl and Christaller make similar observations, notably; there exists a hierarchical order of transport routes, routes in a transport network branch off in a manner similar to a river network, and the angle of branching is closely associated to the direction and volume of traffic. Christaller suggests further that as many small centres as possible should lie on the traffic routes between large towns. Thus, the K=4[2] hierarchy of central places is formed. Higher order central places serve adjacent lower order central places by

1 See Haggett, P., 1972:335.

2 K is a constant that refers to the number of places served by a certain central place. In this case, the K constant consists of a high order central place and three of its adjacent lower order central places.

dominating three of the nearer lower order neighbours or by sharing them with other central places of their order.

These are observations of pioneer location theorists who paid little attention to transportation *per se*. They are based on unrealistic ideal conditions of classical times, notably; an isotropic surface, equal accessibility to/from all directions, equal soil fertility and an evenly distributed population. Modern transport networks have evolved from several interrelated variables. Kohl and Christaller fail to recognise the fact that transport routes sometimes by-pass urban centres.

The observation that routes in a transport network branch in a manner similar to a river network is applicable to a railway network. Railways do not have right angle branch routes as is the case with road transport. The angle of railway junctions often suggests the direction of traffic flow. This study attempts to verify these observations in the context of Kenya's railway network.

Lösch (1940) develops Christaller's model by suggesting the use of hexagonal market areas. He extends market areas to higher orders by superimposing all market areas on a common central place then rotating them so that the greatest number of higher order central places coincide. This arrangement seeks to minimise the aggregate distance between industrial locations, their shipments and the number of transport routes. Lösch ends up conceptualising the transport network shown in figure 2c.

Lösch's model is based on abstract ideas which are academically relevant but do not reflect real life conditions. By superimposing all market areas on a common central place then rotating them so that the greatest number of higher order central places coincide, he implies that in real life, some market centres have to be relocated so as to fit into his model. The high cost and inconvenience of such an undertaking make it not feasible on a national scale. Lösch's model is thus used as a guide to theory building.

Lösch[3] considers the problem of selecting the cheapest transport route between two points lying in regions with different but internally homogeneous transport costs. He uses the sine law to generate suitable locations of railway stations (junctions and points of interchange) and derives the model presented in figure 1.

Regions A and B have different transport costs, f_a and f_b respectively. Lösch suggests that the least cost route is the one whose ratio of the sines of angles α and β is equal to the ratio of costs f_a and f_b. This least cost solution is analogous to the law of refraction which describes the path taken by a ray of light moving from a dense to a less medium and *vise versa*. The number of possible locations which satisfy this approach are numerous. The derived solution is obtained from the following mathematical formula:

$$T = f_a(X^2+Z^2)^{\frac{1}{2}}+f_b[Y^2+(Z+z)^2]^{\frac{1}{2}} \quad \ldots\ldots \quad (1.1)$$

Formula 1.1 has been empirically tested and modified to:

$$0 = 0.5f_a(X^2+Z^2)^{-\frac{1}{2}}(Z^2)+0.5f_b(Y^2+Z^2+z^2)^{\frac{1}{2}}(Z^2-2Z) \quad \ldots\ldots \quad (1.2)$$

Where: T and 0 - least transport cost,
x - shortest distance from the origin to the railway,
Y - shortest distance from the destination to the railway,
z - distance from first junction to the next optimal location of the station,
f_a - transport costs in region A,
f_b - transport costs in region B.

Equation 1.2 can be solved for z if given the values of f_a,f_b, x, Y and Z.

3 See Hay, A., 1973:68.

Lösch's least cost transport route is derived from an extremely theoretical model that is scientifically consistent but of minimal application to social, economic and political considerations. He does not incorporate elements of decision making processes which influence transport investment. The model zealously relies on the classical economic assumption that consumers are rational and always seek to minimise costs. The assumption neglects the influence of physical constraints to route alignment.

Isard (1956:272) improved Lösch's model (figure 2d) such that the size of market areas is inversely proportional to the distance from the core and transport routes. Market areas are six sided but differ in shape and size. Isard recognises the fact that economic activities occur in a time space continuum. He finds it imperative for one to think in terms of the influence of transport so as to fully comprehend the significance of space in totality. He discusses the joint influence of transport, labour, raw materials and capital on industrial location and suggests that when more transport inputs are utilised (profitably), the spatial extent of production is, in general, increased.

Isard's model is based on abstract economic ideas. He focuses too much attention on the shape of market areas and neglects the morphology of transport routes. He envisions straight line transport routes without considering the detouring effects of barriers. This study attempts to verify Isard's observation that size of market areas is inversely proportional to the distance from transport routes. This observation appears to suggest that there is a higher population density close to transport routes.

Rice (1987) contends that towns act like magnets which attract people and commodities. Thus, transport routes radiate from towns into surrounding peripheral areas. He suggests that the density of transport networks is directly proportional to the population served by a particular town. The transport network is used to move people and commodities to and from the town. Rice ends up conceptualising the communications model (figure 2e).

Rice's model is basic and simple. It suggests that raw materials from peripheral regions of one town are transported to another town and distributed to peripheral rural areas. The model is based on the flow of a single hypothetical commodity. It gives the false impression that commodities flow in one direction only. In real life, spatial inequality of resource endowment has resulted in places trading in different goods and services. The communications model is useful to the extent that it recognises the possibility that two or more modes of transportation may be used to transport the same consignment of goods. The model is used to analyse the relationship between railway and road transport services.

In most underdeveloped countries, railways and roads were built during the colonial period. Colonial transport networks are externally orientated and often designed to link inland production centres to coastal seaports. Taaffe, *et al.* (1963) discuss the expansion of transport networks in West Africa and formulate the model of a typical ideal sequence of the development of a transport network (figure 3). The model attempts to portray the relationship between transport networks and the size of several centres.

The model identifies six stages that form an ideal typical sequence of the development of a transport network. The initial stage occurs in the form of a coastline with scattered small centres and ports. These are small, relatively independent and have small hinterlands. The second stage becomes manifest with the emergence of routes from coastal ports and centres penetrating into the interior. Favoured ports are able to enlarge their hinterlands to the extent that they can consolidate traffic from neighbouring less favoured ones.

The third stage is characterised by the development of feeders. Long lines of penetration form major ports because trunk routes from which minor branch routes to nearby interior centres emerge. The fourth phase is characterised by the emergence of inter-connections. These result from the gradual linkage of intermediate coastal and inland centres by feeders.

The fifth stage is attained when the inter-connections are complete and form a network of transport routes. Throughout these phases, some centres increasingly expand their markets and grow to dominate others. The final stage is characterised by the emergence of trunk routes serving large centres. It is represented by figure 3f which depicts a fully developed transport network.

This model is unrealistic to the extent that in real life transport networks do not expand uniformly through space and time. The railway reached Kisumu in 1901 yet there are no branch lines serving the coastal belt nor does the network criss-cross as suggested by stages 5 and 6 (figure 3e and 3f). The model highlights the development of a road network. It is relevant to this study to the extent that it recognises the facts that:

i) Kenya's railway network originated from the coast.

ii) The building of the railway is historically and spatially related to the early expansion of urbanisation in the interior of Kenya.

The model is based on a hypothetical landscape. It overlooks the fact that transport routes can decline and disappear as new ones emerge. The model creates an erroneous impression that transport networks expand uniformly in time and space. Lack of a clear temporal dimension has made the model not to reflect the development of Kenya's static railway network.

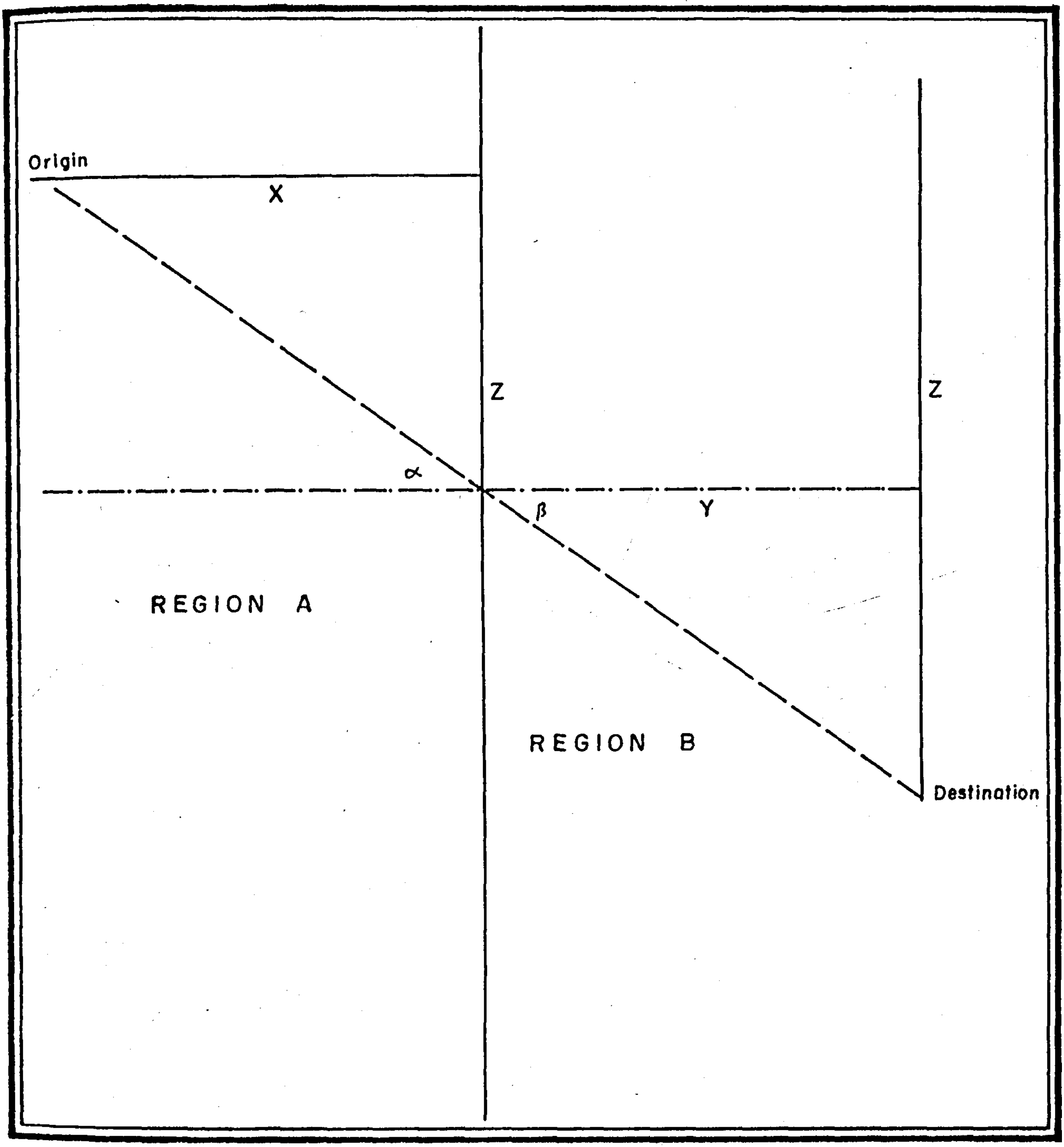

Fig. 1: LÖSCH'S LEAST COST TRANSPORT ROUTE

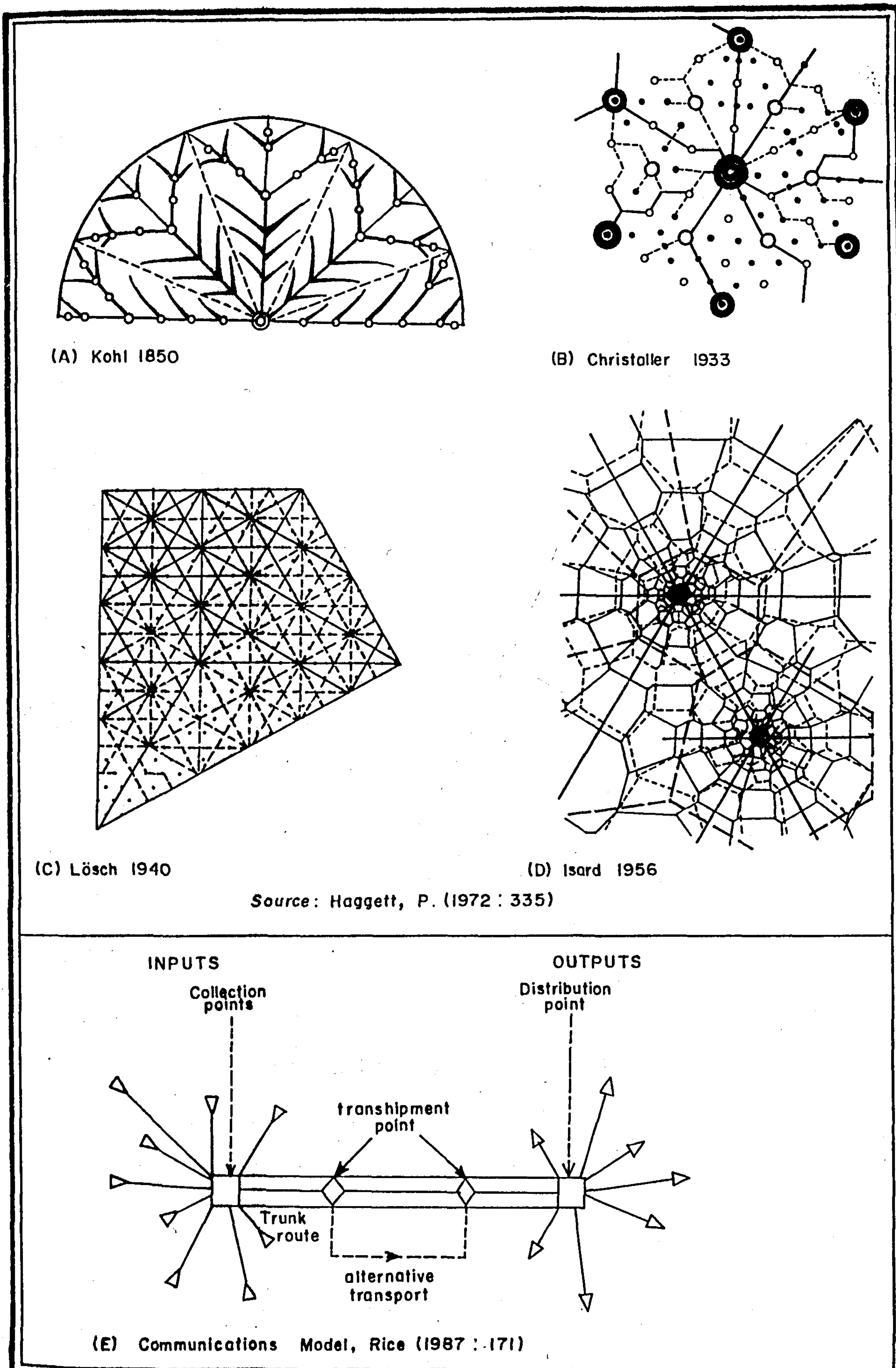

Fig. 2 : TRANSPORTATION MODELS

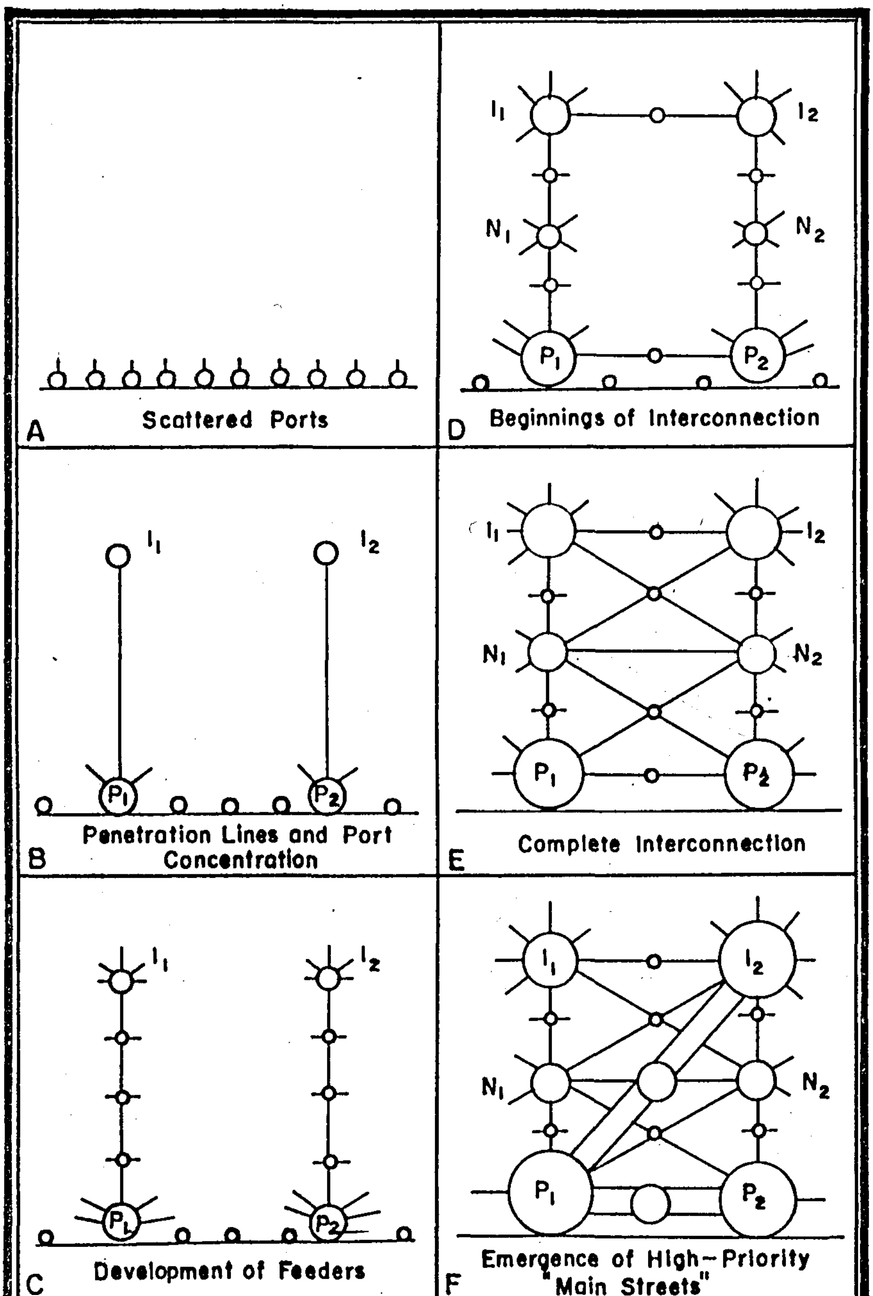

Fig. 3 : IDEAL-TYPICAL SEQUENCE OF TRANSPORT DEVELOPMENT

Source: Taeffe, R.L. , et al. 1963 – Transportation Expansion in Underdeveloped Countries, Geographical Review, Vol. 53, October 1963, pp. 504.

EMPIRICAL BASES

Changes in transport technology affect the spatial dimension of economic systems by changing the general level of intra- and inter-regional links. Lloyd and Dicken (1972) note that transportation improvements tend to be greatest in those areas and between places with considerable economic status. Such places generate a high level of demand for transport services and are most likely to effectively utilise such improvements. Less prosperous places tend to become increasingly isolated, in relative terms, as a result of the differential impact of innovations in transportation. This scenario suggests that the uneven improvement of transport facilities may increase polarisation effects in the economy. There is need to establish the relevance of these observations to Kenya.

Hofmeier (1973) contends that a transport system is not the only variable in the development process. It is an integral part of a country's infrastructure which affects all the decisive impulses that stimulate economic activity. Transportation is therefore one of the many ingredients necessary for accelerating the pace of economic activity. In most cases, it plays a leading role and sets the limits of economic progress. Transportation facilitates the exploitation of natural resources by overcoming the barrier of distance.

This is a sweeping generalisation of the collective role of all modes of transportation in national development. It does not indicate the specific contribution by each mode of transport and thus unable to establish their individual contribution to national development. This study deviates from excessive generalisation by attempting to establish the role of railway transport in Kenya's economic development.

Appleton (1976) observes that morphological analyses are indispensable parts of all sound geographical work, yet transport geographers have not been enthusiastic about such approaches. There has been no detailed geographical work which emphasises the formal shape and properties of transport routes. Most emphasis has been placed on their functional characteristics while their morphological features are taken for granted. Appleton points out that the morphology and function of transport systems do not necessarily lead to absolute correlations. The precise alignment of a transport route is decided on the basis of anticipated traffic (which might be right or wrong).

He conveniently avoids to discuss the fact that morphological analyses of transportation tend to be descriptive and exclude socio-political factors in the determination of the precise alignment of transport routes. He does not convincingly justify the necessity for morphological studies, which he admitted, do not necessarily lead to absolute correlations between the morphology and function of transport routes.

The provision of a transport infrastructure may give a place (region) advantages that advance polarisation effects. Soja (1968:16) notes that the *Mombasa-Buganda* axis became the major artery of communication in the whole of East Africa after the building of the *Uganda Railway*[1] superseding, up to today the *Zanzibar-Bagamoyo-Tabora* axis. This idea is also discussed by Irandu (1982) when he observes that the building of the *Uganda Railway* was responsible for the emergence of Mombasa as a leading urban centre along the East African coast towards the end of the 19th century.

Irandu further notes that the *Uganda Railway* revolutionised economic activities in East Africa, drastically reduced transport costs

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1 *Uganda Railway* was the initial name given to the railway from Mombasa to Kisumu.

and eliminated human porterage[5] and enlarged Mombasa's hinterland. Zanzibar, the then leading regional commercial centre, began to decline in importance as the railway re-orientated the then existing trade pattern. This observation does not highlight the value of the railway to Kenya's economy. The observation has a localised basis and concentrates on the influence of the railway to the growth of Mombasa town in isolation. This study examines the spatial patterns related to the railway with a view to assessing their polarising (or otherwise) effects on a nationwide scale.

Taaffe (1960) discusses the role of railway transport in the transformation of one of the outlying areas in the Soviet Union into a zone of specialised economic activity. He observes that the addition of a dynamic element to static patterns of distribution adds a perspective which leads to a better understanding of a particular region and how it relates to the rest of the nation. This gives a deeper meaning to the patterns of inter-regional traffic flows.

Taaffe's observation is not universally significant. The Soviet case includes three unique factors, namely; a nation of vast dimensions, a large proportion of the nation experiences very harsh environmental conditions that inhibit the development of surface transport and it was then a command economy. These unique conditions are so different from the Kenyan situation and thus arise the need for a local based study.

Shortly after the *October Revolution* which initiated a command economy, the Soviet Union abandoned the western idea that transport is an essential stimulant to regional economic development. Transport

5 Human porterage is the most expensive mode of overland transport (especially when long distance bulky goods are involved) both in monetary and temporal costs. It was the dominant mode of overland transportation in East Africa by then.

was henceforth seen as a support service to an existing economy. The Soviet Union thus begun to implement development policies that were designed to exploit capital already invested in transportation and to plan transport expansions within the broader framework of socio-economic planning.

Hunter (1965) uses the Soviet experience to study the role of transport in the development process. He concludes that transport facilities are a concomitant to and not a pre-condition to economic development. This observation seems to be appropriate to the then planned Soviet economy in which resource exploitation and investment decisions were made by public institutions. This study attempts to establish the relevance of the Soviet experience to Kenya's railway transport network.

The building of the *Uganda Railway* was based on military, political and philanthropic reasons more than commercial gains. Kenya was regarded to be a track of land that had to be traversed before the railway reached Lake Victoria.[6] The railway was initially not intended to serve Kenya. Colonial authorities realised later on that Kenya's traffic was needed so as to make the railway operate profitably and thus avoid being a financial liability.

Historical evidence suggests that there is a direct causal relationship between the building of the *Uganda Railway* and the development of a commercial economy in Kenya. Bhatt (1966) notes that railway construction was the most revolutionary action by the colonial powers. Ogonda (1986) points out that transportation is one of the key inter-related factors that stimulate and/or support development programmes. Ogonda makes a passive reference to

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6 Lake Victoria was not part of Kenya when the railway reached Kisumu (Port Florence).

Kenya's railway transport services while focusing too much attention on the historical development of Kenya's road network. This study augments Ogonda's work by focussing attention on the role of railway transport in Kenya's development process and discussing the coexistence of rail and road transport services.

Van Dongen (1954) discusses Bowman's law of *effective economic limit*[7] with respect to the East African transportation complex. She suggests that transport costs impose an effective economic distance within which producers can transport their commodities for sale at a profitable price. Thus, transport costs determine the kind of goods that are made available for intra- and inter-regional sale at a profitable price. Commodities with a high intrinsic value relative to weight, say manufactured goods, can be marketed over long distances. Van Dongen's study is outdated, broad and covers all modes of transportation in East Africa by them. It is concerned more with the effects of economic activities on the transport pattern rather than the reverse. Her study pays little attention to the role of branch railways in Kenya's economic progress. This study attempts to update her views from a geographical perspective.

The development of transport facilities is often recommended as one way of alleviating the development problems of the less developed countries, especially those with unevenly distributed economic development projects like Kenya. Macharia (1966) suggests that the building of branch railways to *backward* areas can hamper their envisaged development. This opinion appears to contradict the western view which holds that an effective transport system is a

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7 Isaiah Bowman uses this term in his work "The Pioneer Fringe" (AGS Special Publications No. 13) New York: American Association of Geographers. He suggests that transport costs and the price of a commodity determine where it will be marketed.

pre-requisite for extensive economic growth. Macharia suggests that the *Uganda Railway* and climatic conditions were jointly responsible for Kenya's agricultural transformation in the 20^{th} century. He backs these observation by noting that there were no white settler farms along the first 402km of the railway from Mombasa.

This study adapts a different interpretation of available historical evidence. The *Uganda Railway* preceded the arrival of settler farmers who transformed Kenya's agricultural sector. Thus, whereas physical factors (including climatic conditions) have been relatively constant, the building of the *Uganda Railway* is historically related to the transformation of Kenya's agriculture. The *Uganda Railway opened-up* Kenya's interior. Subsequent branch lines were built at a time when road construction (to feed the railway) was beginning and as such had little *opening-up* effects. The issue is therefore whether new branch lines significantly influenced regional economic activities in Kenya.

O'Connor (1965) observes that the acreage of cultivated land in areas served by branch lines increased by a considerable margin during and/or soon after their construction. The railway was extended to Kitale in 1926. Between 1924 and 1927, cultivated land in Trans Nzoia district rose from 90,000 to 195,000 hectares. By 1930, it was 268,000 hectares. The cultivated land in Nyeri district rose from 192,000 to 352,000 hectares during the expansion of the Nairobi-Nanyuki branch line. Macharia (1966) also discusses these lines and notes that *"... these lines literally opened-up the Kenya highlands and, as far as Kenya is concerned, it seems as if the opening-up era ended with them."*

New railway routes can no longer *open-up* remote regions because they are already served by the more flexible and extensive road transport network. The gist of O'Connor and Macharia's views seems to be that railways are built in an attempt to gain access to inaccessible territories. This poses the following questions:

- Is the *opening-up* of territories the prime goal in railway building?
- If so, is the railway age in Kenya gone?

This work attempts to empirically verify Macharia's view that new railway branch lines to *backward* area will hamper their envisaged development. The study also seeks to establish whether the main function of a railway is to *open-up* inaccessible territories.

Hazelwood (1964) examines the coexistence of road and rail services in East Africa. He suggests that the railways experience financial problems caused by the loss of freight and passengers to road transport. He does not back these observations with factual data. His argument suggests that the coexistence of rail and road transport services ultimately leads to destructive competition. This approach overlooks the fact that railway and road transport services can coexist in a harmonious framework.

Bhatt (1966) is also of the opinion that road transport competes against the railway in a destructive manner. He points out that the newly bitumenised roads in Kenya lead to increased competition from bus services whereby causing the decline of railway passenger traffic. This work attempts to analyse, in detail, the relationship between rail and road transport services from a geographical perspective.

Owen (1968) discusses the relationship between rail and road transport in India. He concludes that the expansion of roads is not always detrimental to railway interests. Roads play a leading role in the expansion of agricultural, industrial and mining activities by making new areas accessible and thus create new economic opportunities. These factors result in increased traffic which also benefits the railway. Owen does not indicate the proportional distribution of traffic between railways and roads, but incorporates a clear spatial dimension of the coexistence between railway and road transport services. Bhatt (1966) also shares this school of thought and suggests that it was only after independence that the urgency to construct a network of country roads in Kenya was realised. These roads were meant to rehabilitate Africans and provide an economic base upon which they would improve their situation by making it possible for them to bring their agricultural produce to the market. Bhatt merely recognises the role of road transport but does not discuss its relationship to railway transport. This study adapts Owen's approach by relating his observations to Kenya with a view to establishing the distribution of traffic between railways and roads and incorporate a clear spatial dimension of the coexistence between rail and road transport services in Kenya.

Transport has often been seen to play a central and causal role in economic growth and development in general. de Neufville, *et al.* (1973) question this belief and suggest that transport is merely another industry which should be justified in a manner similar to other forms of economic activity and capital formation. They argue that the role of transportation in economic growth is similarly not unique. Transport investment is no more an initiator of growth than any other form of investment or deliberate policy. They proceed to indicate that under certain conditions, transport may turn out to be strategic, although the same can be said of any other specific investment policy. They view the lack or availability of transport facilities as an important factor in development, though in a permissive role. The existence of adequate transport capacity is a necessary but not sufficient condition for stimulating economic growth and activity. These cautious remarks emphasise the complementary role of transport on economic growth and development.

They are in part a reaction to theories that stress the need to develop transport infrastructure.

Verberckt (1987) suggests that environmental issues do not influence modal choice in passenger transport. He identifies speed, frequency of service, costs, comfort and accessibility to a place as the major determinants of modal choice in passenger transport. He further suggests that railway transport is the most environment friendly mode of transportation, yet, as long as an economic system allows people to freely choose a mode of transport, only a marginal proportion of them will voluntarily use trains in the interest of the environment.

Verberckt does not discuss the role of pro-environment legislation in curtailing the supply of other modes of transport and thus encourage passengers to switch to railway transport. He also appears to have found it convenient to ignore the fact that freight services constitute the majority of railway services and whether cargo shippers have environmental considerations while choosing a mode of transportation. His observation is based on urban commuter traffic which can, in a large city, seriously degrade the environment. Thus, he praises the railway which, in addition to generating minimal pollution, occupies a very narrow space compared to roads. Verberckt's observations do not feature prominently on a national scale such as the scope of this work.

1.3 JUSTIFICATION

Railway transport is the dominant mode of mass transportation in kenya whose primary task is to provide low cost mass transport services. This study focuses attention towards this end by looking into how the railway is a national instrument for redistributing people and commodities *en masse*.

The importance of an integrated transport system favour broad-based transport studies. Macro-scale analyses based on general and universal measurement criteria provide sufficient techniques for assessing national mobility levels. Kenya's railway network lends itself admirably well to a study of the multifaceted relationship between spatial interaction and development.

Future transport needs require the ability to envision and construct comprehensive solutions. This study discusses some broad perspectives for identifying and interrelating transport problems with a view to formulating solutions at the national level. Planners are exposed to some of the basic factors that underlie transport problems and alternative approaches to policy goals.

Whereas no country has completely solved the many complex issues that arise from the formulation of a comprehensive transport policy, Kenya lacks a formal transport policy. The government tends to concentrate too much attention on settling disputes among transporters rather than take advantage of that ability of transportation to enhance economic well being. This work attempts to provide a base upon which an institutionalised, comprehensive and long lasting transport policy that is consistent with broader national interests may be formulated. Special attention is given to the directions in which such a national transport policy should move so as to adequately support national goals.

Changes in transportation affect relationships in space and the degree of specialisation in human activities. Traffic flows indicate the degree of spatial interaction which is a basic measure of spatial differentiation. The efficiency of a transport system is therefore a surrogate measure of the level of socio-economic development. Spatial differences attributed to Kenya's railway network are herein analysed in terms of; effects on by-passed areas, effect on effectively linked places and overall relationship to the location of economic activity in Kenya.

Railway transport is the oldest contemporary mode of transportation in Kenya. It began to loose the monopoly of business in its area of operation in the 1930s when competition in the national transport market emerged with the onset of road expansions. This was the period when railway expansion in Kenya came to an end. A study seeking to establish the contemporary status of the railway *vis-a-vis* road transport in Kenya is thus made worth-while.

Apart from historical monographs, the literature on Kenya's railway transport is inadequate, general and fragmented. There has been no clear attempt to establish the relationship between Kenya's railway network and national economic development. This condition has persisted despite the fact that the railway has to a large extent been responsible for Kenya's economic transformation in the 20th century. A geographical investigation into some issues of railway transport in Kenya is thus made worth-while. In this respect, this study provides an academic forum for conducting a geographical analysis of Kenya's railway network.

This study is inspired by:

i) The desire to understand how Kenya's railway network relates to the national economy.

ii) The need to find out whether the railway generates distinct spatial patterns, has a polarising effect and account for the existence of such patterns.

iii) The desire to understand how the introduction and improvement of alternative modes of transportation relate to the competitive position of railway transport in Kenya.

1.4 OBJECTIVES OF THE STUDY

The overall objective of this study is to analyse the significance of railway transport in Kenya from a spatial perspective. The component objectives are:-

i) To determine the empirical estimates of the distance decay effect [the distance decay exponent (d^{-b})] on movement capacity. This objective seeks to establish the relationship between the railway and resource distribution. It focuses attention on the:
   - polarising or depolarising effect of the railway network,
   - location of major economic activities *vis-a-vis* the railway network, and
   - gravity model as a tool for predicting the volume of railway traffic.

ii) To establish the relationship between the railway and levels of economic development. This objective seeks to find out if Kenya's railway network creates distinct spatial patterns. It involves the analysis of:
   - types of commodities transported by rail in Kenya,
   - volume of traffic flows along the network, and
   - major commodities transported by rail in Kenya.

iii) To establish the relationship between rail and road transport services in Kenya. This objective focuses attention on the coexistence of rail and road services in Kenya by examining the following:
   - roads parallel to the railway network,
   - roads feeding the railway, and
   - innate characteristics of railway and road transport services.

1.5 HYPOTHESES

1 H_0 Railway traffic does not decline significantly as distance increases.

H_1 Alternative

2 H_0 There is no significant relationship between the location of major economic activities in Kenya and the railway network.

H_1 Alternative

3 H_0 Kenya's railway services are not significantly influenced by the presence of alternative modes of transport.

H_1 Alternative

1.6 THE CONCEPTUAL FRAMEWORK

The terms and concepts discussed below are used consistently throughout this text. Their use in ordinary language or any other contexts may vary significantly from these definitions and discussions. They are defined and discussed in a manner that reflects their intended meaning in the context of this work.

OPERATIONAL DEFINITIONS

Accessibility: This is the opportunity available to an individual to easily reach particular events and destinations.

Block System: This is a system of line use in which railway tracks are divided into sections called blocks. Only one train/motorised trolley is permitted in any one section at a time. Access to a block is gained by the receipt of a token (for a train) or key (for a motorised trolley) upon entrance into the block. The blocks comprise sections between two stations or passing loops.

Demurrage Charges: These are charges levied against goods left in train wagons serving as a kind of auxiliary warehouses at crowded plants. The charges are intended to encourage prompt unloading of train wagons.

Discrimination: This is a form of regulation that is designed to protect sectors of a given business line. In railway transport, discrimination includes; different tariffs for different routes, sectors, clients and directions enabling the railway to exclusively haul certain goods.

Geographical Inertia: This is the tendency of human activities to remain and/or continue to accumulate at a given location or site after the conditions that initially attracted them have appreciably ceased to exist.

Marshalling Yard: This is a place with a system of railway tracks usually near a railway station or terminus. It is designed to enable the systematic assembly of coaches and wagons to the same destination into single train units.

Network: The term network is herein used in reference to a set of interlinked routes that criss-cross and intersect in a manner that forms a grid pattern similar to the mesh of a net.

Node: This is a topological point of intersection and/or termination of a route. It may have an actual settlement such as Gilgil and Nanyuki along Kenya's railway network. A node may also be dummy and lack an actual settlement such as the railway junction to Kitale after Eldoret.

Pick-up Train: This is a special train that collects and delivers small quantity loose cargo from wayside stations normally on a weekly basis. It also offers shunting services at such stations.

Public Line: This is a small railway loop that normally leads to the goods shed at a railway station. It is intended for use by individuals and firms lacking a railway siding at their premises.

Regulation: This is a set of laws that govern the business practice and technical standards to be observed by all members of a given profession. Railway regulation include: entry into the business, carrying capacity, tariff control and train scheduling.

Rolling Stock: This is a collective term comprising all wheeled vehicles, namely: locomotives, wagons and coaches belonging to a railway organisation.

Siding: This is a railway extension from a station and/or branch line to a specific site.

Spatial Interaction: This is the movement, contact, relationship and linkage between points in space. It is manifested through the movement of people, commodities, energy and information between places.

Tariffs: These are published schedules of routes, rates and information issued by a transport firm and filed with a public regulatory body. The tariffs state the rates charged by the transport firm for the services rendered.

Transport: This is the process of moving people, messages and/or commodities from place to place.

Waybill: This is a document prepared by *Kenya Railways* which bears a description of what is being transported in the goods wagons, notably: names and addresses of senders and receivers; origin, route and destination of the consignment and the transportation charges.

Wayside Station: This is a railway station located along a major railway section. The station may be located between major origin and destination stations such as Mombasa and Nairobi or along branch routes such as between Nakuru and Kisumu.

Most wayside stations are primarily intended to facilitate train by-pass and overtaking.

OPERATIONAL CONCEPTS

Accessibility

Accessibility refers to the availability of a transport service between two or more places and is not necessarily equivalent to traffic volume. Accessibility reflects the possibility to move, the potential of a connection and the ease of an interchange rather than the actual trip to or from a given place. Therefore, accessibility fosters trips but does not necessarily cause them.

The degree with which a place is accessible depends on who, what and how much can move or when such movements can occur. Accessibility may be measured in terms of; the duration of a transport service, transport costs and the location of a mode of transportation. All factors influencing the decision to or not to transport affect the degree by which a place is accessible.

To many planners, the accessibility that a transport system provides in a region appears to be unspecified, too undefined and lacking in immediacy to be seriously taken into account. This is a cardinal error in most national transport plans. The accessibility concept can be used to create development stimuli for various parts of regions, provide essential services to low income areas, and improve community organisation and cohesion.

Complementarity

This concept was postulated by Ullman (1965) when he summarised the gravity model into a triad. It is based on the traditional belief that the spatial interaction occurs because of areal differentiation. The concept suggests that in order for movement to occur between two places, there must be a demand in one place and a complementary supply by the other. Complementarity is therefore the initial stimulus for an interaction to system to occur in space. It facilitates the emergence of transport routes.

Intervening Opportunity

The concept of intervening opportunity suggests that complementarity between two places will generate interaction only if there are no intervening opportunities. Intervening opportunities are alternative sources of supply or demand for goods and services. In special cases, a series of intervening opportunities can help to link distant complementary places. This occurs when a series of intervening opportunities enable the step-wise construction of a transport route that eventually links distant complementary places.

Transferability

The concept of transferability completes Ullman's triad. It refers to the ability to overcome distance. This concept recognises the fact that interaction in space is not based on complementarity and lack of intervening opportunities alone. The ease of transportation in terms of time, money, costs, safety, pilferage and comfort also determine whether or not there will be interaction in space. Thus, distance measured in real terms of time and money is the final barrier to movement in space.

Movement will occur between two places after the conditions of the complementarity, intervening opportunities and transferability concepts have been satisfied. There will be no movement if any of these three concepts is not satisfied.

System

This is a set of phenomena that form an organised complex of related elements. A system comprise sets of; fixed elements and connections between elements and their environment. The basic features of a system are its structure, function and development. The structure of a system is the sum of all its elements and connections between them. Function(s) comprise all changes in the structure of the system in time and space. The complex interrelationship between the elements that comprise the transport system make the systems approach basic to transport studies.

Of all the infrastructure sub-systems, transportation is the most difficult to isolate, in a descriptive or normative sense, from the surrounding context of all the other subsystems that it guides and serves. Figure 4 represents a conceptual model of the link between social, economic and environmental systems. Political and cultural systems are included in the social system.

THE CONCEPTUAL MODEL

The broad conceptual background to this study is based on a systematic model of an efficient, specialised and integrated railway network. It is based on the proposition that the various overland modes of transportation should specialise in transport services that are most suitable to them. The conceptual model (figure 4) attempts to define a theoretical framework in which societal, environmental and economic values relate to the railway. National goals and objectives seem to be the pivot upon which the four systems act in an attempt to achieve some desired spatial development structure.

The model suggests that social, economic and environmental factors affect the accessibility of a place. The transport system is understood to be important to the extent that it limits the amount of traffic needed to achieve desired goals. Social and economic systems are considered to be of secondary value because they determine the potential to transport (demand for transport services). The social system comprise a set of cultural, political and religious values which influence individual perceptions and priorities. The economic system seeks to avoid financial loses, maximise material benefits and enhance national economic stability. The environmental system is included in an attempt to emphasise the role of physical checks and balances to the operation of a transport system. It imposes restrictions that favour pollution-free modes of transportation, compatible land-use and uncongested transport networks.

These systems are so intertwined that their interrelationships have been simplified in order to avoid multicorrelations. The model is based on how Kenya's railway network relates to the other systems individually. The joint influence of any combination of the social, economic and environmental systems upon the transport system is thus omitted.

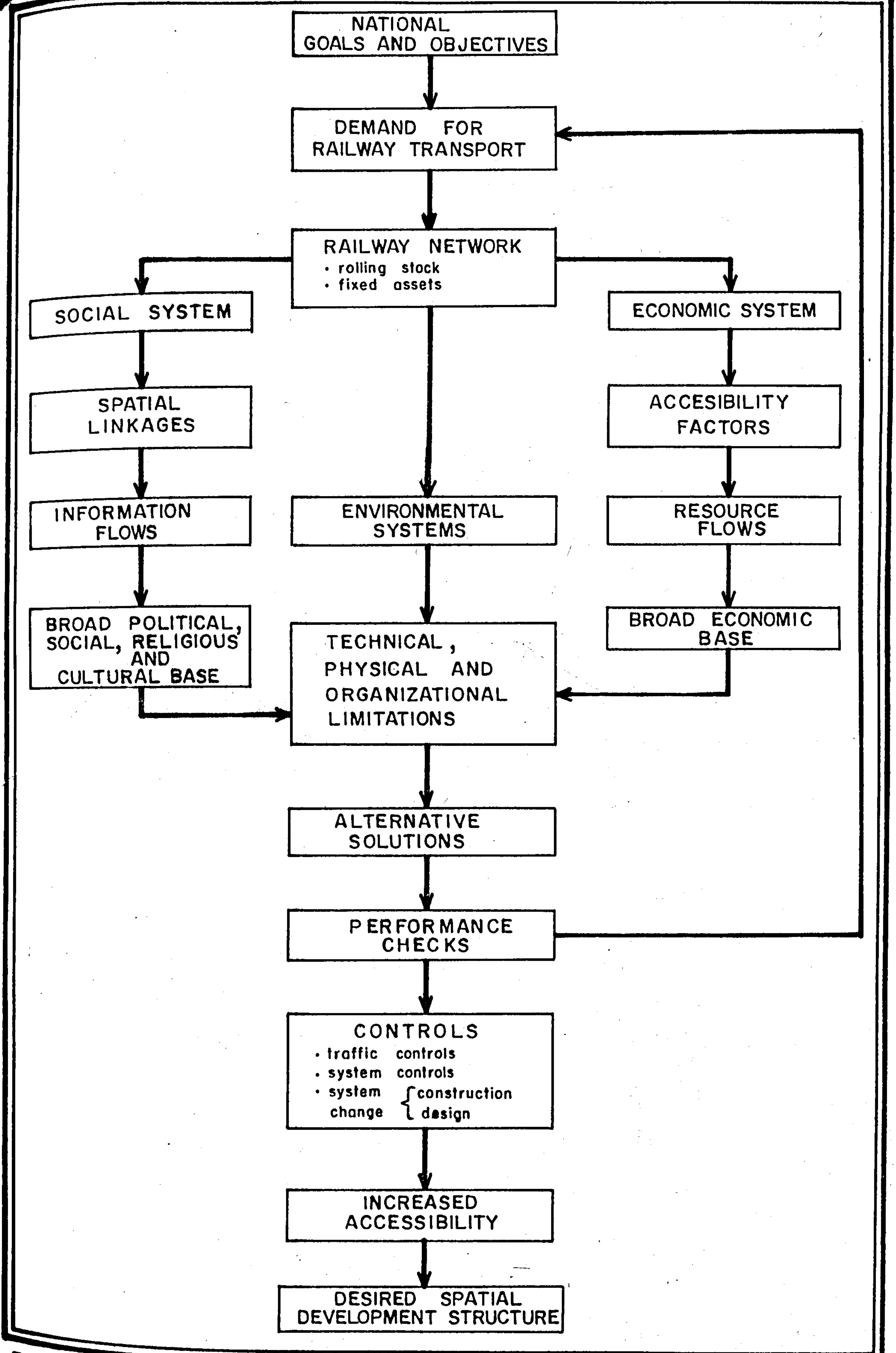

Fig. 4 : THE CONCEPTUAL MODEL : AN IDEAL RAILWAY TRANSPORT SYSTEM

CHAPTER TWO

THE STUDY AREA

2.0 INTRODUCTION

This chapter highlights some of the salient forces that are responsible for the current pattern of railway services in Kenya. Kenya's railway transport is seen to have evolved from a complex interaction of geographical phenomena, economic conditions, historical events and political trends. The entire area of the Republic of Kenya is the object of this study.

2.1 GEOGRAPHICAL BACKGROUND

This section highlights salient geographical features that relate to Kenya's railway network. It seeks to demonstrate that transport networks are influenced by the geography of the area being served.

SIZE AND LOCATION OF THE STUDY AREA

Kenya occupies an area[8] of approximately 588,046 km^2 and is located on the Eastern seaboard of the African continent. The country is surrounded by; Somalia, Ethiopia, Sudan, Uganda, Tanzania and the Indian Ocean (map 1). Kenya is almost bisected by the equator and is enclosed by longitudes 34°00'E and 42°00'E, and latitudes 5°00'N and 4°30'S.

THE RELIEF OF THE STUDY AREA

Kenya has a wide variety of relief features which can be

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[8] Source: Measured by the researcher.

classified into two broad groups namely; highlands and lowlands. The 910m contour delimits the dome shaped highlands from the lowlands (map 2).

The highland area is almost bisected by the rift valley. It occupies the area between central Kenya and the western border of the country. The highlands are characterised by a rugged relief that is closely associated with volcanic activity, tectonic movements and dissection by rivers. The highlands to the East of the rift valley form a series of lava plateaus dotted with inselbergs. Western highlands have tors which merge into a plateau that extends into Uganda.

The highlands pose the greatest relief barrier to railway transport. Trains are very sensitive to gradient. Steep slopes and high altitude necessitate the use of a lot of locomotive energy for uphill train movement. The highest point on Kenya's railway network is 9,136 feet above sea level between Equator and Timboroa Stations. The traction capacity of locomotives is greatly affected by the ruling gradient of particular sectors. Several light locomotives are used in hilly sectors with low pound rails which cannot withstand heavy and powerful locomotives. Deeply dissected highlands need many bridges, slopes cut into and detours made in an effort to maintain a gradual gradient. Sharp bends have to be superelevated[9] so as to allow for higher speeds them.

The rift valley and its peripheral areas experience a few tremors annually. This poses a risk of frequent repairs of the railway in the event of tremors with strong seismic waves. The rift

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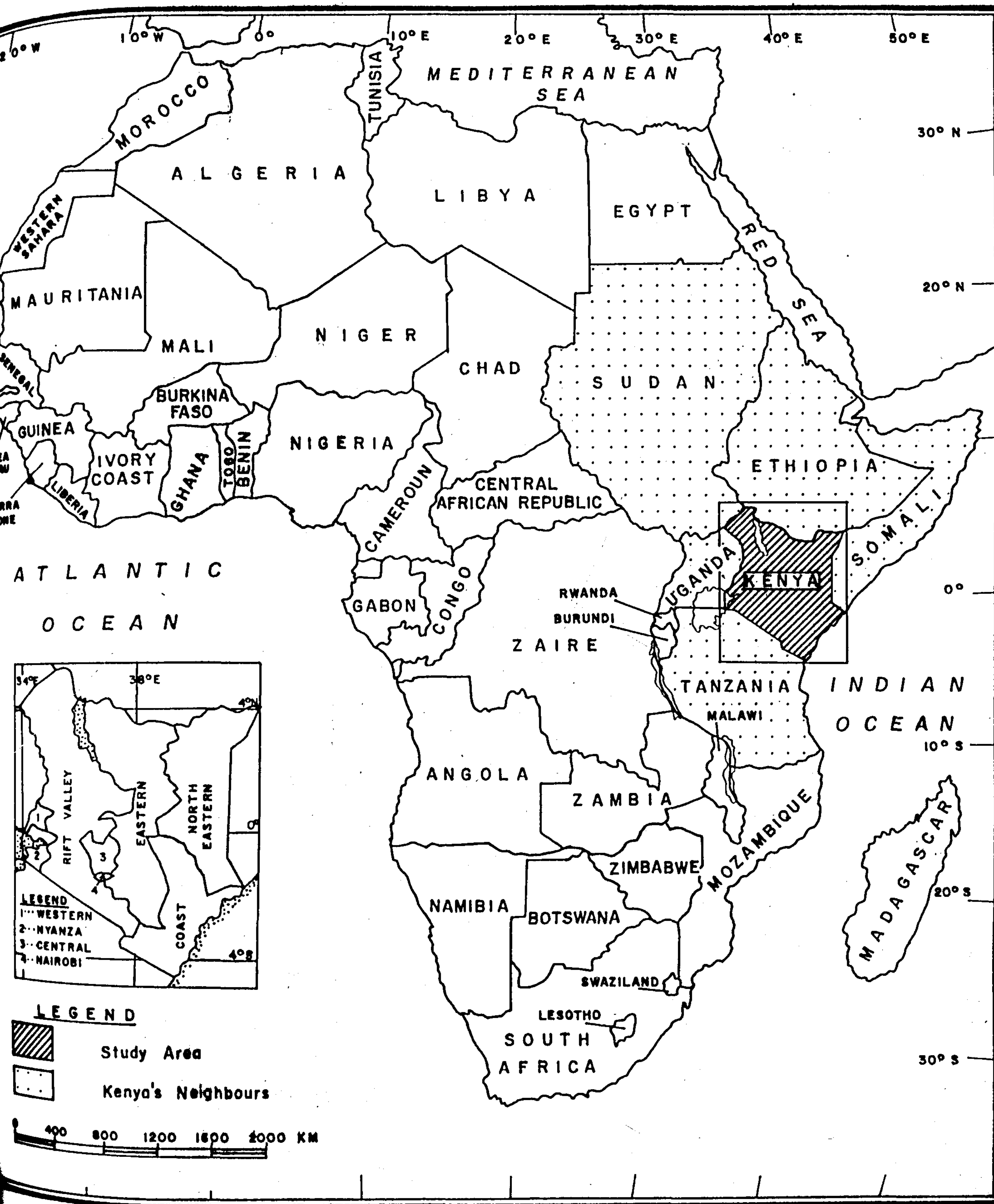
9 Superelevation is the raising of rails on the outside of bends higher than the inside so as to accommodate higher speeds around bends without external forces. This can cause the derailment of slow moving trains. It is suitable to fast moving passenger trains.



MAP 1 : THE STUDY AREA

valley is prone to frequent seismic activity. It has in the recent past experienced incidents of land subsidence and the emergence of underground rivers. This does not augur favourably for railway transport which uses heavy and slow moving locomotives.

Lowland areas form a series of low plateaus and plains that are often dotted with inselbergs. They are generally flat with gradual increase in altitude. This is an advantage that reduces railway construction costs. However, flat terrain is associated with poor drainage conditions. Thus flood waters can easily engulf the line during heavy rains. Such conditions have been experienced at Voi and resulted in train derailments.

CLIMATIC CONDITIONS

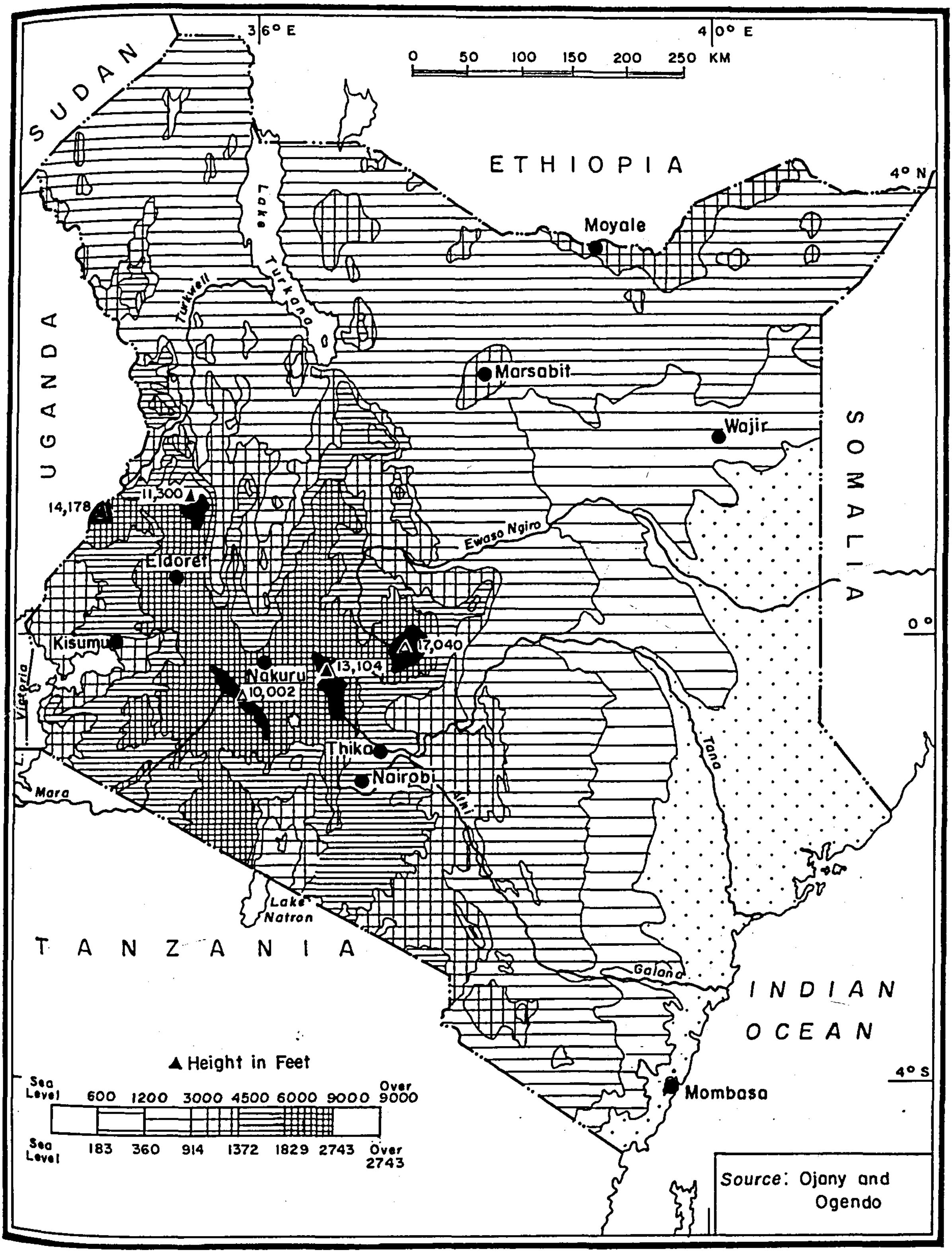
Kenya has tropical and equatorial climates which have been modified by relief and large water masses. Most of the country receives a lot of sunshine throughout the year. The small temperature range is an advantage in that the railway is not distorted by expansion and contraction resulting from rapid temperature changes.

High temperatures have a negative effect on the performance of engines. Engines operating in high temperature environments do not attain desired levels of thermodynamic efficiency because of low ambient temperatures. In such cases, the locomotives' power output is less than would have been at a lower temperature.

POPULATION DISTRIBUTION

In 1988[10], Kenya's population was estimated to be 22.7 million and a mean population density of 39 people/km^2. The population was

[10] Source: Africa Business, June 1988, No. 118.



MAP 2 : RELIEF OF THE STUDY AREA

estimated to be growing at a rate 3.8% *per annum* in 1987. This population is unevenly distributed and is dense around Lake Victoria, central Kenya and Coast Province.

The potential model suggests that the potential to transport is a function of the population of a place and its distance from all other places in the region. Areas with a high population density tend to have a higher demand for commodity and passenger movements than areas with a low population density. Incidentally, Kenya's railway network links densely populated areas that have the most productive agricultural land and the highest concentration of urban and industrial centres in Kenya.

2.2 ECONOMIC BACKGROUND

This section discusses the spatial relationship between transport and Kenya's economic setting. It suggests that the geographical basis of transportation underscores the uneven distribution of resources in space.

AGRICULTURE

Agriculture is the mainstay of the Kenyan economy. Over 80% of the people of Kenya depend on agriculture for their livelihood. The success of Kenya's agriculture is underscored by its ability to satisfy and maintain a basic self sufficiency in the food requirements of a rapidly increasing population. The sector also produces a surplus of exportable commodities which earn foreign exchange for the country.

Kenya's railway network serves high potential agricultural areas. It enables the speedy distribution of bulky consignments of fertilizers to centres that are close to farmers. The railway is also used to transport surplus produce to deficit areas or export outlets. Kenya's railway network is externally orientated. Thus, it is not possible to reach many places in Kenya by rail.

There is a small difference in the variety of regional agricultural produce. This situation violates the basic assumption of the complementarity concept. Most agricultural produce is thus consumed in their areas of production. Very few areas produce substantial surpluses of agricultural output. Thus it is common for a lot of produce to be consumed within their districts of production. The agricultural produce that is railed in Kenya include; maize, beans, rice, wheat, tea, coffee, sugar and pyrethrum.

MANUFACTURING

Kenya's manufacturing sector has established a remarkable growth record since 1963. It has increased its capacity to produce, absorb labour and in the diversity of its products. High levels of local and foreign investment, technology and entrepreneurial skills have been applied. The result has been a tremendous increase in the range of economic activities in urban centres such as Nairobi, Mombasa, Thika, Kisumu and Eldoret. Rural areas have also benefitted from the expansion of Kenya's manufacturing sector. Cash crop production has been promoted by the establishment of raw material orientated agricultural manufacturing industries.

The manufacturing sector increases the value of goods and thus enables them to have a large effective economic limit. The availability of a railway network serving manufacturing units enables them to transport their products *en masse*. Some of the manufactured goods that benefit from Kenya's railway network include; sugar, pulp and paper products, cement, salt and flour. The railway is also used to transport raw materials from Timboroa to the

Pan African Paper Mills factory at Webuye.

INFRASTRUCTURE

Kenya has an inadequate and unevenly distributed modern infrastructure. The government provides the bulk of the infrastructural facilities with the private sector making a small but significant contribution. Railway services have been operational in Kenya because of the availability of supporting facilities. *Kenya Railways* manages and maintains public railway facilities in Kenya. Private firms indirectly support railway services by building godowns for storing the freight hauled.

There are several rural access roads which feed the railway. These roads are continuously being upgraded. They are intended to increase the accessibility of railway stations and thus create conditions that favour increased railway traffic. However, the upgrading exercise has enhanced the competitive position of roads against the railway and restricted the railway's ability to attract and retain traffic.

INVISIBLE OUTPUT

Invisible output comprise all services with a monetary value but cannot be quantified in physical terms. Tourism is a renown invisible 'product'. Kenya is one of the few countries in the world whose wild animals are left to freely inhabit their natural habitat. 8%[11] of the total land area has been set aside for the conservation of indigenous *flora* and *fauna*. They are a major tourist attraction in Kenya today.

Kenya's railway network passes through a broad range of the

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11 See Mburugu,J.M. (1987:7).

country's scenic features. The line also passes through wildlife inhabited areas such as Tsavo East and West National Parks, Athi and Kapiti plains and the Gilgil-Naivasha area. Kenya's slow moving trains make the railway attractive to wonderlust tourism.[12] This has not been possible partially because passenger trains pass through scenic areas at night. *Kenya Railways* temporarily introduced an antique safari service using historic steam engine locomotives in 1987. It was intended to transport tourists between; Nairobi and Mombasa, and between Nairobi and Naivasha during the day. A weekend daytime deluxe train between Nairobi and Mombasa was temporarily operated during the course of conducting this study. The daytime deluxe train was intended to serve tourists.

Kenya's economic activities can theoretically be carried out in an enormous variety of places. The railway offers substantial opportunity for changing Kenya's space economy. This can be achieved by integrating railway and road transport services. The railway should dominate long distance bulk transportation while roads concentrate on local and feeder services.

2.3 HISTORICAL BACKGROUND

In 1884, the Imperial British East Africa (IBEA) company built the first railway in East Africa. This seven mile (11.263 km) tram way on Mombasa Island called the *Central African Railway* was soon uprooted. The Treaty of Berlin (1885) required that all European powers interested in Africa should show effective occupation of their respective spheres of influence. Building a railway was one way of doing this. Europeans begun to build railways from the coast to the

[12] Wanderlust tourism is the pleasure of watching the scenery go by as one travels.

interior of Africa.

Britain wanted to control Egypt because of the strategic location of the Suez canal. Controlling Egypt would enable the British to build a railway that would link the Mediterranean and Red Seas – a shorter sea route to India. The British realised that whoever controls the source of the Nile controls Egypt. Thus, there arose the need to build a railway to Uganda so as to put the source of the Nile under the British sphere of influence.

George Whitehouse, the chief engineer of the *Uganda Railway* and its first General Manager arrived in Mombasa on the 11th of December 1895. In August 1896, the Houses of Commons and Lords of the British Parliament passed the Uganda Railway Bill. Construction work began on the 5th of August 1896. Mombasa was selected as the origin because the deep Kilindini harbour could receive massive tonnages of building material and rolling stock, mainly from India.

The entire course of the intended route had a low population density and very few male adults capable of offering construction services. A large number of Asians were brought in 1896 to offer their labour in building the railway (figure 5). The one metre gauge was chosen because rolling stock was readily available from India.

Initial construction work was based on hasty surveys and laying a light railway which was washed away by flood waters as was the case when the railhead[13] reached Taru. Labour shortages, inadequate rolling stock, limited medical facilities and man-eating lions (between Voi and Makindu) reduced the pace of construction work. The railhead reached Nairobi in May 1899. The Mombasa-Nairobi line was opened to public use in August 1899 with the first

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13 A railhead is a terminus beyond which other means of transport must be used. It also refers to the furthest point where rails have been laid during construction.

official train (UR35) leaving Kilindini Station as Mombasa Station had not been built by then.

The escarpment, just beyond Nairobi, required great caution and ingenuity. It was soon overcome and the railhead reached Nakuru in 1900. By this time, an advance survey party had recommended a shorter route to Lake Victoria. Initially, it had been planned that the line would almost reach Mount Elgon before turning to Port Bunyala (Victoria) on Lake Victoria. The railway was now laid along the Mau escarpment to Kisumu (Port Florence) and reduced mileage by approximately 160km.

The stretch from Nakuru to Kisumu was temporarily interrupted by the Nandi resistance. On the 21st of December 1901, Florence Preston drove home the key in the last rail to mark the completion of the *Uganda Railway*. Although the railway had reached Kisumu, it still needed to be strengthened in some sections. Many sections were temporary, bridges had to be built, sidings laid out and quarters, workshops and water tanks put up at the stations. Thus, the effective building of the *Uganda Railway* was completed on the 17th of September 1904. It had been completed at the cost of £5,500,000 - almost double the initial estimates. The *Uganda Railway* had not been built so as to *open-up* Kenya. It was intended to link Lake Victoria (by then in Uganda) to Mombasa, a sea port.

Railway authorities soon realised that Uganda alone could not generate enough traffic to maintain the railway. The purveyors of the railway had to redeem themselves by making the railway pay for itself. White farmers were now encouraged to come and farm the fertile Kenya highlands within easy reach from the railway.

The 1902 boundary review placed all the land to the East of Lake Victoria under the jurisdiction of the then East African Protectorate (Kenya). In 1920, Kenya was declared a British Colony.

The *Uganda Railway* was confined to Kenyan territory until the extensions into Uganda were made. The name of the railway was officially changed to the *Kenya and Uganda Railway* on the 3rd of February 1926. The control, management and working of railway, port, harbour, wharf and steamship services were vested in the High Commission for Transport, Kenya Colony.

In 1948, *Kenya and Uganda Railways and Harbours* and *Tanganyika Railways and Harbours* were amalgamated to form the *East African Railways and Harbours.* In 1977, the East African Community disintegrated and the *East African Railways and Harbours* was dissolved. The *Kenya Railways Corporation* was formed and it still runs public railway services in Kenya. Kenya's railway network (see table 1) developed in the following manner:

i) 1912-1915: Magadi Soda Company builds the Konza-Magadi branch line.

ii) 1924: The Voi-Maktau-Taveta branch line was completed.

iii) 1926: The Nakuru-Eldoret-Kitale branch line was completed.

iv) 1926-1930: The Gilgil-Nyahururu and Rongai-Solai branch lines were built.

v) 1928: The Kisumu-Yala branch line was completed.

vi) 1930: The Nairobi-Nanyuki branch line was completed.

vii) 1931: The Yala-Butere extension was completed.

The extension to Uganda serves Turbo, Webuye, Sudi (Nzoia), Bungoma, Myanga and Malaba. The Voi-Taveta branch line was built during world war one to supply the forces countering an invading German army. Inter war expansions of the railway network were closely associated with the pattern of resettling ex-world war one soldiers from British dominions in Kenya. The railway network to date serves a different purpose from the 'official' reasons for its construction. Its structure still reflects a colonial legacy. It was

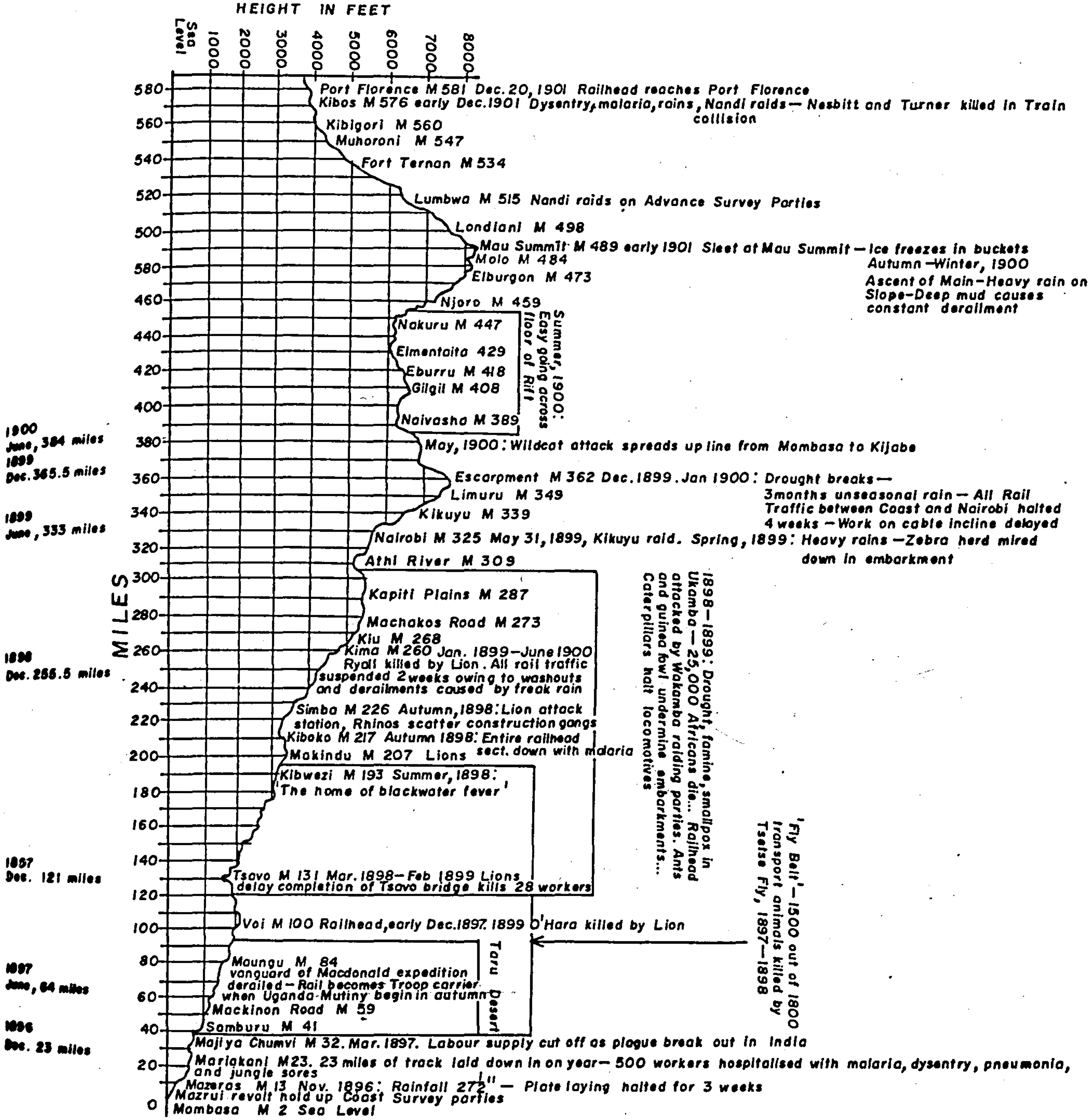

Fig. 5 : PROGRESS ON BUILDING THE 'UGANDA RAILWAY'

Source: Miller, C. (1971)

designed during an era of preference for externally orientated transport networks. Today, *Kenya Railways* has a rolling stock comprising 249 locomotives, 829 coaches, 8,398 wagons, 493 livestock wagons and 567 departmental vehicles. These sum up to 10,536 vehicular units of rolling stock.

Table 1 KENYA RAILWAY'S TRACK MILEAGE

LINE	LENGTH (km)
Principal Lines	
Mombasa - Nairobi	530
Nairobi - Malaba	552
Nakuru - Kisumu	248
Minor Lines	
Eldoret - Kitale	90
Gilgil - Nyahururu	82
Kisumu - Butere	69
Nairobi - Nanyuki	262
Rongai - Solai	28
Voi - Taveta	119
Worked but not owned	
Konza - Magadi	150
Miwani Sugar Company Siding	2
TOTAL	2,205

Source: Costs and Statistics Office, *Kenya Railways* Headquarters

2.4 POLITICAL BACKGROUND

Kenya's political background has its roots in the British initiative to control the source of the Nile. Kenya was declared a British Protectorate in 1895 and white settlers began to arrive in large numbers. They were settled in the fertile highlands close to the railway. Indigenous Africans were displaced from their ancestral land and confined to African reserve areas, mainly in marginal parts of Kenya.

The colonial administration banned Africans from cultivating cash crops up to the time when Swynnerton's plan of 1954 was implemented. White settlers occupied the fertile land, had access to credit facilities and were allowed to cultivate cash crops. Thus, the railway was mainly extended to settler regions which could generate enough traffic to justify their extension. The Kisumu-Butere line is the only line that was intended to serve an African reserve area.

The colonial administration favoured the railway so much that it dominated Kenya's transport scene in the first half of the this century. The end of the first world war ushered in a new era that lay the foundation for extensive road development. A new group of white settlers, particularly displaced soldiers, began to arrive in large numbers. The railway was extended mainly to new settler areas. Railway extensions could not meet all the transport requirements of the nation. This necessitated the emergence of roads from settler farms to markets and points served by the railway.

Kenya's road network developed along an axis aligned to the *Uganda Railway*. The roads were initially intended to supplement the railway as feeder and distribution outlets. Thus, the colonial authorities deliberately refused to upgrade the quality of trunk roads that were parallel to the railway. As a result, the railway enjoyed a favoured status in the transport market.

The development of Kenya's railway network occurred during the colonial era when attention was focused on the flow of commodities between Kenya and Britain. Ogonda (1986:171) suggests that the modernisation of Kenya's road network began in 1948. The global economic recession that occurred immediately after the second world war disrupted the country's externally orientated economy and necessitated the construction of a road network that would facilitate the continuous flow of traffic. Thus, road construction became the focus of government attention on transportation. A new era of the relationship between road and rail transport in Kenya had emerged. The change of focus in government transport policy was reinforced when Kenya became politically independent in 1963. Roads parallel to the railway were made all weather and upgraded to highway status. These highways now constitute Kenya's national trunk roads and pose the greatest challenge to the railway in terms of competition for traffic. The roads include: Mombasa-Nairobi, Nairobi-Kisumu, Nakuru-Malaba and Nairobi-Nanyuki. Rural access road continue to be upgraded while railway expansion appears to have been confined to the periphery of government plans.

Transport networks are often designed to suit political rather than economic interests and Kenya is no exception to this tendency. The political leverage is based on the fact that the government is the principal source of capital for investment in transport infrastructure. This is particularly applicable to the provision of transport infrastructure in locations with scanty economic returns and where government action is necessitated by the lack of any initiative from the private sector. This appears to be the trend in Kenya where the political mood is in favour of the expansion of rural access roads. Kenya's railway interests have often been protected by the imposition of bans on road transport, such as say, no carrying of logs along roads parallel to the railway.

Government initiative and intervention in all aspects of transportation is desirable and should extend beyond the realms of political muscle-flexing. It should reflect the need to safeguard public interests, standardise infrastructure, protect the environment, control the technical state of transport equipment and provide appropriate operational ethics. The development of the railway in Kenya is strongly rooted in the colonial policies of the British

Empire. The post independence political establishment has a new role to play. It must provide leadership in identifying and solving national transport issues by co-ordinating the components of the transport sector and integrating them in the economy. Political considerations have an upper hand in the area of setting up regulatory policies. These must be done with caution and effectively implemented.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

This chapter discusses the research methodology that has been used in an attempt to achieve the objectives of this study. Attention is focused on; the procedure for collecting data, methods of data analysis and the limitations that were encountered in the course of conducting this study.

3.1 SAMPLING PROCEDURE

The scope of this study is extremely broad. Financial and time limitations necessitated the use a small manageable sample of railway stations. The entire railway network of Kenya comprises the universe from which random samples of railway clients and officials have been drawn. A random sample of 31 railway stations drawn from a total of 168 railway stations (see figure 6) constitute the principal observation points. The observation points comprise approximately 20% of the stations. The railway network is sub-divided into main and branch lines. Each sub-division is based on the line's major function. The criteria are:-

i) Lines supporting agricultural crops production;
ii) Lines supporting the exploitation of mineral resources;
iii) Lines supporting agricultural livestock production; and
iv) The composite activity main line because it is served by all branch lines.
v) The initial line because other lines developed from it.

One line was randomly selected in cases where many lines fitted into one category. The following lines were selected for close observation:

i) Nairobi-Nanyuki: rich agricultural land (Central Province);

ii) Konza-Magadi: mineral deposits (Lake Magadi);

iii) Gilgil-Nyahururu: livestock area (Nyahururu and Nyandarua);

iv) Mombasa-Malaba: the main line; and

v) Nakuru-Kisumu-Butere: initial destination and only branch line to a non-white settler region.

The observation points were visited in the following order; Mombasa, Kilindini, Changamwe, Voi, Nairobi, Kibera, Magadi, Thika, Sagana, Nanyuki, Nyahururu, Gilgil, Nakuru, Molo, Kipkelion, Muhoroni, Kisumu, Butere, Bungoma, Malaba, Taveta, Dagoretti, Limuru, Webuye, Eldoret, Kitale, Turbo, Rongai, Athi River, Inland Container Deport (Embakasi), and Kibwezi.

Five questionnaires were administered. 200 copies of Questionnaire I were administered to railway passengers in an attempt to assess railway passenger services during the research period. Out of these, 60 completely filled-in copies were returned to the researcher. 80 copies of Questionnaire II were administered to firms along the railway network in an attempt to assess railway freight services during the research period. Out of these, 23 completely filled-in copies were returned to the researcher. 31 copies of Questionnaire III were administered to the staff of *Kenya Railways* at the observation points and used to gather information on the services rendered by *Kenya Railways*. Questionnaire IV was administered to a public relations officer, *Kenya Railways*, with a view to generating information on policy matters that affect railway transport in Kenya. Questionnaire V was administered to a public relations officer, *Kenya Ports Authority*, with a view to generating information on policy matters that affect the relationship between shipping and railway transport in Kenya. These questionnaires are made of open, guided and opinion questions.

3.2 DATA COLLECTION

Data was gathered from primary and secondary sources.

PRIMARY DATA

Primary data was gathered from direct field observations. Most primary data comprise qualitative information. Questionnaires were administered to respondents with a view to generating information concerning railway services in Kenya during the research period.

SECONDARY DATA

Secondary data was extracted from previous publications and official records. Most secondary data is in a quantitative format. Sources include: annual reports, books, statistical surveys, newspapers, periodicals and the Costs and Statistics Office, *Kenya Railways* Headquarters. The data is herein used to assess the performance of railway services in Kenya prior to this study.

3.3 METHODS OF DATA ANALYSIS

COMPUTER PACKAGES

The *Word Perfect 5.1* computer package was used in word processing while *Lotus 1-2-3* and the *Statistical Package for Social Scientists (SPSS)* were used in data entry and analysis.

STATISTICAL TECHNIQUES

Statistical methods that incorporate significant theoretical techniques devised to provide computationally feasible solutions are herein applied. They limit the scope of the conclusions reached and prevent excessive generalisation and grandiose conclusions.

THE GRAVITY MODEL

The gravity model suggests that the amount of interaction between two places is directly proportional to the product of their population and inversely proportional to some power of the distance between them (Chapman, 1979). The model is based on the assumption that the interaction capacity between two places is a function of distance between them, that is:

$$I_{ij} = f(d) \quad \ldots \quad (3.1)$$

Where: I_{ij} - transportation intensity between i and j;
d - distance from i to j; and
ij - interacting pair of places.

The gravity model embodies two elementary bases of spatial interaction, namely positive and negative factors. The numerator consists of positive factors generally referred to as 'mass'. These are the attractions between places that lead to their interaction. The denominator has negative factors represented by distance which is seen to be an inhibiting factor to spatial interaction. A distance decay exponent is used to indicate the magnitude by which distance curtails interaction. The gravity model suggests that two places interact with each other at a level that is proportional to the product of their masses and inversely according to some function of the distance between them. The model is mathematically represented as follows;

$$I_{ij} = f(M_i M_j)/f(d_{ij}) \quad \ldots \quad (3.2)$$

Where: I_{ij} - interaction between i and j over some time period;
d_{ij} - distance between i and j;
ij - interacting pair of places; and
M - mass of interacting pair of places.

The strength of the gravity model can be tested using the multiple regression model. Data is transformed into natural logarithms in order to approximate normality. The model becomes:

$$\text{Ln } I_{ij} = \ln a + b_1 \ln M_iM_j - b_2 \ln d_{ij} \quad (3.3)$$

Where: $\text{Ln } I_{ij}$ - logarithm of the dependent variable;
$\text{Ln } a$ - logarithm of the Y-intercept (calibrating constant);
$\text{Ln } M_iM_j$ - logarithm of the inteacting pair of places;
$\text{Ln } d_{ij}$ - logarithm of the distance between the interacting places;
b_1 and b_2 - regression coefficients.

Logarithmic transformations enable one to measure the individual influence of a, b_1 and b_2 on the relationship between I_{ij} and M_iM_j and d_{ij} using model 3.3.

The gravity model simplifies very complex relationships. In so doing, it becomes ambiguous and obscures the influence of several positive and negative factors by generalising them into mass and distance. The propensity for interaction between two places is not simply a function of size (Stewart 1948). Cultural traits, mode of transport and income levels also influence interaction capacity between places and yet they are not easy to discern from the gravity model.

The gravity model has been widely applied in geography. Ngau (1986) uses this model to analyse '*Transportation characteristics of urban travel in Nairobi*'. He evaluates the use of the model to derive a functional form of the distance-interaction intensity (trip generation) in Nairobi and estimate distance decay effects ($d^{-\beta}$) on categories of local travel. This model is herein used in a similar approach to estimate the influence of distance on the transportation propensity by finding the distance decay effects ($d^{-\beta}$).

THE POTENTIAL MODEL

Stewart (1947) introduces the use of population potential maps as a geographical tool for analysing population distribution. This model has been modified by Warntz and Neft (1960). The population potential is the relative proximity of the total population to a specified place. Kenya's population potential surface has been constructed with a view to estimating the national transportation potential. It is herein used to quantitatively estimate the strength of the relationship between population distribution and transportation potential. The model is analogous to Newton's field of gravitation potential. It has been used to derive measures of inter-district transportation probability.

The model suggests that the potential (V) created at the origin $_i$ by each destination $_j$ is equal to the mass at $_j$ divided by the distance from $_i$. It is mathematically computed using the formula:

$$V_i = \frac{M_1}{d_{i1}} + \frac{M_2}{d_{i2}} + \frac{M_3}{d_{i3}} + \frac{M_j}{d_{ij}} + \ldots + \frac{M_n}{d_{in}} + \frac{M_i}{d_{ii}} \quad \ldots\ldots\ldots\ldots$$

Where: V_i - transportation potential of place i (origin);
M_j - mass of j (population of any destination);
d_{ij} - distance from i to j; and
M_i/d_{ii}[ii] - the potential that a place exerts on itself.

The appropriate measure of mass in the potential model depends on the anticipated level of interaction. The population of a district represents its mass. District population size is used as a surrogate measure of the demand for transport services. The influence of distance in determining the transportation potential has been measured by calculating the rate at which railway traffic varies

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ii M_i/d_{ii} is calculated using the formula M_i/d_{ij} where d_{ij} is half the distance from $_i$ to its nearest neighbour $_j$.

with respect to changing distance. The potential model was used to generate two population potential surfaces.

MULTIPLE REGRESSION MODEL

The multiple regression model was first applied to transportation studies by Osofsky (1958)[15]. He was interested in finding *"a reliable, logical and practical method of developing data to be used in designing and locating freeways of the future."* It is used to explain factors that control movement decisions by relating independent variables to a dependent one while holding all other independent variables constant. Multiple regression equations act towards this end by choosing variables which minimise the overall error between the dependent variable and actual values.

Multiple regression analyses are used to indicate the manner in which variables are related, the form of the relationship, possible anomalies (deviations from the overall form) and enable the estimation of values based on the knowledge of the trend of the other variable. It has been used to analyse and interpret the railway network in terms of observed relationships between distance, location, pattern and shape and relate them to the processes that may have caused them. The model determines the nature of statistical relationships. It is computed using the following mathematical formula:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n + e_i \quad (3.5)$$

Where: Y – the dependent variable,
β_0 – the Y-intercept (calibrating constant),
$\beta_1, \beta_2, \beta_3 \ldots \beta_n$ – regression coefficients,
$X_1, X_2, X_3 \ldots X_n$ – independent variables, and
e_i – error term (residuals).

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15 Osofsky, A. -1958- "A multiple Regression Approach to Forecasting Urban Area Traffic Volumes" In Proceedings of the American Association of State Highway Officials, Washington, 1958.

The multiple regression model is based on the following assumptions:

i) The expected error of observations sum up to zero [$e_i = 0$ or $(\Sigma e_i)=0$];

ii) The error terms have a common variance (homoscedasticity);

iii) The residuals of the error terms are not spatially correlated;

iv) The independent variables are not expected to be highly correlated (the correlation between any two independent variables should be less than that between any of them and the dependent variable).

v) Both the dependent and the independent variables are normally distributed.

All multiple regression and correlation analyses have been carried out using the SPSS statistical package.

MULTIPLE CORRELATION ANALYSIS

Multiple correlation analysis involves the use of partial correlations[16] to determine the strength and direction of the statistical cause and effect relationships derived from multiple regression analyses. The multiple correlation coefficient (R) is used to measure the strength of linear relationships between the dependent and independent variables of a multiple regression model by augmenting the deviation(s) of the independent and dependent variables from their means and standard deviations. It estimates the degree by which individual independent variables influence the dependent variable in a multiple regression model.

R has been used as a descriptive device for summarising the strength and direction of statistical associations between sets of

[16] A partial correlation is the product moment correlation between an independent and the dependent variable, holding the variance of some specified other variable(s) constant.

variables. It has also been used to assess the resulting statistical relationships with a view to eliminating the possibility of deriving spurious correlation coefficients of multivariate populations derived from small samples.

Multiple correlation analysis is a continuation of the multiple regression model. It measures the strength and direction of statistical cause/effect relationships based on the multiple regression analyses. The multiple correlation model is therefore based on the multiple regression model's assumption that the correlation between any two independent variables is less than that between any two of them and the dependent variable. This assumption is violated by most Social Science observations which are characterised by multicollinearity. Thus, the correlation between independent variables also jointly affects the obtained value of the dependent variable. The influence of the variables not included in the multiple regression equation is assumed to be covered by the $(1-R^2)$ value.

Statistical correlations do not necessarily prove the existence of a causal relationship. Correlation analyses merely emphasise the degree and direction of co-variation between sets of data. Thus, correlation analyses are herein supplemented by field observations which sought to uncover the processes that underlie the obtained correlation values.

CONFIDENCE INTERVALS

The normal distribution function is appropriate for the calculation of confidence intervals only when the sample size is large. The confidence interval about a sample mean is the interval within which the underlying population mean is expected to be found at a known probability level (Matthews, 1981). It is assumed that the samples are not biased because they were randomly drawn. Thus, obtained *sample means* are likely to have been drawn from the population whose *hypothesised means* are calculated. They are used to test the hypotheses of *no difference* between the *sample* and *hypothesised true means.* When the confidence interval between the *sample mean* does not enclose (is greater than) the *hypothesised true mean* (t value obtained from the t table or significant T), it is concluded that there is a significant difference between the *sample mean* and *hypothesised true mean.* Null hypotheses stating that there is *no difference* are rejected at the 95% significance level (α = 0.05).

Null hypotheses are rejected if the calculated t lies within the critical region. The student's t table has t values relating to specific probability levels and degrees of freedom which are used to establish the value of the *hypothesised true mean.*

RESIDUAL MAPPING

R^2 values are used to interpret regression analyses. They measure the proportion of the variation in a variable that is predicted by change in the other variables. Residual values (e_i) for each observation are used to indicate how well the calibrated function predicts the dependent variable for the particular observation. The predicted values for the sample points are subtracted from the observed values of the phenomena. The values of the differences are then used to construct an isoline map which show the areal variation in the degree of fit of the regression equation. Small residuals reflect a strong association between the actual and the predicted values. Residual mapping is used to highlight areas where the regression model over predicts (positive residuals), under predicts (negative residuals) and makes accurate predictions (near zero residuals). Thus, residual mapping depicts the spatial difference between the predicted value of the dependent variable and its actual or observed values.

Residuals are standardised before being mapped. The units of the dependent variable are in absolute values and are made dimensionless by dividing them with their standard deviations (the standard error estimates). Relative residual values (Z_i) are mathematically computed using the formula:

$$Z_i = \frac{e_i}{SE_{\hat{y}}} \qquad (3.6)$$

Where: Z_i - relative residual value,
e_i - residual value, and
$SE_{\hat{y}}$ - standard error of the estimate.

This procedure alters the magnitude of the residuals without affecting their patterns. Residual mapping is essential in geographical analyses as it enables the spatial description of the accuracy pattern of derived regression predictions. It shows areas with weak and strong regression predictions. Areas with negative residuals indicate the presence of a strong influence from one or several other variable(s) stronger than the independent variable whose influence on the dependent variable is being analysed. Areas with positive residuals indicate the absence of a strong influence by one or several other variables competing with the independent variable in affecting the variation in the dependent variable.

GRAPH THEORY

Graph theory comprises the set of techniques that are used to analyse the topological characteristics of a network. Graph theoretic indices are used to generate quantitative measures of some qualitative aspects of Kenya's road and railway transport networks. Topological attributes of the networks have been used to derive uniform and consistent measures of network structure. Irandu (1989) uses this technique to analyse the Eldoret road network and calculates its *beta* and *gamma* indices using topological graphs.

Topological graphs are used to generate abstract transformations of the relative position of places along the railway and road networks while retaining essential topological characteristics and exclude incidental features. The topologically transformed networks disregard distance and direction but retain the relative positions of places.

Settlements, termini and route junctions are termed vertices (nodes) while the routes linking any two vertices are termed edges (links). Vertices, edges and sub-graphs (*P*) form the basis for developing the series of network measures used herein. This work is based on planar graphs comprising two dimensional networks with physical routes that form a node at all intersections. *e, v* and *P* values have been obtained from topological abstractions of the railway and road networks. They form the bases for calculating *alpha, beta, gamma,* and *connectivity indices* and the *cyclomatic number*. The graph theory has been used as a surrogate tool for demonstrating the relationship between overland transport and regional development while simultaneously incorporating the influence of district rail and road networks.

CYCLOMATIC NUMBER (μ)

The cyclomatic number has been used to calculate indices of network structure which do not vary under isomorphic transformations although they do not provide readily intelligible measures of structure. It represents the number of observed circuits in a network. μ lies between 0.0 and the maximum number of fundamental circuits. It is a function of the number of nodes in the network and is herein used to identify tree-like patterns and discontinuities in Kenya's road and railway networks. μ is a weaker form of the *alpha index* and is computed mathematically using the formula:

$$\mu = e - v + P \qquad (3.7)$$

Where: μ - cyclomatic number,
e - edges in the graph,
v - vertices in the graph,
P - number of sub-graphs in the network.

ALPHA INDEX (α)

α is the ratio of the observed number of fundamental circuits in the network (μ) to the maximum number of fundamental circuits that may exist in the network. α is computed using the mathematical formula:

$$\alpha = \mu(2V - 5)^{-1} \text{ or } \alpha = \mu/(2V - 5) \qquad (3.8)$$

Where: α - alpha index,
μ - cyclomatic number, and
V - number of vertices in the graph.

Maximum connectivity is achieved when $\alpha = 1.0$ while $\alpha = 0.0$ means no connectivity. It therefore follows that $0 \geq \alpha \leq 1$ must always be obtained. α can be multiplied by 100 and used to estimate the percentage redundant.

BETA (ß) INDEX.

ß is used to measure the tree-likeness of a network. It is computed using the mathematical formula:

$$\beta = e/v \text{ or } \beta = ev^{-1} \qquad (3.9)$$

Where: ß - Beta index,
e - number of edges in the graph, and
v - number of vertices in the graph.

Empirical evidence suggests that $0 \geq \beta \leq 3$. A tree or discontinued graph leads to $\beta < 1$, a single circuit network lead to $\beta = 1$ and a complex network results in $\beta > 1$.

GAMMA (Γ) INDEX

Γ is used to calculate the ratio of the actual number of edges (e) in the network to the maximum number of edges [$3(v-2)$] in that network. The maximum number of direct connections in a network is a function of the number of its nodes. Thus, Γ approaches its upper limit (1.0) as e increases and its lower limit (0.0) as it decreases. Γ is invariant under isomorphic transformations while retaining common upper and lower limits for all networks. It is computed using the mathematical formula:

$$\Gamma = \frac{\text{Actual number of edges in the graph}}{\text{Maximum number of edges in the graph}} \text{ or } \frac{e}{3(v-2)} \quad \ldots \quad (3.10)$$

Γ has conveniently been converted into percentage values ranging between 0.0% and 100% by being multiplied by 100.

CONNECTIVITY INDEX (*C.I.*)

The connectivity index is computed using the Γ.

C.I. = e/e max or C.I. = $e/3(v-2)$ or *C.I.* = $e.3(v-2)^{-1}$ . . . . . . (3.11)

Where: C.I. - connectivity index,
e - actual number of edges, and
e max - maximum possible number of edges [$3(v-2)$].

N.B.: Γ and *C.I.* are the same and are interchangeably been used to refer to the same thing, namely Connectivity Indices.

DIAMETER (d)

The diameter of a network is the number of edges that are traversed while moving from one extremity of the network to the other by the shortest route. It is the shortest connection between the most widely separated nodes and has values ranging from one to infinity. The higher its value is the lower the network's connectivity and *vise versa.* *d* has been incorporated in this work in order to shed some light on a network's connectivity and accessibility with a view to achieving meaningful topological analyses of Kenya's railway and road networks.

3.4 RESEARCH LIMITATIONS

Several limitations were experienced during the field study and in the in-built deficiencies of the techniques of data analysis. Fieldwork problems include: lack of access to classified information, financial constraints, unco-operative respondents and problems related to data collection and organization where secondary data was in the form of voluminous raw data.

FIELDWORK PROBLEMS

Collecting people's opinions at times proved to be a hazardous task. Previous research experience has shown that some respondents tend to evade opinion questions. Thus, opinion questions were minimised in favour of guided questions with several options. Supplementary questions were asked whenever an opinion question was evaded thus providing an opportunity to probe into certain answers.

Several potential respondents were not co-operative and either refused to be interviewed or return the questionnaires. This necessitated the drawing of new samples and preparing new copies of the questionnaires - an exercise that was costly and time consuming.

The unwillingness to answer questionnaires IV and V by the relevant officers created a vacuum regarding official policies *vis-a-vis* railway transport in Kenya. The researcher relied on deductions from press reports, and Presidential/ Ministerial directives as indicators of the goals pursued by Kenya's transport sector. These sources are inadequate to the extent that they do not reflect the internal policies pursued by *Kenya Railways* and how they relate to the overall objectives of the national transport sector. The road transport sector has numerous carriers most of whom do not keep accurate records or compile comprehensive reports of their performance characteristics.

Apart from the Kenya Ports Authority (Kilindini Harbour and the Inland Container Depot, Embakasi), reliable quantitative data on road transport was not readily available in a format that allows for comparison with railway services. The national road network was found to be too complex and broad for accurate monitoring by the present study. Interviewed road transporters often claimed that their records are inaccurate and poorly maintained.

The euphoria of the Gulf Crisis-*cum*-war led to increased transport costs during the field study and greatly diminished the researcher's funds. This problem was partially alleviated by the generous award of four free complementary train tickets from *Kenya Railways* and several friends and relatives who provided free accommodation at several observation points outside Nairobi.

Most relevant secondary data available at *Kenya Railways'* Costs and Statistics Office was voluminous and raw. This led to the researcher spending a lot of valuable time collecting and arranging data in a manner that is compatible with this study. Some of the data was in a coded form and required lengthy decoding sessions.

STATISTICAL LIMITATIONS

Logarithmic transformations have three major shortcomings, namely:-

i) The equations are calibrated using values different from the ones that actually define the association being tested. Thus, their lines of best fit minimise the squares of logarithms of the independent variables rather than the independent variables themselves. This amounts to using "relative" residuals rather than the absolute residuals.

ii) Fitting least squares map into logarithms may result in two residuals being treated equally. This requires great caution and accuracy in interpreting interacting levels for long distances.

iii) It is difficult to test if the model is a good fit to the data using inferential statistics when "relative" errors have been used to derive the model. This creates the issue of whether it is right to assess relationships in absolute terms when they are calibrated using relative values.

Despite the shortcomings of logarithmic transformations, they have been necessitated by the need to calculate standardised values of the distance decay exponent of the gravity model.

Multiple regression and correlation analyses do not prove causal associations. They merely give credence to explanations based on estimates of the population regression parameters and correlation coefficients justified on logical grounds. Such explanations have been found to be satisfactory in this study because they are tested by techniques which were chosen in anticipation of the obtained results before data collection.

The regression model is primarily used to generate interpolations within the data range but where necessary, it has been slightly elongated beyond the data range. The interpolations provide predictions based on data collected at specified times. The highly dynamic socio-economic variables used herein mean that extrapolations do not necessarily reflect past or future conditions. Thus, the regression model tends to falsely imply that the obtained relationships could have been obtained in the past or may be obtained in the future. It overlooks the effect of varying background factors which invalidate such forecasts.

The regression line can be used to predict values beyond the range of available data. This is a hazardous practice because the relationship between variables in spatial units has a ceiling which acts like an elastic limit. Beyond this ceiling, further changes in the independent variable(s) does not accurately reflect change in the value of the dependent variable. Thus, any forecast beyond such a point is invalid to the extent that it predicts a non-existent relationship as a diminishing returns type of relationship will have come into effect. The researcher avoided the extrapolation of regression lines as a tool for predicting past and future associations between variables.

Regression analysis is a tool for making causal predictions. It seeks to estimate the extent by which a variable can be predicted from another by indicating how the variation of the independent variables affects the dependent variable. The validity of a regression prediction is set by the t test while its strength is determined by the R^2 value. Thus, the presence of a high degree of correlation only lends weight to an assumption of dependence or causation.

The selected variables are not the only ones that affect the relationship between the independent and the dependent variables. There are other non-quantitative factors which influence the association between variables in Social Sciences such as political changes, war, economic recessions and religious beliefs. The influence of the omitted variables is assumed to be accounted for by the $1-R^2$ value.

Despite these shortcomings, regression and correlation analyses were found to give succinct descriptions of spatial interaction patterns in Kenya. The basic parameter of the regression coefficients are easily interpreted in terms of flows. They have been used in the analyses because they provide simple measures of the decline in interaction as distance increases.

Graph theoretic indices are based on abstract graphs which merely retain the topological features of the networks discussed. This means that they cannot be used to analyse the effect of distance and direction which are essential variables in transport geography.

The collected data is static and reflects conditions that prevailed during specified time intervals. Analyses based on static data falsely assume a constancy of several dynamic and controlling factors such as inventions and market conditions. The analysis of static data is justified in this study only when the relevant data is responsive to change although they do not initiate change. For example, a change in transit time will upset an equilibrium already established by a regression model. Its components will adjust themselves and arrive at a new stationary equilibrium that reflects the new influence of changed transit time.

Distance is the basic variable to the statistical analyses in this text. It is closely associated to the distance decay function which is central to this work. Distance merely represents one structural characteristic of transportation and is not a dynamic process variable (Taylor, 1975:6). The structural element of distance makes it to directly influence many of the dynamic processes although it is not an absolute variable for measuring transportation. It is an appropriate surrogate variable that is easy to measure and incorporate in dynamic analyses.

The research methodology remained open to alteration in the face of serious unforeseen circumstances, say lack of compatible data and conceptual uncertainties related to the definition and quantification of some variables that are relevant to this study. In such instances, either the most suitable statistical method(s) of data analysis was applied to the available data or surrogate measures were used. Relevant steps were taken to ensure that the results obtained accurately reflect the status of railway transport in Kenya.

CHAPTER FOUR

THE RAILWAY AND SPATIAL INTERACTION IN KENYA

4.0 INTRODUCTION

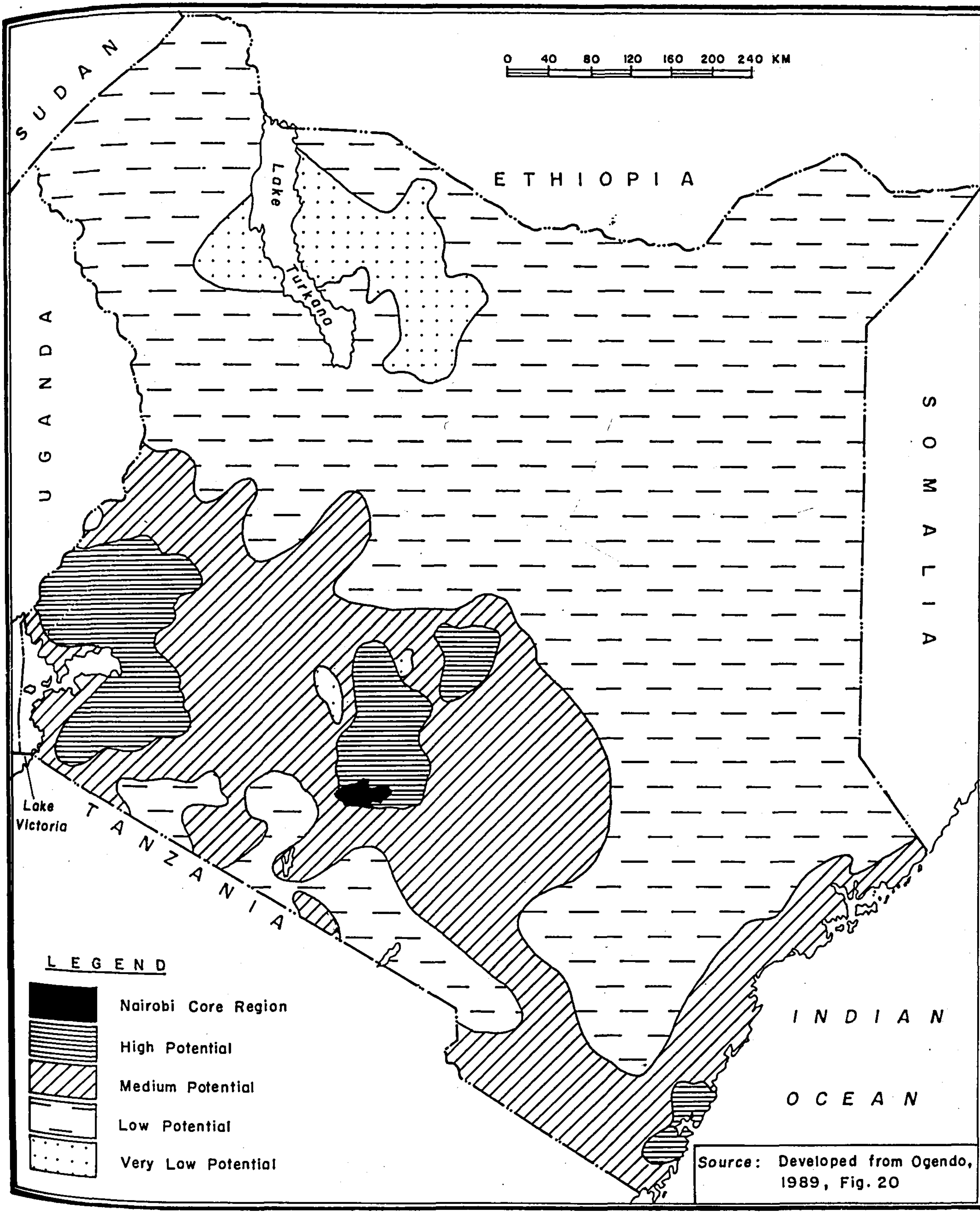
This chapter discusses aspects of spatial interaction that are related to Kenya's railway services. It seeks to identify and account for the geographical distribution of Kenya's railway traffic. An attempt is made to realise the objective seeking "*to determine empirical estimates of the distance decay effect [the distance decay exponent (d^{-b})] on movement capacity.*" The null hypothesis stating that "*railway traffic does not decline significantly as distance increases*" is tested.

4.1 THE RAILWAY AND SPATIAL INTERACTION

Kenya's railway network strongly influenced the initial siting of major national production enterprises. It was designed to render externally orientated transport. As a general trend, the railway tends to pass on the outskirts of towns and thus features prominently in nationwide rather than local haulage. The network serves those parts of towns that have a high concentration of heavy industrial and commercial activity. Thus, there is a strong relationship between the location of mass consignments and proximity to the railway. Kenya's railway services appear to be influenced by;

i) past decisions on the orientation of the national transport infrastructure,

ii) available means for meeting contemporary transport needs, and



MAP 3 : THE POLARISED SPACE ECONOMY OF KENYA

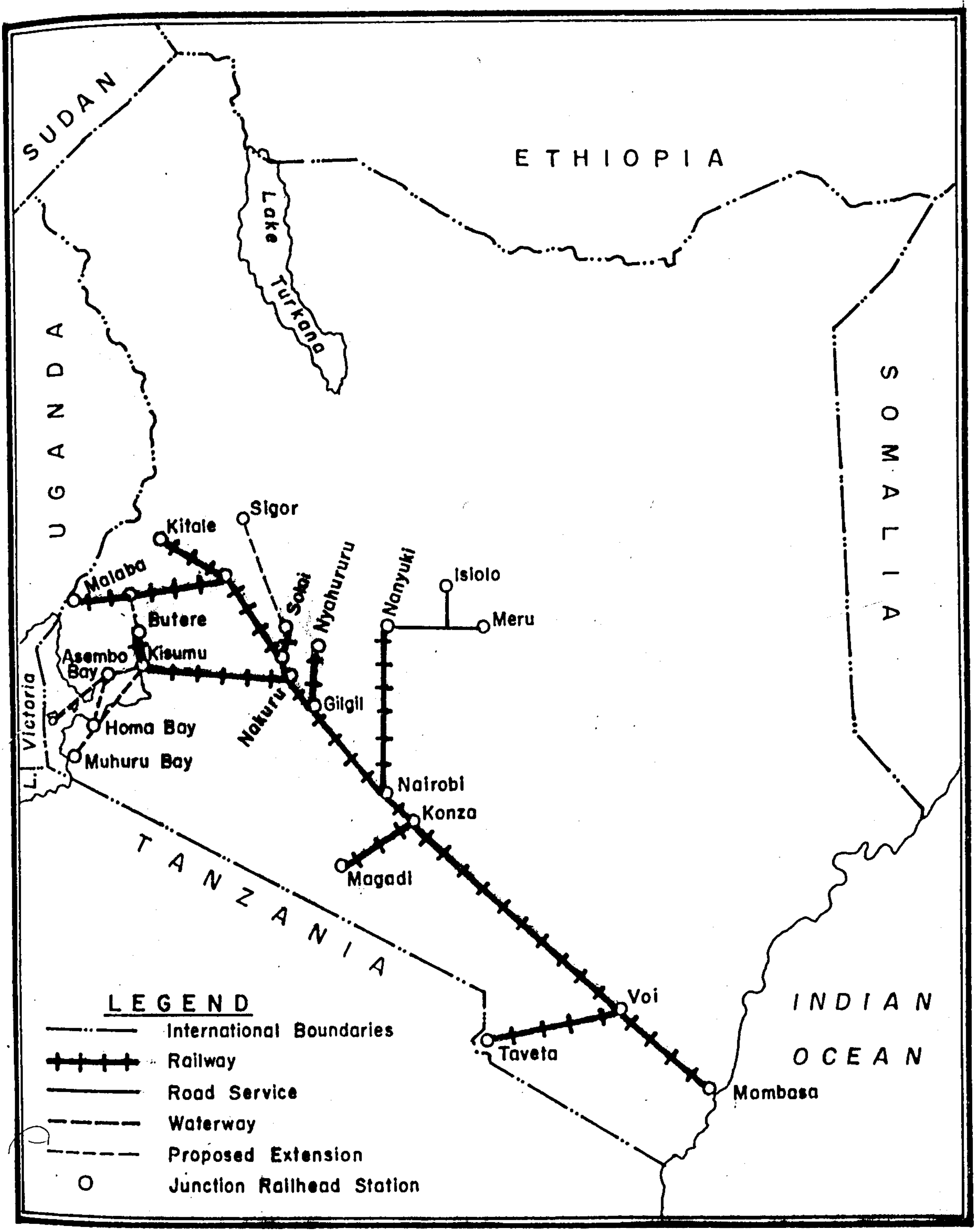
iii) the need to influence spatial interaction in future.

The railway still enjoys the support of many committed clients. 58% of the interviewed passengers indicated that the train is their most regular means of transportation. 46.7% of the respondents indicated that they travel between 0-4 times a month while 48.3% claimed to be travelling between 5-9 times a month. The regular railway clientele is largely attributed to vegetable hawkers serving wayside stations. The fear of escalating fuel costs during the Gulf Crisis (when this study was conducted) may have made 93.3% of the respondents chose the train as their most regular mode of transport today while 96.6% indicated that they intend to travel by train again. These responses highlight the fact that a certain section of the Kenyan population is committed to railway transport. However, the obtained percentages do not reflect the position of the entire national passenger traffic. Domestic road and air transport in Kenya attract a very large proportion of the passenger market.

95.7% of the interviewed freight clients indicated that the railway is their regular mode of transport. This high response is partially attributed to the fact that only railway clients were willing to be interviewed. This view has been given more weight in due regard of the fact that 87% of the respondents also chose road transport.

4.2 KENYA'S RAILWAY NETWORK

Kenya Railways operates a simple single track railway network which is tree shaped and divided into blocks. Access to a block is controlled by the possession of a token (trains) and a key (motor trolleys) that permit movement within the block. The token or key is carried to one end of the block for use during reverse movements.



MAP 4: A TOPOLOGICAL MAP OF KENYA'S RAILWAY NETWORK

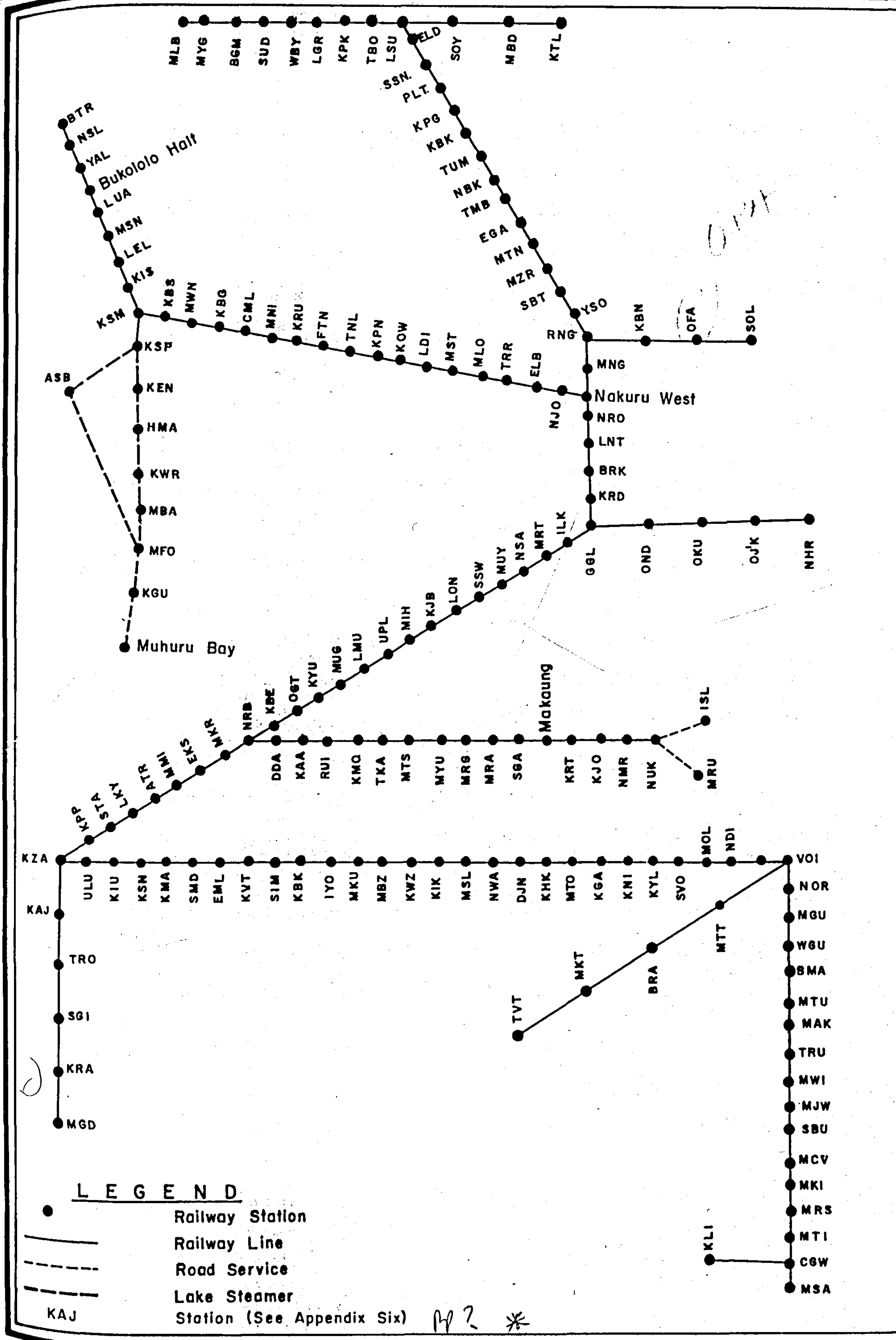


Fig. 6 : RAILWAY STATIONS IN KENYA

The token method of controlling traffic is still being used in Kenya despite the existence of modern electronic signalling equipment that operate automatically. This situation may be attributed to the fact that trains in Kenya are in general slow and will not gain much from speedy transit facilities through stations. Tokenless services enable express trains to move faster through railway stations by eliminating the slowing of trains through a station so as to deposit and collect a token.

Passing loops best serve on-coming traffic when train movement is synchronised and homogeneous. Train speed in Kenya is heterogeneous. Thus, passing loops minimise the delay of fast moving passenger trains by providing an opportunity for overtaking the slow moving goods trains. Heterogeneous train speed along a singe track network require the strict adherence to a careful timetable so as to maintain high traffic levels. Single line tracks are rigid. Delays caused by the impassability of any section along the line can spread through the whole network or branch lines depending on the location of the disruption.

Multiple tracking and non-tree networks alleviate these transit related problems. The tree network has resulted in zero connectivity values of the railway network. A network that is highly connected is better placed to provide high levels of integration while facilitating easy rerouting of traffic in the event of congestion or a mishap.

4.3 RAILWAY TRAFFIC IN KENYA

FREIGHT TRAFFIC

The amount of freight handled by most stations varies seasonally in terms of variety and quantity. Fertilizers, agricultural produce and import based traffic is identified as being unstable throughout the year. Such traffic is either seasonal or erratic and often lead to sudden traffic growth that threatens to outstrip the short term carrying capacity of the railway. This calls for measures designed to encourage the spreading of freight traffic in both time and space. Small consignments indicate the small scale of operations by the consignor and/or consignee. It also reflects temporal demand schedules which require frequent small consignments rather than less frequent but large ones. If these small consignments reflect conditions at both the origin and destination centres, the demand situation is not easily changed. On the other hand, the small scale operations may exist only at one end of the transport operation necessitating the creation of a mass storage system to consolidate traffic for distances beyond the immediate vicinity of the centre.

Small consignments adversely affect the economic operation of railway services. Each consignment requires documentation, weighing, consignment notes and invoicing. Such traffic lacks the advantage of economies of scale. Increased cargo handling per unit weight and reduced transit speed as a result of transhipment are time consuming and necessitate the running of pick-up trains.

Nairobi and Mombasa feature prominently as destinations of railway traffic. Kilindini Harbour, Malaba Railway Station and Kisumu Pier are the principal destinations of transit commodities. The commodities listed in table 2 achieved more than 7,500 tonnes and rank among the principal commodities that furnish the railway with significant freight traffic. Some of them are also moved in large quantities by road transport. The transportation of these commodities is important from the point of view of volume.

Salt and salt compounds are on nationwide demand. They are used as raw materials for various industrial processes. A large proportion of salt and salt compounds in Kenya are extracted from Lake Magadi. All the salt is railed to various locations for industrial processing or direct consumption by industries as a raw material.

Paper is widely used throughout the country. Printing presses have emerged in almost all the provincial headquarters. Most of the paper is railed to Nairobi and Mombasa. These are the leading urban centres of the country in terms of population concentration, business potential and demand for paper. Nairobi is particularly notable as the nation's leading publishing centre. The city houses the head offices of leading national publications (daily, weekly and monthly). In this respect the speedy delivery of large quantities of newsreel is essential if the local press has to operate within schedule.

Iron ore is a very important industrial raw material from which iron and steel are obtained. Kenya lacks domestic deposits of iron ore and therefore has to import them. Table 2 reveals that there exists a notable amount of iron and steel traffic from Kilindini to Nairobi and Ruiru. The centres receive a lot of iron and steel by railway because they are the furthest and leading fabricators of iron and steel products from Mombasa. There is an iron sheet fabricating plant at Mariakani, approximately forty kilometres from Mombasa which has a railway siding but is mainly served by the faster road hauliers.

Table 2 MOVEMENT OF MAJOR COMMODITIES (1988/89)

COMMODITY	FROM	TO	TONNES
Salt and Salt Compounds	Mombasa	Malaba	10,246
		Kisumu	13,824
		Kisumu Pier	10,298
Paper	Webuye	Nairobi	29,979
		Mombasa	8,964
Iron and Steel	Kilindini	Nairobi	24,946
		Ruiru	25,880
Cement	Mombasa	Nairobi	20,820
		Kisumu	36,219
		Malaba	15,437
Fuel Oil	Kilindini	Nairobi	18,895
		Magadi	12,993
		Webuye	42,141
	Changamwe	Athi River	28,010
		Nairobi	22,904
		Kisumu	9,003
Petrol Oil	Nairobi	Nakuru	30,464
		Eldoret	31,856
		Naro Moru	8,210
		Nanyuki	16,594
		Kisumu	45,266
Oil (Gas)	Nairobi	Eldoret	20,071
		Kisumu	11,590
Oil (Diesel)	Nairobi	Nakuru	11,879
		Kisumu	14,279
Fluorspar	Kaptagat	Mombasa	36,108
Soda Products	Magadi	Mombasa	13,882
		Nairobi	10,662
Sugar	Mombasa	Nairobi	30,443
		Malaba	20,870
	Bungoma	Nairobi	57,622
	Sudi	Nairobi	13,127
	Kisumu	Nairobi	10,225
Manures & Fertilizers	Mombasa	Nairobi	52,043
		Nakuru	29,774
		Eldoret	21,333
		Thika	18,462
		Kitale	17,555
		Kipkelion	10,689
		Sagana	10,617

Wheat	Mombasa	Nairobi	44,767
		Nakuru	34,386
		Thika	12,517
		Kisumu	22,171
	Nakuru	Nairobi	13,684
	Eldoret	Nairobi	14,662
Bitumen	Changamwe	Nairobi	12,789
Maize	Nairobi	Mombasa	391,819
	Kitale	Mombasa	12,550
		Nairobi	11,453
	Moi's Bridge	Mombasa	9,004
	Eldoret	Mombasa	12,878
		Nairobi	8,455
	Nakuru	Mombasa	11,888
		Nairobi	12,164
	Webuye	Nairobi	8,138
	Kisumu	Mombasa	18,546
		Nairobi	13,444
		Thika	7,501
	Nanyuki	Mombasa	9,328
	Kipkelion	Mombasa	13,350
		Nairobi	10,758
Tea	Eldoret	Mombasa	8,020
	Kipkelion	Mombasa	9,435

Source: Costs and Statistics Office, *Kenya Railways* Headquarters

Cement is demanded throughout the country. It is used in the building and construction industry. The building and construction industry is ever increasing. New buildings, bridges, factories and other structures are continuously being built. Cement is also a heavy and bulky commodity with a low weight to value ratio. Table 2 reveals heavy cement traffic from Mombasa to Kisumu and Malaba. This reflects the general trend that cement from Bamburi, Mombasa is mainly for the export market while the local market is predominantly served by the Athi River cement factory. This goes a long way to demonstrate the significance of the railway as a low cost mode of mass transportation. Nairobi, Kisumu and Malaba are the leading destinations. The Malaba bound cement is mainly for export to neighbouring countries. Field evidence indicates that there is a significant amount of cement traffic railed from Athi River to upcountry distribution centres.

Fuel and petrol oil are a leading nationwide source of energy for both domestic and industrial uses. Kenya does not have domestic sources of these fuels. However, the country has a petroleum refinery at Changamwe, Mombasa. A pipeline from Changamwe supplies most of the refined petroleum products to the Makadara depot in Nairobi. Individual firms such as the Magadi Soda Mining PLC, Muhoroni Sugar Factory, Pan African Paper Mills (Webuye) and Nzoia Sugar Factory get their diesel supplies directly from Kilindini and Changamwe by railway. The Kenya Pipeline Company has extended the pipeline to Western Kenya. This extension is expected to reduce the amount of fuel railed from Makadara (Nairobi) to destinations in the western parts of Kenya.

Oil (gas) is a widely used commodity in the country mainly for cooking purposes in both homes and institutions with large resident populations. Gas is also a highly flammable commodity that requires great caution during its transfer. The railway has the safest record of the mass delivery of large quantities of gas to distant destinations in the country. Table 2 indicates that the leading recipients of railed gas deliveries from Nairobi are Eldoret and Kisumu. These are the leading regional distribution centres of western Kenya.

Oil (diesel) is widely used in the transport and industrial sectors. Diesel is railed both from Changamwe and Makadara and supplied to leading distribution centres throughout the country. The leading railway recipients of diesel include large scale consumers such as the Magadi Soda Mining PLC, Muhoroni Sugar Factory, Pan African Paper Mills and Nzoia Sugar Factory.

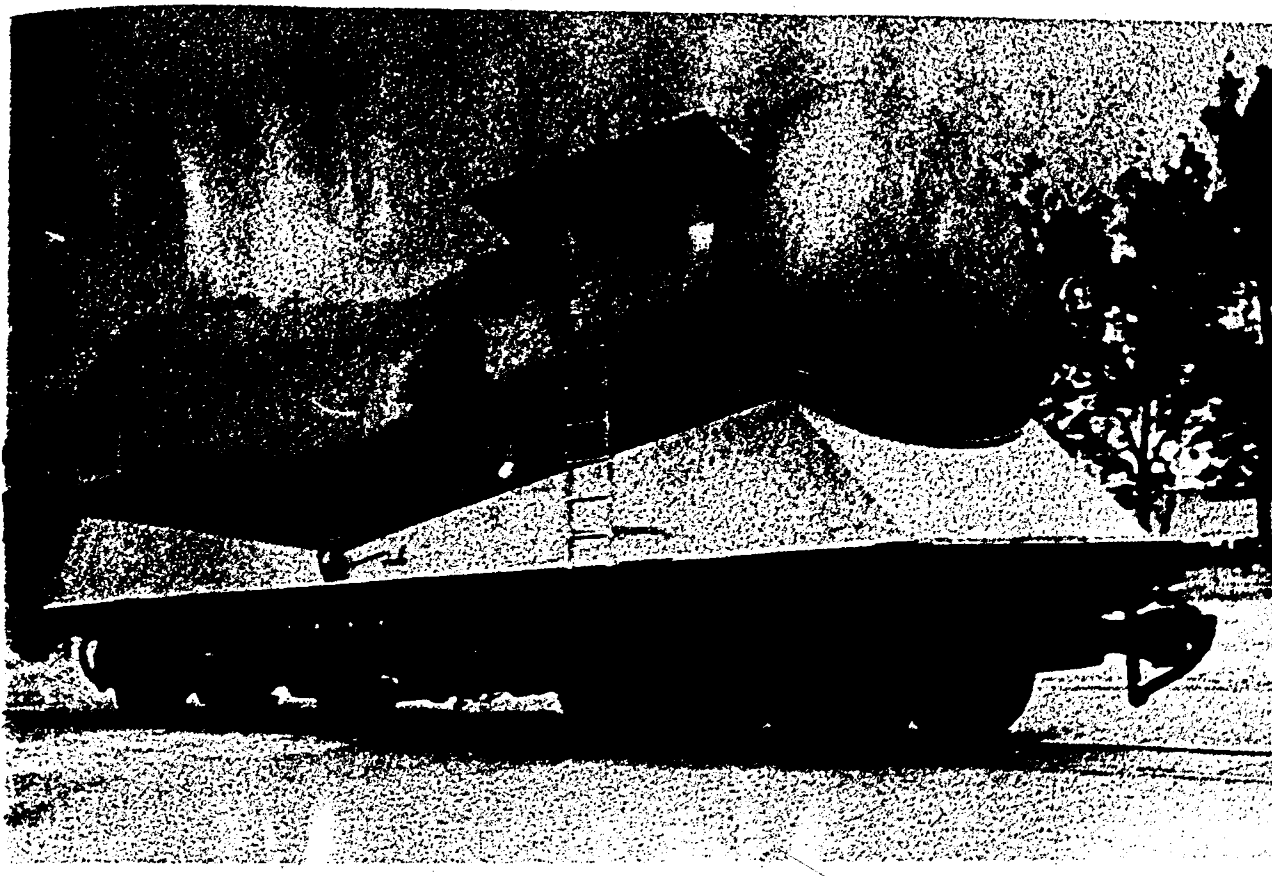


Plate 1 A bulk cement boggie.

Fluorspar is obtained from the Kerio Valley through Kaptagat. It is railed to Mombasa for export mainly to the Soviet Union. Fluorspar is one of the leading export minerals of Kenya. The extraction and transportation of fluorspar appears to be so significant that *Kenya Railways* has already conducted a feasibility study to establish the engineering requirement for the construction of a branch railway from Solai to Sigor in the Kerio Valley, West Pokot District. What is now left is to assess the economic potential of such a project, its traffic generation capacity and acquiring funds for constructing the proposed railway extension.

Soda ash is the most significant export mineral from Kenya. It is mainly exported to the Soviet Union, Japan and the United States

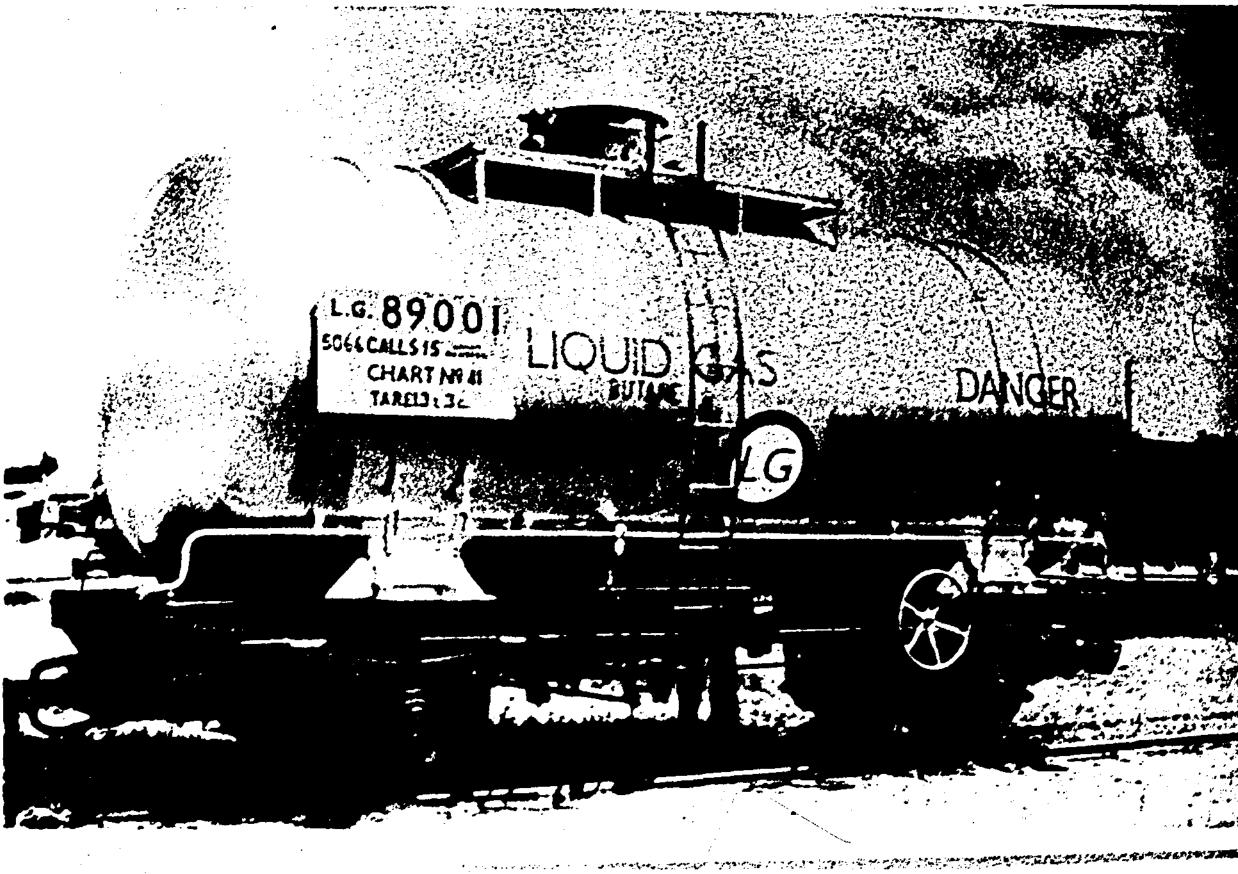


Plate 2 A liquid gas boggie.

of America. Soda ash is extracted from Lake Magadi and railed to Kilindini harbour for shipment to export markets. The extraction of soda ash was the principal reason for the building of the Konza-Magadi railway branch line. Magadi Soda Mining PLC built this branch line and handed it over to *Kenya Railways*' forerunner to run it. Magadi Soda's operations are well organised and include private shunting engines at Magadi. Specialised hopper wagons are used for mechanised bulk haulage of soda ash. The soda ash is railed directly to the Shimanzi depot, Kilindini harbour.

Sugar is widely used throughout Kenya for domestic and industrial purposes. Sugar sweetens foodstuffs, preserves them and is used for brewing purposes. Kenya's sugar is mainly obtained from

Plate 3 Loading bulk soda ash into a hopper wagon at Magadi.

the Western Kenya sugar belt. The sugar belt comprises Mumias, Nzoia, Muhoroni, Chemelil, Miwani, and South Nyanza (Sony) sugar factories. Mumias and Sony sugar factories are not directly connected to the railway network. Mumias Sugar Factory is served by the nearby Bungoma Railway Station. The importance of sugar traffic to Kenya's railway operations is highlighted by the prominence of the Kenya National Trading Corporation (Appendix II) as one of Kenya Railways' leading clients. Table 2 indicates that some sugar is railed from Mombasa. Considering that the Ramisi Sugar Factory in Kwale District closed down, it is clear that this sugar is imported. The

Plate 4 Loading bulk soda ash into hopper wagons at Magadi.

imported sugar is mainly for industrial purposes though some is meant to supplement domestic output in the event of a shortage. Bungoma Railway Station serves Mumias Sugar Factory, which has the biggest production capacity in the country and is rightly identified by table 2 as the leading source of sugar traffic.

There are plans to establish a new sugar factory at Nambale in Busia District. If the project is successfully completed, either Bungoma Railway Station will receive more sugar traffic or Myanga Railway Station will in addition to the predominant cereal traffic begin to handle sugar traffic. Alternatively, the *Kenya Railways* or the administration of the proposed Busia Sugar Factory may, like in the case of Miwani Sugar Factory, consider the option of constructing a railway siding from the Bungoma-Malaba railway sector to Nambale.

Manure and fertilizer traffic is very important to the Kenyan economy considering that Kenya is predominantly an agricultural country. Most of the fertilizer used in the country is imported via

Kilindini harbour. The fertilizers are normally imported shortly before the planting season begins. Thus, there is a sudden urgency to have the fertilizers delivered to farmers before the rains which mark the beginning of the planting season. Any delay in the delivery of the fertilizers may render them useless to farmers who will have suffered a great loss in terms of unutilised rains and planting opportunity. In this respect, the ability of the railway to offer low cost mass transport services is significant. Thus, the railway is used to make *en masse* deliveries of fertilizers to distribution centres close to farmers. Nairobi, Nakuru, Eldoret, Thika, Kitale, Kipkelion and Sagana are the leading recipients of fertilizers according to table 2. Wheat bran is the leading manure that is railed in Kenya.

Fertilizer traffic easily causes congestion. It is improperly timed by consignors under pressure and often with limited free warehouse space. Such traffic is easily prone to accumulating heavy demurrage expenses as the consignment tends to be left in wagons over a long period of time.

Wheat is one of the three leading cereals of the country. The others are maize and rice. Wheat is the second major cereal of Kenya and has a wide variety of uses. It is predominantly used in the baking industry. Other uses of wheat are in the production of breakfast cereals, confectionery, pasta, macaroni and spaghetti. Kenya is not self sufficient in wheat production. The *Durum* variety of wheat that is grown in Kenya is of a lower quality. Its dough has a low elasticity and does not minimise cracking during baking. A large proportion of the wheat used in the country, particularly the *Triticale* variety, is imported through Kilindini harbour. Thus, a lot of wheat is railed from Mombasa to leading wheat consuming areas such as Nairobi, Nakuru, Thika, and Kisumu. Some wheat is railed from, Nakuru and Eldoret to Nairobi.

Bitumen is mainly used in the road construction industry. It is a by-product of the petroleum refining process based at Changamwe in Mombasa. Bitumen is a bulky commodity with a low weight to value ratio. Bitumen requires low cost means of transportation. Kenya is increasingly laying bitumen surfaces on her road network. Thus, there has been a continuous flow of bitumen from Changamwe to inland destinations of which Nairobi has been identified by table 2 as one of the leading railway destinations.

Maize is the leading cereal crop of Kenya and the chief staple food crop of the country. The cultivation of Maize is almost nationwide. However, there are a few areas which actually achieve surplus harvests and supply the rest of the country. These areas are located in the sparsely peopled parts of Western Kenya mainly in Trans Nzoia, Uasin Gishu and Bungoma Districts. The leading source and destination railway stations of maize traffic have been identified by table 2 as;

i) Nairobi to Mombasa (391,819).[16]

ii) Kitale to Mombasa (12,550) and Nairobi (11,453).

iii) Moi's Bridge to Mombasa (9,004).

iv) Eldoret to Mombasa (12,878) and Nairobi (8,455).

v) Nakuru to Mombasa (11,888) and Nairobi (12,164).

vi) Webuye to Nairobi (8,138).

vii) Kisumu to Mombasa (18,546), Nairobi (13,444) and Thika (7,501).

viii) Nanyuki to Mombasa (9,328).

ix) Kipkelion to Mombasa (13,350) and Nairobi (10,758).

Tea is one of Kenya's leading export crops and generates a lot

16 Nairobi is merely a collecting and transhipment point rather than a producer of maize.

of foreign exchange. *Kenya Railways* has been handling very little tea traffic as most of it is transported by road. Table 2 indicates that the leading railway stations in the origination of tea traffic are Eldoret (for Nandi District) and Kipkelion (for Kericho District). Both stations send their tea to Mombasa for auctioning and shipping to foreign markets.

GEOGRAPHICAL MOBILITY OF VEHICLES

The average train speed in Kenya is 35 km/hr. Kenya Railways' diesel electric locomotives can achieve a speed of 72 km/hr. The maximum speed is achievable at very limited sections of the railway, particularly between Taru and Tsavo, Kyulu and Mtito Andei and Kikumbulyu and Kima. The current average transit time between Nairobi and Mombasa is 22 hours instead of the desired 18 hours. At an average speed of 35 km/hr, the 530 km railway distance between Nairobi and Mombasa should ideally be covered in 15 hours and 10 minutes. 15 hours and 10 minutes is approximately the time taken by passenger trains and the railtainer. These are trains that are offered great transit priority that often cause the *en route* delay of goods trains.

Table 3 LOCOMOTIVE TYPES AND THEIR ROUTES

LOCOMOTIVE TYPE	ROUTE OF SERVICE
Class 93 & 94	Nairobi - Mombasa
Class 92	Nairobi - Nakuru
Class 87	Nakuru - Kisumu
	Konza - Magadi
	Voi - Taveta
Class 62	Nairobi - Nanyuki
Class 47	Shunting

Source: Fieldwork

Differences in the technical capacities along the railway network have resulted in the relaying of long distance freight traffic to branch lines. Cargo from Mombasa to Kisumu is relayed. This is as a result of the need to change both the crew, locomotives and/or wagons. Locomotives and wagons are changed so as to adjust to the carrying capacity of branch routes which is governed by the weight of the rails, strength of the bridges and the ruling gradient (table 3). Thus, Kisumu bound traffic from Mombasa is railed to Nairobi by one train. A second train rails the cargo to Nakuru and finally a third train hauls the cargo to Kisumu. This constant shift from train to train often results in a series of delays that slow the operations of the railway. Gilgil station mainly serves as a transhipment point for the Nyahururu based railway traffic.

The movement pattern of freight along Kenya's railway network closely reflects the spatial distribution of leading demand areas. Actual passenger and freight handling capacity depend on the amount of idle coaches/wagons, empty runs and the ease of rescheduling or re-routing. As a general rule, Kenya's railway passenger services strictly observe schedule conditions while freight services, with the exception of the railtainer[17], do not.

The allocation of traffic capacity in time and space appears to be found to be trivial to the extent that;

i) It is often thought that the allocation of capacity automatically matches its demand, and

ii) The spatio-temporal allocation pattern of vehicle capacity is based on a numerous decisions during negotiations between interested parties. Their results can therefore only be

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17 The *railtainer* is a special train that hauls containers between Kilindini Harbour and the Inland Container Depot at Embakasi, Nairobi.

explained in idiographic terms.

Capacity allocation both in time and space is a vital logistic issue that would enhance traffic management along the highly constrained railway network of Kenya. Attention should be focused on how fast *Kenya Railways* can respond to demand separated by time and space. This calls for the consideration of constraints which may be technical, commercial and industrial with a view to providing a specified level of service capacity between specified nodes at specified times. This must be achieved with minimised empty running, transhipment and vehicle stock.

The carrying capacity of a line can be increased by the construction of more or lengthening passing loops, increased number of trains or wagons and increased wagon turn round time. The railway's carrying capacity depends on locomotive power, number of available railway tracks, number and type of wagons, location of marshalling yards, length of passing loops, ruling gradient, speed and signalling technology.

Spatio-temporal capacity allocation of rolling stock in Kenya is often inconvenienced by a marked cyclical demand schedule. Freight traffic often coincides with planting and harvesting seasons while passenger traffic is closely associated to the advent of long holiday seasons. The railway therefore experiences great congestion during fertilizer distribution periods, after harvesting, and long public holidays such as school holidays, Easter and Christmas.

As a general rule, railway services are offered on sectors with sufficient demand to support the existence of such services. This is to the detriment of wayside stations which often have little traffic' that has to be accumulated over a long period of time.

The scheduling of vehicular movement seeks to provide services between specified origins and destinations. The movement is provided at specified times and seeks to minimise empty runs while maximising the use of operating vehicle stock. The spatio-temporal pattern of train movement in Kenya is closely associated with the prevailing demand conditions. The allocated scheduling capacity does not always match local and temporal demand conditions. Thus, the frequent incidence of idle wagons often necessitates the re-scheduling and re-routing of trains at the dictates of the demand conditions in time and space.

Freight trains are scheduled but only move when there is sufficient traffic to be carried. Thus although there is a predetermined timetable of the movement of freight trains, some of the destinations do not receive scheduled services due to lack of sufficient traffic, for example the Gilgil - Nyahururu branch line.

The difficulties associated with the efficient and economic operation of scheduled freight services create a spatio-temporal shortage of vehicle supply. Capacity allocation in time and space is thus determined by the Kenya Railways Corporation's responsiveness to changing demand conditions within a framework of operational, financial and commercial limitations.

WAGON TURN ROUND TIME

Wagon turn round time is a very important determinant of available traffic capacity. Slow moving trains result in a prolonged period during which traffic accumulates. Traffic accumulation is in this case caused by the lengthy engagement of available rolling stock. Under such conditions, traffic may accumulate to levels surpassing by far the short term carrying capacity of the railway. It is therefore convenient for the railway to minimise traffic accumulation by hauling commodities as soon as they are made available for transportation. This requires faster wagon turn round times or more wagons.

Wagon turn round may be increased by using block trains on routes with a high traffic density. Such routes are able to provide a daily supply of wagon loads sufficient for making complete train units. Large scale clients such as the Magadi Soda require the services of a block train so as to speed up the rate at which their products are delivered *en masse* to various destinations, especially to Kilindini Harbour.

The introduction of the *railtainer* is a positive move towards the use of block trains. The *railtainer* is able to move fast because it is not delayed by shunting *en route* since all the wagons are consigned to the same destination, namely, Kilindini Harbour or Inland Container Depot, Embakasi. The *railtainer* enjoys another added advantage as a priority train and thus its transit through stations and blocks is speeded up as goods trains are held behind.

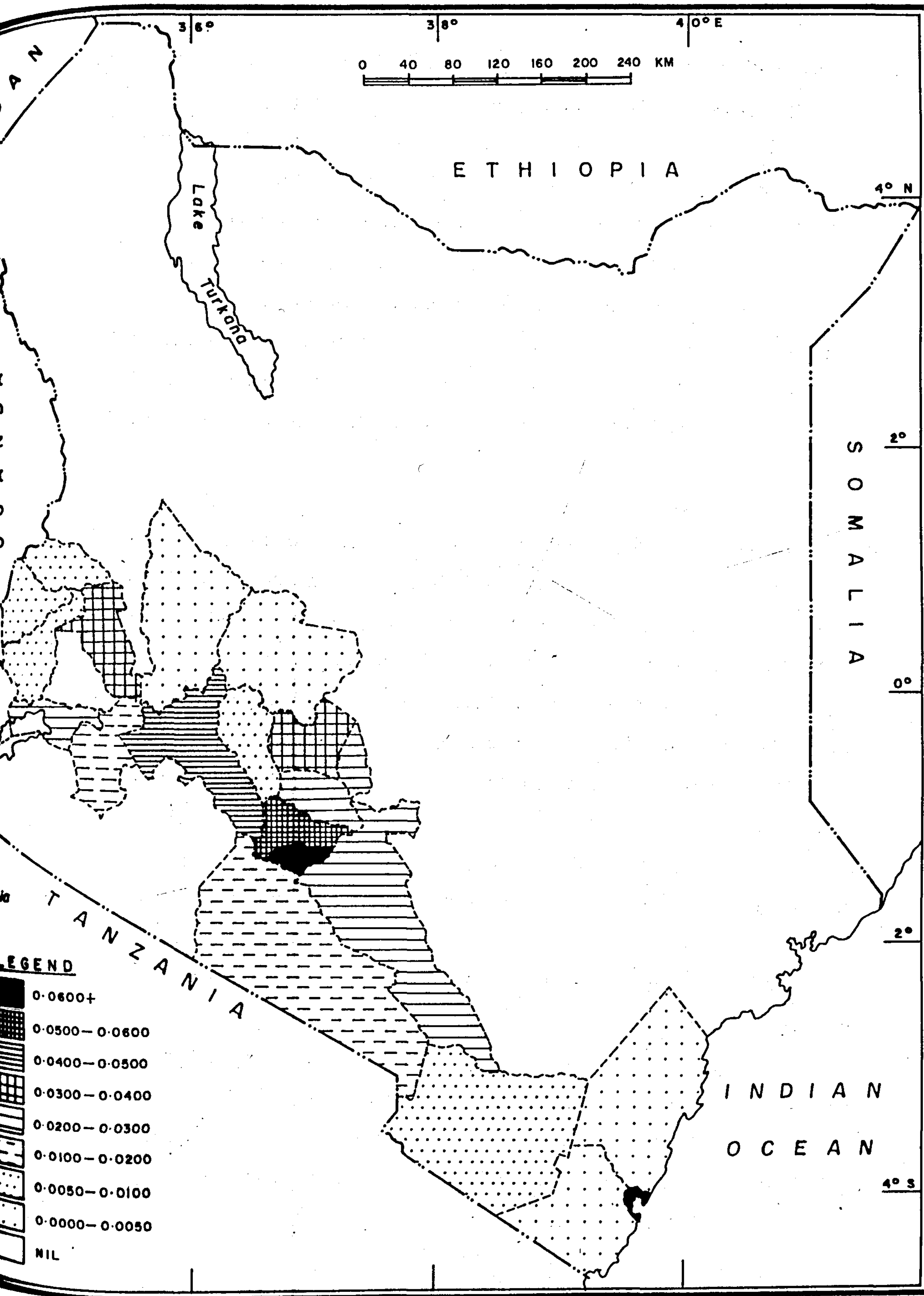
FACTORS INFLUENCING WAGON TURN ROUND TIME

Distance is an important factor that great influences locomotive turn round time. It goes without saying that the longer the distance to be traversed, the longer it will take a train to reach a given destination. One may in this case conceptualise Kenya's railway traffic as originating from Nairobi which is centrally located along the national railway network. The city also lies in the heart of Kenya's population concentration. Over 60% of Kenya's population is concentrated within 300 kilometres from Nairobi. This is an added advantage in that railway traffic can easily be monitored from Nairobi which is the focus of national attention and close to a large population concentration. The city generates a lot of railway traffic and enjoys low aggregate distances to all other stations on the railway network. As a result, Nairobi based railway stations enjoy a better wagon turn round which enhances their carrying capacity.

Speed is another important factor that influences wagon turn round. Maximum train speeds are achieved along limited sections of the railway network and mostly by passenger trains. Slow goods trains share the same railway track with the fast moving passenger trains. All trains must be separated by a safe distance. This is a logistic and technical limitation to the attainment of maximum speed that must be seen in the light of Kenya's single track network, varied ruling gradients and narrow gauge. As a result, goods trains are held at traffic by-pass points for a longer period of time than the high priority passenger trains and the *railtainer*. Goods trains are often stopped to facilitate the by-pass of on coming trains and over- taking by the high priority passenger trains and the *railtainer*.

The nature of traffic also bears heavily on wagon turn round. The *railtainer* and passenger trains receive preferential treatment in the allocation of movement opportunity through blocks. When it comes to a choice, railway authorities would prefer to have their passengers reach their destinations first and then consider the other traffic. Thus, trains serving preferential traffic are able to achieve greater turn round times.

Trains operate under certain technical limitations, namely locomotive power and ruling gradient. The capacity of a locomotive engine to haul determines the turn round time of the vehicles. Powerful locomotives can haul many wagons with great loads within a shorter time period than would have been the case if one train had to make two trips. It is common for one to see two locomotive engines hauling short mixed trains (passenger and cargo) along the Voi-Taveta and Kisumu-Butere branch lines.



5 : DISTRICT RAILWAY DENSITY (Km/Km²)

The movement of freight traffic along the railway is such that some locations have deficits of rolling stock while others have surpluses. The surplus-deficit relationship in space and time is constantly changing. Thus, it is possible for wagons to be delivered at a station and find that the surplus traffic that was previously available has already been cleared by the readily available road transport. On the other hand, surplus wagons may be dispatched from a station lacking traffic which suddenly develops a surplus of traffic soon thereafter. This relationship is most likely to occur at entry points such as Mombasa, Kisumu Pier and Malaba.

TIME LOSS

Trains often lose a lot of time while *en route* mainly as a result of logistic constraints at marshalling yards and sporadic shunting opportunities. There are a few shunting engines along the railway network most of which are confined to major stations that handle heavy traffic such as Nairobi, Mombasa, Changamwe, Thika, Nakuru, Eldoret, Magadi and Kisumu. The most affected stations are wayside stations which lack permanent shunting engines. Pick-up trains are the most affected by time loss at wayside stations. They render shunting services while collecting or delivering wagons. Thus, pick-up trains are delayed for many hours because of rendering shunting services at wayside stations.

Pick-up trains also lose a lot of time by delivering and collecting numerous consignments from wayside stations. The trains have to be shunted so as to detach wagons meant for a specific station. This is a time consuming exercise that has greatly affected the operation of small quantity freight services. The most outstanding example in this case is the handling of personal effects. The shippers of personal effects often complain that their consignments reach their destinations after a very long period of time. There are occasions when goods handled by pick-up trains have erroneously delivered to the wrong destination. This takes a long time for the error to be corrected since pick-up trains are rare and mainly operate on a weekly basis.

There is a weekly pick-up train that operates between Nairobi and Athi River or Konza, depending on the amount of available traffic. As a result, it takes a long time to clear small consignments from wayside stations between Nairobi and Konza. This trend reflects the long duration over which sufficient wagon loads, that warrant the assembly of a train, are accumulated.

Hand shunting is sometimes practiced at wayside stations and railway sidings. This is a dangerous practice as it is very difficult to stop, particularly a loaded wagon that has gathered sufficient momentum. It can easily lead to the damage of property and even threaten human life. Hand shunting is often practiced as a time saving measure at wayside stations and railway sidings where shunting engines are not readily available.

Passing loops have been sources of delay to railway traffic. Trains are often held up so as to facilitate the by-passing of on coming trains and also permit the faster and more preferred trains to overtake slow trains. Thus, passing loops are areas of time loss to all trains either through the waiting for on coming trains to by-pass or slow trains paving way for the fast moving or priority trains. The current average transit time for goods trains between Nairobi and Mombasa is 22 hours instead of the desired 18 hours. This is a loss of 4 hours of transit time that is mainly attributed to delays *en route*.

In the recent past, there have been a few incidents of train delays attributed to railway staff action based on industrial deputes.

This mainly occurs in the form of go-slow tactics that delay the clearance of transit trains through stations. Information gathered in the field indicate that railway staff at wayside stations, particularly those in the Tsavo East National Park are dissatisfied with available security precautions. This is a wildlife infested area with memories of the *man eaters of Tsavo* and has inadequately fenced stations. Thus, railway staff fear to handle transit trains at night.

4.4 TRANSIT SERVICES (RAILWAY)

There are three stations which handle transit railway traffic namely; Taveta, Kisumu and Malaba. Kitale has the potential for handling transit traffic to Southern Sudan on condition it is transhipped to road transport at Kitale. Kisumu Pier and Malaba Railway Station handle the bulk of Kenya's transit railway traffic. Taveta station handles small consignments of foodstuffs from the shores of Lake Jipe near Taveta and the fertile Kilimanjaro Region of Tanzania. These foodstuffs are used for feeding the population of Taita Taveta District. Occasionally, wagon loads of industrial produce and imports are dispatched to or from Tanzania via Taveta. There have been some occasions when newsprint has been railed from Tanzania to Nairobi through Taveta. The Taveta line has 50 pound rails and two class 87 locomotives that haul a single mixed train with a gross weight of 480 tons.

Table 4 suggests that traffic to Uganda has consistently been more than traffic from Uganda. This trend may be explained in terms of the political turmoil that was experienced in the country mainly in the 1970s. The economy of the country was disrupted and reduced the amount of exports. The recently achieved political stability has narrowed the gap between traffic to and from Uganda.

Table 4 UGANDA BASED TRAFFIC IN TONNES

YEAR	FROM UGANDA	TO UGANDA
1977	118,641	251,867
1978	75,888	161,386
1979	62,786	86,086
1980	43,786	58,256
1981	78,820	115,760
1982	102,913	126,511
1983	115,211	121,751
1984	93,370	157,399
1985	100,620	158,229
1986	89,485	127,887
1987/88	124,468	142,585

Source: Annual Reports, *Kenya Railways*.

The proposed Butere-Mumias-Bungoma railway extension provides an option for the easy diversion of transit traffic in case of congestion at either Kisumu Pier or Malaba Railway Station. The Malaba line has 80 pound rails. It will not lose traffic because it will retain powerful locomotives and service large wagons. The Malaba line also has a favourable gradient while the light Kisumu line has numerous weak bridges and hilly sections.

Table 5 suggests that transit traffic to and from Uganda has gradually been diverted from the Malaba route to Kisumu Pier. This apparent diversion of traffic may be explained in terms of the Kisumu Pier being seen to be more efficient. Wagons are simply marshalled into a wagon ferry which ferries them across Lake Victoria thus eliminating the need for transhipment.

Wagon ferries are used to render Lake Victoria based transit railway freight traffic. The Kenya Railways Corporation, Tanzania Railways Corporation and Uganda Railways operate wagon ferries and Steamers on Lake Victoria. The vessels used include *MV Uhuru, MV Victoria, MV Nyangumi, MV Umoja, MV Usoga, MV Kahawa* and *MV Pamba.* Uganda based wagon ferries also carry wagons with

Table 5 GOODS TO/FROM UGANDA IN TONNES (1983-1988/89)

YEAR	VIA	TO UGANDA	FROM UGANDA
1983	Malaba	121,751	115,211
	Kisumu	-	-
1984	Malaba	157,399	93,370
	Kisumu	-	-
1984	Malaba	158,299	100,620
	Kisumu	-	-
1986	Malaba	82,472	66,678
	Kisumu	45,415	22,977
1987	Malaba	7,304	12,594
	Kisumu	95,252	112,065
1988/89	Malaba	9,972	13,817
	Kisumu	101,649	116,750

Source: Annual Reports, *Kenya Railways.*

consignments for Burundi, Rwanda and Zaire. Jinja is the receiving port of Uganda traffic. *MV Uhuru* is a wagon ferry operated by *Kenya Railways* which ferries between 38 and 40 short wagons and about 22 long wagons. *MV Nyangumi* operated by Tanzania Railways Corporation is a tanker that fetches fuel from Caltex's Kisumu depot to Mwanza.

The Kisumu Pier has played an important role in the growth of Lake Victoria shoreline towns such as Kisumu itself, Musoma, Mwanza, Bukoba, Jinja and Port Bell. A lot of supplies to these towns is railed and transhiped at Kisumu Pier. Uganda bound rail tankers are railed through Malaba because oil is classified as a dangerous good which requires extra precaution in its transportation. Wagon ferries and lake steamers sail between Kisumu Pier and Jinja in approximately 12 hours. Kenya Railways' lake steamers often break down and remain out of order for long periods of time. Kisumu Pier and Malaba Railway Station generate a lot of foreign exchange derived from the earnings of handling transit railway traffic.

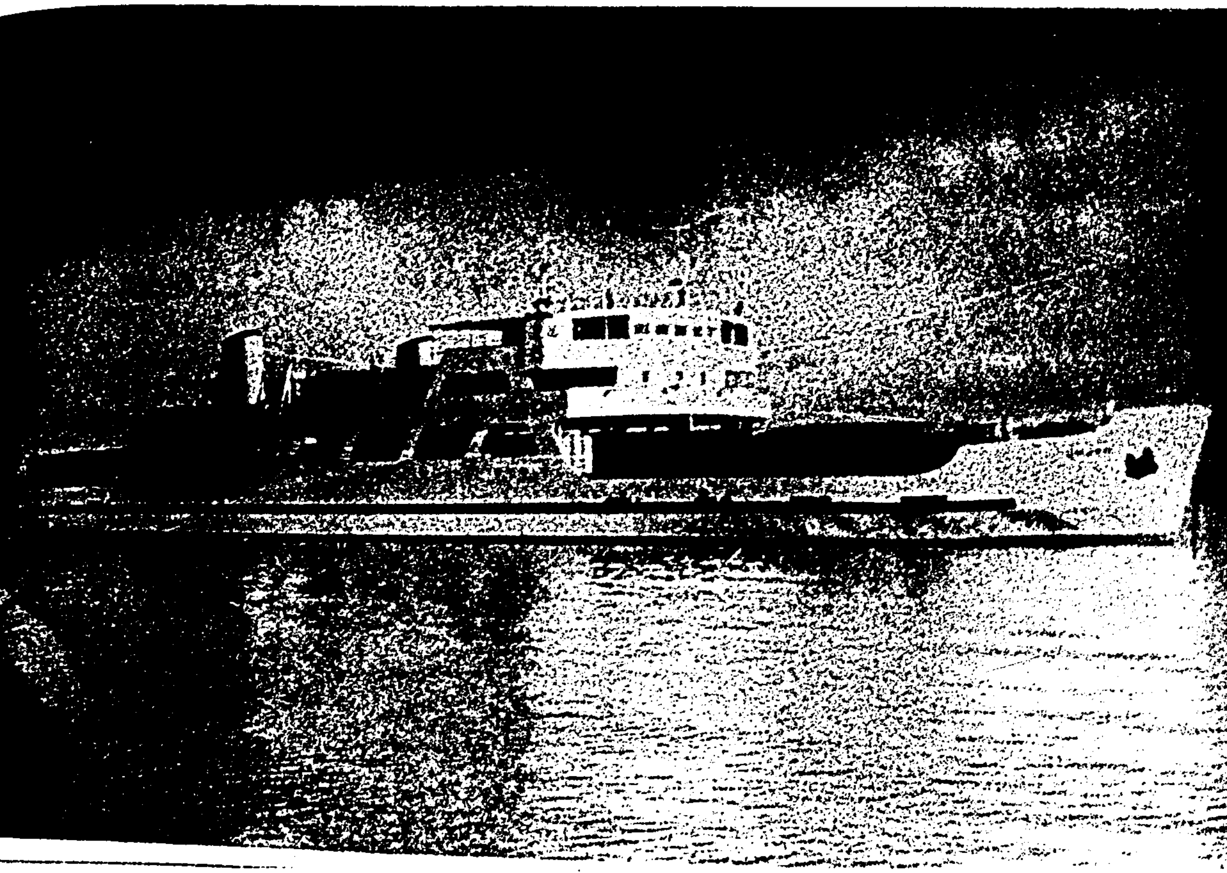


Plate 5 A wagon ferry, *MV UHURU* with railway wagons on Lake Victoria.

Wagon ferries serving neighbouring states have reduced the burden of loading cargo during transhipment. Wagon ferries carry loaded train wagons. Loaded train wagons are simply dismantled into small units and shunted onto or off the wagon ferries. Thus, there is no need for the construction of warehouses at the pier or the installation of high capacity loading equipment such as cranes. Malaba and Kisumu Pier have recently handled erratic amounts of transit freight. Intermittent political tension in Uganda often resulted in the re-routing of traffic destined for Burundi, Rwanda and Zaire through Isebania on the Kenya-Tanzania border to the Southeast of Lake Victoria.

4.5 DATA ANALYSIS I

Attention is now focused on the statistical test of the null hypothesis stating that "Railway traffic does not decline significantly as distance increases." It is assumed that the seats offered at a station reflect the demand for railway services at that particular station while the seats sold represent the "pull forces" to another station. Thus, seats offered are multiplied by seats sold to get the mass which is in turn divided by the distance (Km) of the railway sector between the stations. This exercise is stratified into first, second and third class passenger coaches in order to establish whether there is a variation in the response of the various passenger categories. The distance decay exponent is used to analyse variation in railway traffic with respect to increase in distance. The variables are: Y - Total Passengers, V_1 - Railway Distance (km), V_2 - First Class Passengers, V_3 - Second Class Passengers and V_4 - Third Class Passengers.

Table 6 RAILWAY PASSENGER TRAFFIC (1988/89)

SECTOR	MONTH	V_1	V_2	V_3	V_4
Mombasa-Voi	July	164	5370	9858	20898
Voi-Nairobi	August	366	5559	9938	21566
Mombasa-Voi	October	164	4696	7906	19978
Voi-Nairobi	December	366	5404	10364	16528
Mombasa-Voi	March	164	5832	9709	19319
Voi-Nairobi	June	366	3856	6725	18571
Voi-Mombasa	September	164	4512	8098	18682
Nairobi-Voi	November	366	4666	10251	19122
Nairobi-Voi	January	366	5548	10155	21106
Voi-Mombasa	February	164	5072	8685	81127
Voi-Mombasa	April	164	5232	9805	20569
Nairobi-Voi	May	366	4800	8612	19139
Nairobi-Nakuru	July	181	1172	4392	20340
Nakuru-Kisumu	September	217	1264	4364	23564
Nairobi-Nakuru	November	181	1136	4742	23362
Nakuru-Kisumu	January	217	1333	5033	24512
Nairobi-Nakuru	March	181	1088	7519	25349
Nakuru-Kisumu	May	217	1024	4656	21752
Kisumu-Butere	July	69	0	990	13100
Kisumu-Butere	September	69	0	1620	13800
Kisumu-Butere	January	69	0	1353	14800
Kisumu-Butere	May	69	0	1044	14000
Butere-Kisumu	February	69	0	1008	14000
Butere-Kisumu	March	69	0	1116	14700
Butere-Kisumu	April	69	0	1080	14700
Butere-Kisumu	May	69	0	1044	14000
Nakuru-Nairobi	August	181	1296	4698	24334
Kisumu-Nakuru	October	217	1104	4649	21692
Nakuru-Nairobi	December	181	1744	6963	24598
Kisumu-Nakuru	February	217	1011	3980	23109
Nakuru-Nairobi	April	181	1152	5271	23693
Kisumu-Nakuru	June	217	928	3701	21091
Nakuru-Eldoret	July	204	256	1191	6030
Eldoret-Malaba	September	137	224	1002	4890
Nakuru-Eldoret	November	204	208	941	4726
Voi-Taveta	December	120	0	306	5134
Voi-Taveta	May	120	0	306	5120
Malaba-Eldoret	October	137	240	1019	5000
Malaba-Eldoret	December	137	230	1439	5888
Taveta-Voi	February	120	0	288	4832
Eldoret-Nakuru	March	204	208	929	5374
Taveta-Voi	May	120	0	306	241

Source: Costs and Statistics Office, *Kenya Railways* Headquarters.

Table 7 RAILWAY PASSENGER TRAFFIC (1988/89)

Ln $\hat{Y}$	Ln V_1	Ln V_2	Ln V_3	Ln V_4
10.27	5.100	8.589	4.230	4.375
10.31	5.903	8.623	4.370	4.444
10.19	5.100	8.455	4.191	4.401
10.18	5.903	8.595	4.385	4.524
10.21	5.100	8.671	4.148	4.397
10.14	5.903	8.257	4.150	4.584
10.11	5.100	8.415	4.324	4.281
10.15	5.903	8.448	4.407	4.132
10.34	5.903	8.621	4.406	4.676
11.39	5.100	8.532	4.353	4.361
10.26	5.100	8.563	4.519	4.401
10.23	5.903	8.476	4.157	4.580
10.10	5.119	7.067	4.218	4.450
10.23	5.380	7.142	4.223	4.493
10.22	5.199	7.035	4.362	4.461
10.27	5.380	7.195	4.318	4.458
10.32	5.199	6.992	4.217	4.143
10.12	5.380	6.932	3.928	4.164
9.51	4.234	ERR	ERR	3.319
9.57	4.234	ERR	ERR	3.453
9.64	4.234	ERR	ERR	3.720
9.62	4.234	ERR	ERR	3.325
9.59	4.234	ERR	ERR	4.067
9.64	4.234	ERR	ERR	4.078
9.64	4.234	ERR	ERR	3.947
9.58	4.234	ERR	ERR	3.512
10.27	5.199	7.167	4.316	4.666
10.11	5.380	7.007	3.638	4.108
10.30	5.199	7.068	4.066	4.260
10.17	5.380	6.919	3.930	4.291
10.74	5.199	7.049	4.190	4.344
10.05	5.380	6.833	3.704	4.000
8.84	5.318	5.412	3.957	4.206
8.58	4.920	5.338	4.765	3.575
8.63	5.318	5.481	4.196	4.390
8.61	4.788	ERR	ERR	4.423
8.60	4.788	ERR	ERR	4.185
8.60	4.920	5.768	3.428	3.481
8.77	4.920	5.768	3.490	3.481
8.52	4.788	5.768	3.490	3.481
8.72	5.318	5.338	3.490	3.481
6.33	4.788	ERR	ERR	3.414

Table 6 is transformed into natural logarithms (table 7) in order to approximate a normal distribution. This is achieved by equating the value of e to a power of X (where e is approximately 2.718282 and X is any entry in the data set). Table 7 is used to develop a multiple regression model for measuring the strength of the tested parameters. The rate at which total passengers change as distance vary is represented by the distance decay exponent. Thus, the strength of the distance decay function as a predictor of observed total passengers is made easy to estimate. The SPSS stepwise method of multiple regression analysis is used. Step one involved Y against V_3 and produced the following results:

Table 8: R OUTPUT 1

Multiple R	.91368
R Square	.83482
Adjusted R Square	.83069
Standard Error	.37999

Table 9: ANOVA OUTPUT 1

	DF	SUM OF SQUARES	MEAN SQUARE
Regression	1	29.18918	29.18918
Residual	40	5.77565	.14439
F = 202.15329		Sign. F = .0000	

Table 10: t TEST OUTPUT 1

VARIABLE	B	SE B	BETA	T	SIG T
Variables in the Equation					
V_3	.38220	.02688	.91368	14.218	.0000
Constant	5.73947	.28250		20.317	.0000
Variables not in the Equation					
V_1	.03982	.08133	.68899	.510	.6132
V_2	-.10028	-.11500	.21724	-.723	.4740
V_4	.38827	.72704	.57919	6.613	.0000

In step two, V_4 was included in the analysis against Y and the following results were obtained:

Table 11: R OUTPUT 2

Multiple R	.96028
R Square	.92213
Adjusted R Square	.91814
Standard Error	.26422

Table 12: ANOVA OUTPUT 2

	DF	SUM OF SQUARES	MEAN SQUARE
Regression	2	32.24210	16.12105
Residual	39	2.72274	.06981
F = 230.91470		Sign. F = .0000	

Table 13: t TEST OUTPUT 2

VARIABLE	B	SE B	BETA	T	SIG T
Variables in the Equation					
V_3	.27684	.02456	.66182	11.272	.0000
V_4	.22495	.03402	.38827	6.613	.0000
Constant	3.71386	.36389		10.206	.0000
Variables not in the Equation					
V_1	.35180	.86479	.27255	10.617	.0000
V_2	.42837	.57516	.09364	4.334	.0001

In step three, V_1 was included in the analysis against Y and the following results were obtained:

Table 14: R OUTPUT 3

Multiple R	.99013
R Square	.98037
Adjusted R Square	.97882
Standard Error	.13441

Table 15: ANOVA OUTPUT 3

	DF	SUM OF SQUARES	MEAN SQUARE
Regression	3	34.27833	11.42622
Residual	38	.68651	.01807
F = 632.46254		Sign. F = .0000	

Table 16: t TEST OUTPUT 2

VARIABLE	B	SE B	BETA	T	SIG T
		Variables in the Equation			
V_3	.13615	.01821	.32547	7.475	.0000
V_4	.35013	.02094	.60431	16.721	.0000
V_1	.62706	.05906	.35180	10.617	.0000
Constant	.24704	.37537		.658	.5144
		Variable not in the Equation			
V_2	-.05978	- .11241	.06942	-.688	.4957

The derived multiple regression equation is:

$$\text{Ln } \hat{Y} = .24704 + \text{Ln } V_3 .13615 + \text{Ln } V_4 .35013 + \text{Ln } V_1 .62706 \qquad (4.1)$$

Model (4.1) represents transformed rather than real values. It is made to reflect realistic conditions by antilogging. Since all variables in the model have been transformed into natural logarithms, its antilogged form is:

$$\hat{Y} = \exp .24704 + V_3^{.13615} + V_4^{.35013} + V_1^{.62706} \quad \ldots\ldots\ldots\ldots\ldots \quad (4.2)$$

Model (4.2) is simplified by getting the exponent of the regression constant [exp (.24704)] which is 1.28023. The obtained regression model is simplified as:

$$\hat{Y} = 1.28023 + V_3^{.13615} + V_4^{.35013} + V_1^{.62706} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.3)$$

Model 4.3 suggests that the distance decay exponent of the observed sample is $V_1^{.62706}$. The *t* test (table 9) indicates that all observed *t*-values (T) are greater than the critical *t* (SIG T).

The obtained R^2 from R Output 3 (.98037) when multiplied by 100 suggests that 98.037% of the variation in the dependent variable (Y) is attributed to variation in the independent variables. It has been adjusted to .97882 which when multiplied by 100 suggests that 97.882% of the computed regression output is attributed to the variation in the independent variables.

Suppose that Y is to be predicted from V_1, V_2, V_3 and V_4. The correlation between the dependent and independent variables and among themselves are shown in table 17. V_3 has the highest correlation with $\hat{Y}$ but regression model 4.3 gives the highest weight to V_3. The regression model was re-run several times with the addition of an independent variable at a time and the R^2 value noted. R^2 rises by .09731 from .83482 to .92213 with the addition of V_4 to V_3, while the addition of V_4 increases R^2 by .05824 from .92213 to .98037. V_2 is excluded from the analysis. The addition of V_4 to V_3 cuases R^2 to increase by a marging nearly double that caused by the addition of V_1 to V_3.

The analyses of variance show that F Critical was constanlty greater than Significant F. Both *t* and F tests show that there is a significant relationship between the independent and the dependent variables. The *t* and F tests therefore suggest that the observed is not significantly different from the expected. Thus, the null hypothesis stating that "*railway traffic does not decline significantly as distance increases*" is rejected and the alternative hypothesis accepted.

Table 16 indicates that V_2 (-.05978) is not included in the equation. Though negative, the low value seems to suggest that the frictional effect of distance does not significantly influence railway passengers. The obtained R^2 of 0.98037 suggests that 0.01963 or 1.963% of the obtained result is accounted for by other variables including distance.

Table 17 CORRELATION OUTPUT 1

	Y	V_1	V_2	V_3	V_4
Y	1.0000	.5370**	.7866**	.9137**	.8176**
V_1	.5370**	1.0000	.8057**	.5577**	.0061
V_2	.7866**	.8057**	1.0000	.8847**	.3629**
V_3	.9137**	.5577**	.8847**	1.0000	.6487**
V_4	.8176**	.0061	.3629**	.6487**	1.0000

Number of cases: 42. 1-tailed Signif: * - .01 ** - .001

The independent variables have strong positive correlations with Y, all of which are at the .001 significance level. The correlation output suggests that distance is a positive contributor to the number of observed total passengers. This finding tallies with field observations which indicate that many respondents prefer to travel by train because can sleep comfortably, arrive at their destinations with a fresh mind, and that the train is economical. Buses are fast, levy high tariffs and often reach their destinations late at night after an uncomfortable and gruelling trip resulting in prolonged fatigue.

Table 17 reveals a notable degree of multicollinearity among the independent variables. Some correlation values surpass those obtained from the correlation between the dependent and the independent variables. This is a violation of the fourth assumption of the multiple regression analysis which states that "the independent variables are not expected to be highly correlated". The observed multicollinearity may be attributed to the fact that railway authorities allocate seats on the basis of projected passenger turnout. The correlation between V_1 and V_2 (.8057), and V_2 and V_3 (.8847) suggest that upper class passengers respond to distance in a similar manner. This reflects their monetary superiority and comfortable travelling conditions.

Field observations revealed that very few upper class passengers alight or board trains *en route*. Upper class passengers indicated that they prefer to travel by train over long distances because of comfort.

The correlation between V_1 and V_4 is very weak and suggests that distance has a weak positive influence on third class passengers traffic. This indicates that third class passengers are prone to making numerous short distance trips. Field observations revealed that third class tickets are readily available at wayside stations and do not require any advance booking. On the other hand, upper class tickets require advance booking and confirmation for accommodation from the train's origin.

The ease of acquiring a ticket and the numerical superiority of third class passengers greatly governs the general travelling behaviour of railway passengers in Kenya. Field observations revealed that there is intense embarking and disembarking activity from third class passenger coaches at each train stop. This is attributed to:

- Third class coaches are uncomfortable and do not appeal to long distance travellers.
- Vegetable hawkers use third class coaches to deliver agricultural produce to wayside markets such as Kipkelion, Molo, Njoro, Elburgon, Naivasha, Kijabe, Limuru, Dagoretti and between Voi and Taveta.
- The Voi-Taveta train is used by the *Maasai* (who reside in parts of the Tsavo West National Park) to fetch water for domestic use. Many short distance passengers are found on this short sector of 120km.
- Third class tariffs are attractive to people with a low income.

```
HISTOGRAM 1 - STANDARDISED RESIDUAL
NExp N      (* = 1 Cases,    . : = Normal Curve)
0   .02    Out
0   .05   3.00
0   .12   2.67
0   .27   2.33
1   .55   2.00 :
0 1.00   1.67 .
0 1.65   1.33  .
4 2.42   1.00 *:**
4 3.19    .67 **:*
5 3.76    .33 ***:*
4 3.97    .00 ***:
4 3.76   -.33 ***:
3 3.19   -.67 **:
4 2.42  -1.00 *:**
0 1.65  -1.33  .
0 1.00  -1.67 .
0   .55 -2.00 .
0   .27 -2.33
1   .12 -2.67 *
0   .05 -3.00
0   .02
```

Histogram 1 suggests that sample values do not significantly deviate from the normal curve. This is in line with the fifth assumption of the multiple regression model which states that "both the dependent and the independent variables are normally distributed". There is a close relationship between the distribution of the observed and the expected values. The residual values (HISTOGRAM 1) do not significantly violate the first assumption of the multiple regression model which states that "the expected and the observed error of observation sum up to zero [e_i = 0 or (Σe_i)= 0]". The obtained regression model (4.3) is thus assumed to reflect reality.

4.6 SUMMARY

The data analyses have revealed that Kenya's railway traffic achieves high exponents of the distance decay effect. Regression model 4.3 suggests that the distance decay exponent is $V_l^{0.62706}$. The distance decay function has been found to be theoretically feasible and significantly accounts for variations in Kenya's railway traffic. The observations that have not been accounted for by model 4.3 represent the influence of factors other than the analysed variables. Such factors include government policies, business acumen, competition from road transport, and socio-economic factors governing modal choice in transportation.

Field observations indicate that railway freight services are suited to long distance mass transportation. Where long distances are involved, the cost of road haulage tends to be higher than railway transport. The exact break-even point is been difficult to estimate in the absence of reliable road transport statistics. This situation is aggravated further by the fact that road transporters are not required to publish tariffs and therefore lack uniform rates.

Qualitative field evidence indicates that where low value bulky commodities are concerned, the railway has a competitive advantage against road transport for distances exceeding 450 kilometers. This is an arbitrary figure that takes into account: road transport lacks the economics of scale and is composed of numerous independent operators and vehicle units; the official maximum speed for trucks in Kenya is 80 km/hr and their average journey speed is lower; and trucks attain and sometimes exceed the official maximum speed along very limited stretches of the national road network.

CHAPTER FIVE

THE RAILWAY AND REGIONAL DEVELOPMENT IN KENYA

5.0 INTRODUCTION

This chapter attempts to realise the objective seeking "to establish the relationship between transportation and levels of economic development." The building of the *Uganda Railway* is seen as the principal factor that changed Kenya's space economy in 20th century. It provided the initial stimulus for modernisation in Kenya and still performs a significant supportive role in urban, agricultural, industrial and commercial development. The null hypothesis stating that "*there is no significant relationship between the location of major economic activities in Kenya and the railway network*" is tested.

5.1 URBANISATION IN KENYA

Coastal urbanisation in Kenya dates back for nearly 1000 years. It has not been continuous and many coastal towns have remained small while others such as Gedi degenerated and disappeared. The building of the *Uganda Railway* and subsequent introduction of western administrative and economic values and systems preceded a sudden proliferation of incipient towns in the interior of the country.

The building of the *Uganda Railway* broadened the activity space of most traditional Kenyan communities and enabled them to change from the then predominant subsistence economy into a market based economy. The railway enabled indigenous Kenyans to move further, faster and with less physical effort. The *Uganda Railway* provided a stimulus that contributed a lot and greatly accelerated the sudden emergence of urban centres in the interior of the country. The railway provided a basis for the territorial delimitation of the British sphere of influence. Thus the British set up an administrative structure and peace treaties that saw an end to inter-tribal animosities.

Numerous urban centres in mainland Kenya emerged after 1898 when railway construction work started. These urban centres are located along or close to the railway. They owe their origin and subsequent growth to the building of the railway. The urban centres, among others, include; Voi, Nairobi, Nakuru, Naivasha, Gilgil, Nyahururu, Thika, Murang'a, Nyeri, Nanyuki, Kisumu, Eldoret, and Kitale.

Table 18: URBAN POPULATION CHANGE IN KENYA (x 1000)

TOWN	1948	1962	1969	1979	1983	1990	2000
Nairobi	119.0	343.5	509.3	809.8	828.0	1875.0	2883.0
Mombasa	84.8	179.6	247.1	341.1	508.8	667.5	997.6
Kisumu	10.9	23.5	57.4	152.6	163.0	250.0	499.3
Nakuru	17.6	38.5	47.1	92.9	92.1	129.1	201.4
Thika	4.4	13.95	23.4	41.3	61.5	100.0	199.4
Eldoret	8.2	19.60	18.2	50.5	57.4	102.0	199.7
Kitale	6.3	9.3	11.6	28.3	27.7	43.0	75.2
Nyeri	2.7	7.9	10.0	35.8	31.3	51.6	104.7
Meru	-	-	4.5	70.4	18.1	36.1	99.7

Source: Irandu, 1989.

The railway was the dominant supply line of freight and passengers to Kenya's leading urban centres during the first half of the 20^{th} century. This was the period when most mainland urban centres in Kenya were emerging. It is therefore tempting for one to attribute their size and location to their proximity to the railway. Table 18 provides actual and projected populations for the nine largest urban centres in the country up to the year 2000. Out of all these towns, only Nyeri and Meru do not have a direct railway connection.

Nyeri is served by a nearby railway station (Kiganjo), while Meru is served by the Nanyuki railhead. Proximity to the railway seems to have been one of the principal factors guiding the early period of interior urban development in Kenya and remains a leading factor in their subsequent growth. The *Uganda Railway* was responsible for the creation of new settlements and the transformation of old ones. Railway based settlements may be divided into three groups, namely; railhead, railway workshops and railway junctions. These are often associated with transhipment.

Ogendo (1989) discusses a Kenyan based centrifugal model for spreading development impulses. He suggests that in a system of integrated regional development, urban centres are not merely planned for the special purpose of assisting in rural development. They should also be seen to be in symbiotic rather than parasitic coexistence with their rural hinterlands. The pattern of railway traffic in Kenya appears to foster inter-urban linkages more at the expense of rural-urban linkages. There is thus a significant amount of railway traffic between urban and rural centres. Most of this traffic normally involves the transhipment of commodities with urban centres acting as accumulating and distribution centres. The traffic mainly comprises agricultural produce for export and imported agricultural inputs such as fertilizers and machinery.

The District Focus for Rural Development strategy embodies a noble objective seeking to disperse development opportunities in space. It implicitly highlights the recognition, by the government of

Kenya, of accessibility is one of the major factors that influence the spatial distribution of development opportunities. There is a limited number of suitable development points which are conveniently located adjacent to the existing railway and major road network. However, if these points are exploited to the full, there is a risk of reinforcing a linear development pattern based in the southern parts of the country and over loading the very transport networks that will have led to its development. The district focus for rural development strategy seeks to:

i) Encourage the growth of the medium sized towns in order to provide facilities and stimulate economic growth in surrounding regions.

ii) Attempt to correct the excessive growth of Nairobi by decentralisation, wherever possible, of industries to other urban centres.

iii) Boost urban centres showing vigorous growth potential and areas which have hitherto suffered from neglect.

The urbanisation process in Kenya is largely a product of rural to urban migration. This migration is often attributed to the recent improvements in the national transport infrastructure, modern economic realities and freedom of movement in the post colonial era. As is the case in Kenya, urbanisation resulting from such forces often lacks a strong industrial base. As a result, the urban population in Kenya is to a large extent dependent on the support of the rural sector for the supply of basic commodities owing to widespread urban unemployment. The high concentration of people necessitates the mass movement of basic supplies to urban centres. Urbanisation in Kenya is closely associated with the national transport infrastructure, of which the railway is a prominent component. The railway still plays a significant though declining role in Kenya's urbanisation process. This is mainly through its capability to offer mass deliveries of commodities such as cement, industrial raw materials, finished products, and foodstuffs.

5.2 INDUSTRIALISATION IN KENYA

Industrial development is a function of; transportation, organizational dynamism, interdependence and diversity, and corporate entrepreneurship. This clearly indicates the important role of transportation to industrial development. However, transport infrastructure *per se* does not determine industrial location.

Industrial location in Kenya appears to depend on a wide range of factors which incorporate elements of societal change, adoption, adaptation, and a host of economic and political factors. This situation limits the base upon which one may clearly isolate the role of the railway as a determinant of industrial location in Kenya despite the fact that it features prominently in the movement of industrial raw materials and finished products.

Industrialisation looms large in the smooth operation of Kenya's railway transport services irrespective of the role played by the railway in influencing industrial location in the country. There appears to be a strong relationship between the location of large scale industrial enterprises in Kenya and their proximity to the railway network. Field observations indicate that almost all major industrial areas of the country are within fifty kilometres from the railway or a railhead. This is an advantage because railway transport easily lends itself to low cost mass transportation. Industries are therefore able to take advantage of the transport facilities offered by the railway people.

The location of industries in Kenya is to a large extent determined by the availability of capital and a supporting infrastructure. It is in the area of supporting infrastructure that transportation looms large. Transportation facilitates the movement of raw materials and the distribution of finished products. The relationship between industrialisation and Kenya's railway network is similar to the one that exists between the railway and urbanisation. The railway offered the earliest means of mass transportation and provided the initial stimulus for industrial development. Industrial facilities continue to concentrate around the railway network as a result of geographical inertia.

Weber (1909) argues that industrial location is largely a matter of transport costs and that the best location is one which minimises total transport costs. He has been rightly criticised for emphasising transport costs at the expense of other costs that comprise total production costs. Hoover (1948) develops Weber's argument and emphasises the role of total transfer costs (of which transport costs are a major element) as being basic to industrial location theory. The concept of optimum industrial location appears to be of academic interest with almost no real life value. White and Senior (1983:87) observe that *"... in most cases, the transport element is less than 5% of total costs. Even if relocation reduced transport by 20%, a very large amount, there would be no more than 1% change in costs."*

This observation strongly cautions planners against the assumption that the spatial rearrangement of an economy is made possible by merely providing transport facilities. Transport improvements can and often provide an incentive that promotes industrial development in cases where movement *per se* looms large. This situation is commonly associated with low value and weight loosing industrial raw materials such as timber.

In large scale industrial concerns such as cement and sugar production, economies of scale can be obtained from large plants. This has favourable implications for the railway which can offer large scale mass transit services within a short period of time. In this respect, the availability of railway services looms large in the location and exploitation of large scale industrial opportunities.

The majority of the industries in Kenya are light and small scale operations. They use little inputs of raw materials and energy. Their significance to railway operations lie in their numerical superiority and spatial diversity rather than individual traffic needs. These industries do not require block trains. Individual industrial enterprises may receive or send wagon load consignments. Thus, a large concentration of small scale industries such as in Nairobi, Mombasa, Thika, Athi River, Nakuru, Eldoret and Kisumu has enhanced the total volume of railway freight traffic to these towns though serving numerous clients. Most of these clients are served by pick-up trains, which as we have seen in chapter four, face numerous constraints.

Light industries are often found to be *foot-loose.* They are suitable for small scale operations which favour short distance road services. Road transport is readily adopted to the small and sporadic traffic along complex networks. The significance of railway transport as a factor that influences industrial location in Kenya is clearly seen in the case of large scale industrial enterprises such as the Magadi Soda Mining PLC and Miwani Sugar Factory.

Cement is a bulky commodity with a low value *vis-a-vis* its weight. Its production is strictly limited to locations with limestone. However, it is also a vital commodity in the construction industry with a nationwide market. In this regard, its transferability is an important factor that affects the decision to exploit limestone reserves for the purpose of cement production. Movement costs and mass transportation loom large in the distribution of cement in Kenya.

Ogendo (1989:19-20) regards industrialisation as capable of facilitating concrete progress because:

i) It increases regional (or national) income faster than primary or extractive economic activities.

ii) Industrial development facilitates diversification of exports, thereby improving the availability of both foreign exchange earnings and goods.

iii) Encourages the reduction and possible elimination of unemployment, particularly if the chosen industries are labour-intensive.

iv) Industrial development encourages and should be seen to encourage the production and supply of industrial raw materials which support such local industries.

He further observes that "*Industrialisation has a greater potential for economic development to the extent that industrial technology can easily be relocated through the movement of equipment. The spread of industrial technology is to a significant extent determined by the availability of transport.*"

Field observation indicate that most large-scale manufacturing concerns in Kenya are located close to the railway. It is, indeed, rare to find a large-scale industrial concern that is located more than 75 km from the railway or a railhead. The railway appears to influence *industrial location*[18] and site in Kenya. It was noted that the railway network in Kenya is primarily inter-urban. Apart from Mombasa, the railway passes on the outskirts of towns which are designated as industrial areas.

[18] Industrial location refers to the external links of an industrial firm with respect to the position of its related firms and market outlets.

The observed spatial relationship between Kenya's railway network and the location of large-scale industrial firms seems to enforce the view that railways specialise in large-scale mass transportation over long distances rather than the highly flexible and localised small traffic. This relationship may be attributed to the fact that railway land is often in a prime location and leased by firms which may from time to time require railway services.

The spatial relationship between Kenya's railway network and industrial firms may also be explained in terms of geographical inertia. The railway was for a long time the only or dominant mode of transportation in Kenya. Today, many industrial concerns are still close to the railway though a large number of them have increasingly shifted to road transport. In this case, such industries may not have been attracted by the railway *per se* but rather by the need to be close to related industries or the availability of free land.

The railway provides a mechanism for extending markets by setting the limits of the spatial demand scope for goods. Bulk movement and unprecedented spread over long distances enabled mass production and thus extended market areas in the early days of this century. The railway is particularly suitable in this area because it provides low cost mass transport services which facilitate the movement of goods required for agricultural, industrial and commercial development. Mass production and market opportunities in Kenya are related to mass transportation and spatially aligned to a transnational railway network.

Ogendo (1989) has mapped human-based development resource pattern with a view to portraying the nature of Kenya's space economy and highlighting its composite pattern of potential resource bases for future planning. He attributes this pattern to *"... the nature of colonial and early independence periods' regional economic*

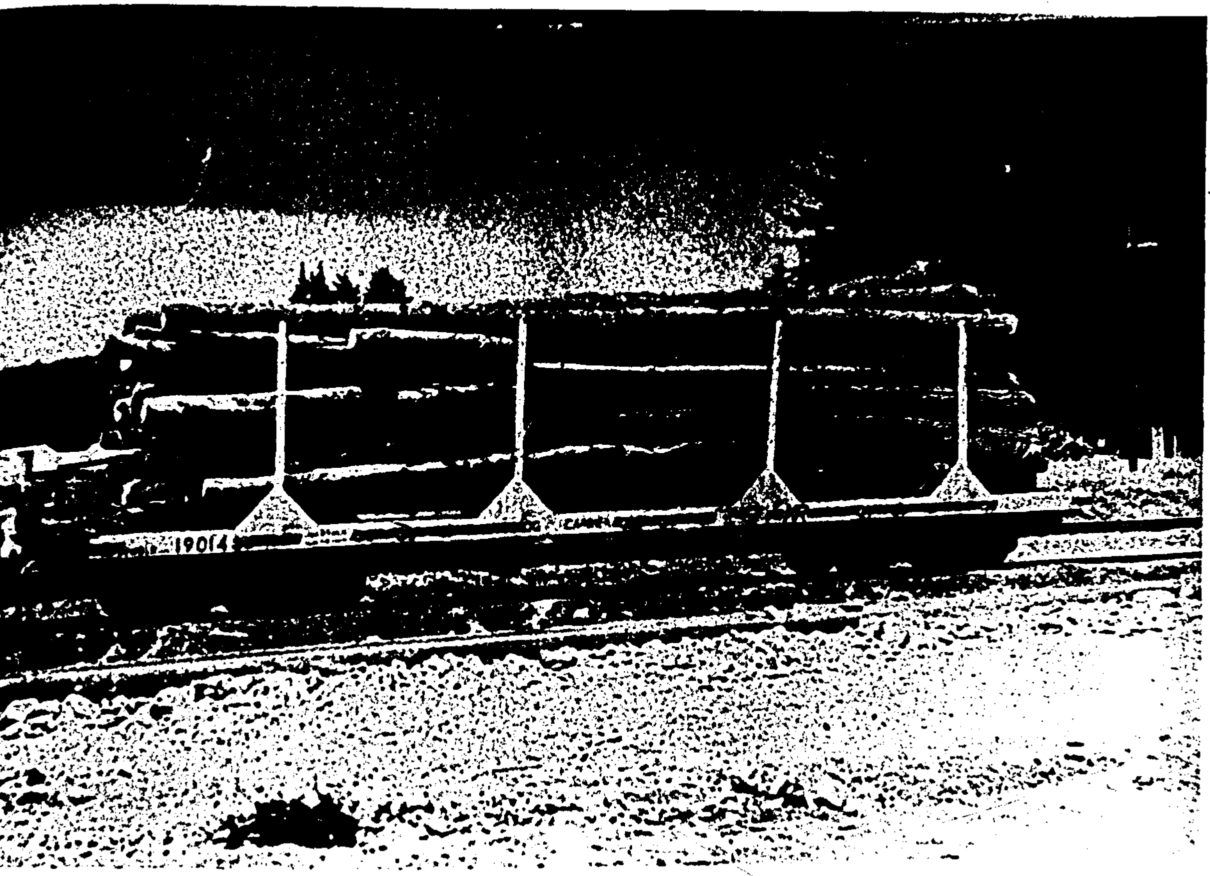


Plate 5 A loaded log carrier in Kaptagat forest.

development planning models such as ... Friedmann's type of growth centre model ... or ... Christaller's central place model, causing a serious polarised Kenyan space economy due to biased disaggregation of development policies favouring the so-called alienated areas, especially the white highlands". The resultant development trends have been strongly polarised in a negentropic sense and highly centralised.

5.3 AGRICULTURAL DEVELOPMENT

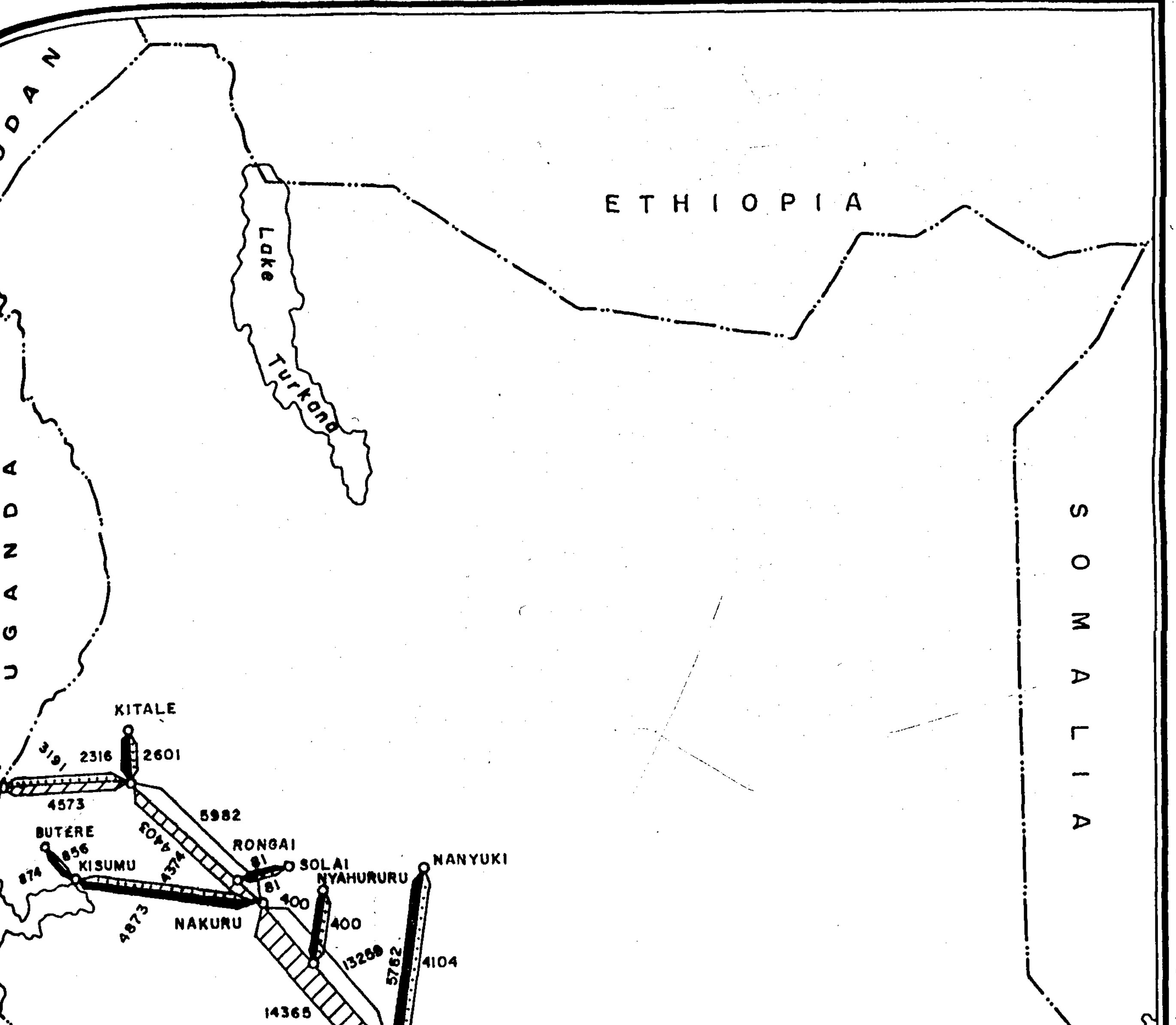
The building of the *Uganda Railway* provided an early incentive for the acceleration of agricultural and livestock rearing activities. The literature review indicated that Kenya experienced notable increases in the acreage of cultivated land and livestock populations in many areas during and soon after the construction of branch railway lines. This observation appears to emphasise the pioneering role of the railway in Kenya's agricultural and livestock development.

The railway still contributes significantly to the development of agriculture in the country although its role in livestock transportation has declined to almost a stand still. The contribution of the railway in the country's agricultural development is manifested in its ability to offer cheap mass transport services. The railway has since its inception applied a differential tariff by charging lower rates for agricultural produce. The agricultural sector provides industrial raw materials, export commodities and food for the rapidly increasing population.

There is a notable concentration of agricultural activities in the Central and Western parts of Kenya. The concentration of agricultural activities in limited areas implies the need for an efficient transport system to move surplus produce to deficit areas. Agriculturally productive parts of the country are far from the coast and require an efficient system to deliver foodstuffs, export commodities and receive inputs, mainly fertilizers.

The railway promotes and sustains the agricultural sector by delivering large quantities of fertilizers to upcountry distribution centres within a very short period of time. Fertilizers are not ordered for throughout the year. Their supply is seasonal, often shortly before the commencement of the planting season. The demand for fertilizers is such that they have to be supplied to farmers before or at the beginning of the rain/planting season. A delay in the delivery of fertilizers can lead to serious consequences.

Kenya's agricultural activities are confined to a few places which have the same planting season. This situation implies that the



MAP 6: AVERAGE FREIGHT TRAFFIC DENSITY (1981—1986/87)

Source?

Plate 7 Loading fertilizers from a ship onto a wagon at Kilindini Harbour.

areal demand for fertilizers is almost simultaneous. Fertilizers are traditionally imported *en masse* shortly before the main planting season which begins in March. The railway becomes a very important instrument for the mass delivery of large consignments of fertilizers to inland distributing points.

The Kenya Grain Growers Co-operative Union (KGGCU) is the main supplier of fertilizers in the country and one of the leading clients of *Kenya Railways*. The union has several depots distributed throughout the republic. Fertilizers are transported from the coast by both rail and road. The railway transports fertilizers to leading distribution points such as Nakuru, Eldoret, Bungoma, Nairobi and

Nanyuki. Road transport is then used to deliver fertilizers to distribution outlets not linked to the railway network and farms.

Transportation can considerably influence the composition and pattern of agricultural activities. In the process, it bears heavily on rural land use. Before the advent of modern low-cost transport in the form of railway transport, farming in Kenya was largely subsistence in nature. Prior to the construction of the railway, Kenya had an extremely limited capacity to import or export surplus agricultural and livestock products. The quality of the country's transport facilities restricted the choices open to farmers and delayed the onset of market based large scale production enterprises. This observation has been highlighted by O'Connor (1965) and Macharia (1967).

CEREALS

The principal role of the National Cereals and Produce Board (NC&PB) is to control the availability of strategic cereals both in time and space. This is an onerous task that requires the collection, transportation and storage of large quantities of cereals. The significance of the railway to the activities of the NC&PB lies in its ability to offer mass transportation services.

The transportation of cereals handled by the NC&PB is strictly regulated by law. Individuals are by law not allowed to transport quantities exceeding ten kilograms without a movement permit which is valid between 6:00 am and 6:00 pm. The importance of the railway becomes significant when one considers the second restriction. Kenya Railways transport cereals without time restrictions. Road transporters are often forced to make night stops in order to comply with movement permit restrictions.

Night stops by road transporters in effect delay delivery and minimise the difference in time between long distance road and railway delivery time. Many roads in Kenya are narrow and often lack a smooth surface even when bitumenised. Heavy duty commercial vehicles are legally forbidden from exceeding a speed of 80 km/hr. Legal speed limits, poor road surfaces and heavy loads combine to slow the movement of road hauliers. Low truck speeds are achieved along the poorly maintained old road from Nairobi to Naivasha which has been set aside for use by vehicles whose tare weight exceeds seven tonnes.

Maize is the staple food for most Kenyan communities. Its consumption is spread throughout the country. The spatial dimension of the production of this vital cereal appears to reflect the population distribution in the country. This pattern suggests that little maize enters the national market. Peasant farmers sell surplus maize which is often a very small percentage of the total harvest. Thus most maize is consumed within the localities where it is produced and therefore not available for formal marketing and storage arrangements.

There is a distinct spatial imbalance between the supply and demand of maize in Kenya. The Western parts of the country, namely the central parts of the Rift Valley province, and parts of Western and Nyanza provinces often achieve surplus maize harvests particularly in Trans Nzoia and Bungoma Districts. The remaining parts of the country are deficit areas, particularly major urban centres such as Nairobi, Mombasa, Kisumu, Nakuru and Eldoret. Urban centres have high population concentrations. These are areas of intense consumption of maize meal and are supplied with maize from elsewhere. It is also important that the stocks of strategic maize reserves are distributed equitably throughout the country with a view to minimising delivery times to specific regions in the event of a sudden unexpected food shortage in any section of the country. Thus, Kenya Railways is well placed to render a nationally significant service based on its ability to offer mass transportation services.

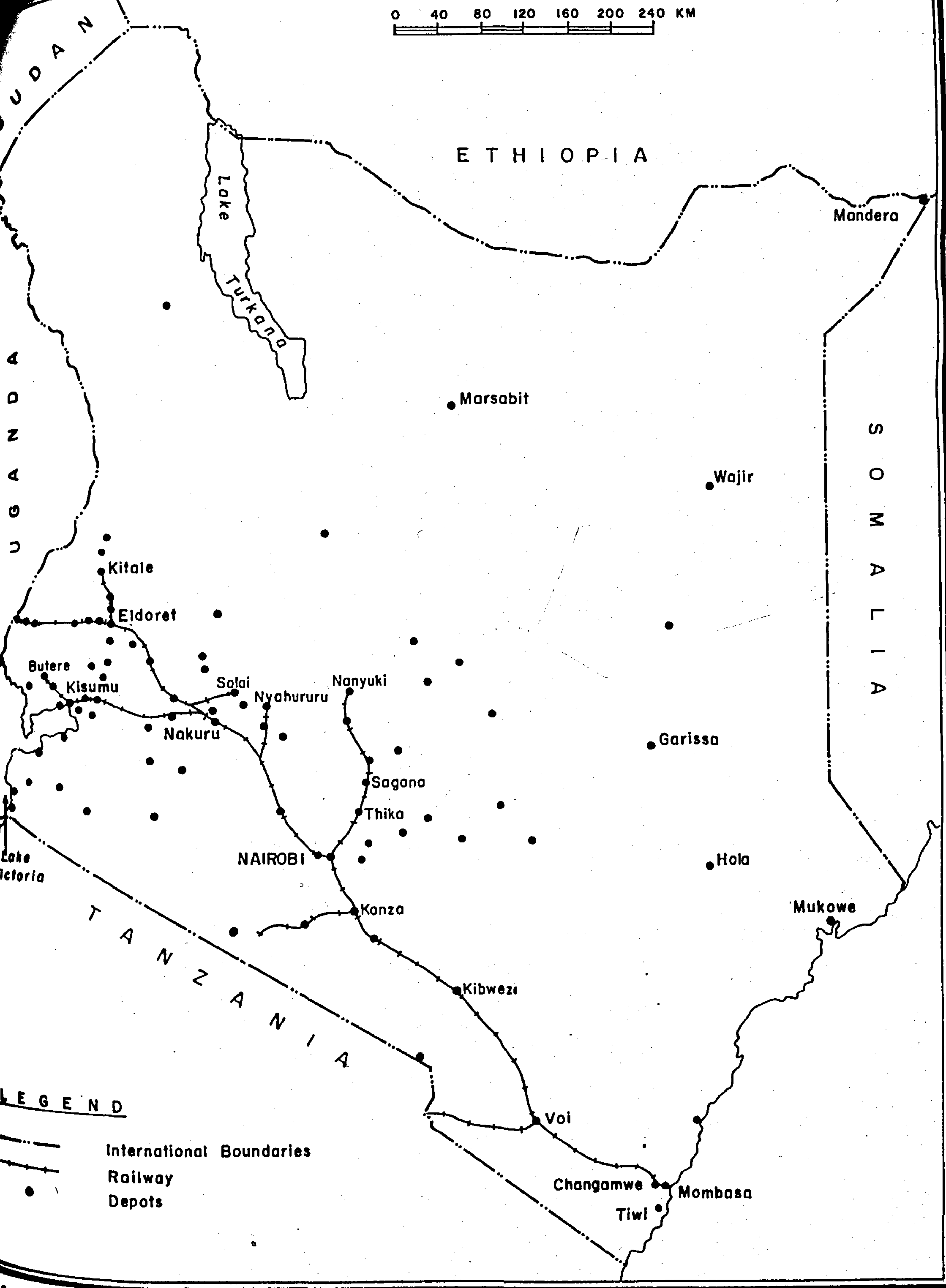
There is an imbalance between the timing of the supply and demand of cereals in the country. Cereals in Kenya are obtained from a geographically restricted area. As a result, the crops mature almost simultaneously and result in mass harvests. The net result is that there is a lot of agricultural produce to be delivered to various storage centres within a short period of time. This often exerts great pressure on the operations of the railway. The deliveries have to be made quickly so as to avoid the destruction of cereals due to poor storage conditions on farms and at buying centres.

The NC&PB may import a lot of grain, say wheat. The ship delivering the grain has its own movement schedule which may not conform to the storage arrangements at Mombasa and Changamwe depots. Under such circumstances, the only option for the NC&PB is to transfer the agricultural produce that is stored in Mombasa and Changamwe depots to upcountry depots with space. This is a measure that seeks to create space so that the imported cereal is closely monitored so as to facilitate proper accounting. Such situations often require speedy removal of large quantities of produce from available godowns within a very short period of time. In such instances, the railway is well placed to offer such services. However, without prior consultations, it is very easy for the NC&PB to urgently require the services of the railway yet the railway is unable to respond immediately because their wagon fleet is already engaged elsewhere or has to be assembled and relocated.

The NC&PB's chain of depots has evolved from the spatial differences in the supply and demand for cereals in the country. These depots perform two important functions in addition to the storage of produce, namely; the purchasing and selling of cereals. Large depots lie along the Kenya Railways network. In this regard, one would expect the NC&PB to utilise, as much as possible, the readily available railway services. This is in fact part of the policy of the board. In recent years, there has been a considerable reduction in the volume of the N.C. & P.B's traffic handled by rail. There is an apparent shift of traffic to road transport which coincides with a sudden increase of heavy duty trucks. Such trucks were in the past confined to regional international freight movements.

It is difficult for one to asses the significance of the apparent gradual shift by the NC&PB from railway to road transport. Part of the problem lies in the fact that Kenya's railway network is highly restricted. Railway served depots often serve as regional collection and distribution centres. Most of the depots are served by road transport (map 7). Thus, as long as the railway network remains limited in its spatial extent, any increase in cereal traffic will imply a greater reliance on road transport. It is also worth noting that the number of road carriers increases at a greater rate than that of railway carriers.

Observations made during the fieldwork suggest that there has been a notable decrease in the amount of cereals transported by road particularly from railway based NC&PB depots of Western Kenya. One may expect an increase in traffic based on non-railway dependent depots to result in increased road traffic. This apparent shift from rail to road transport appears to be misplaced particularly when it comes at a time when Kenya Railways has, in the view of many of its clients, improved its services significantly. Two suggestions may be put forward to explain this apparent anomaly, namely;



AP 7 : NATIONAL CEREALS AND PRODUCE BOARD DEPOTS

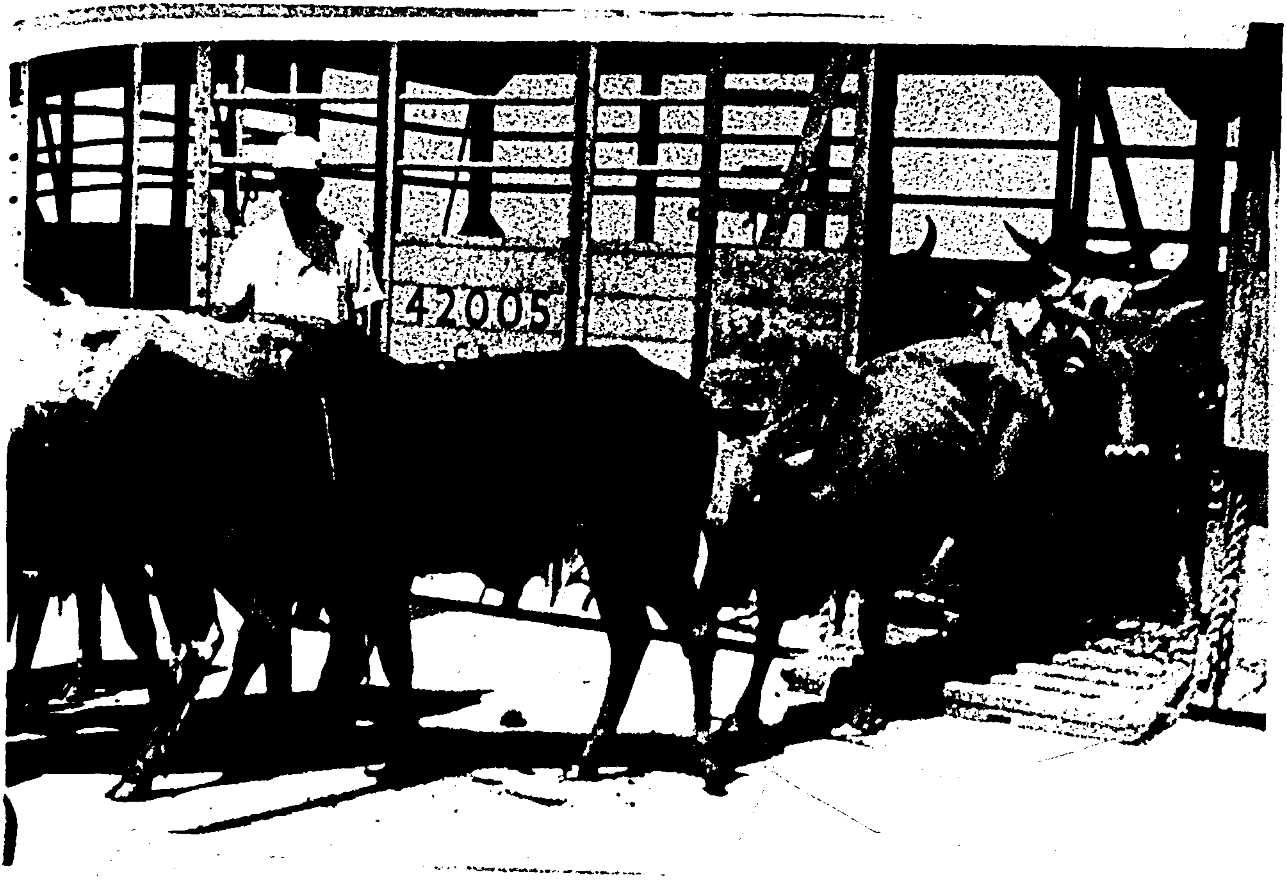


Plate 8 Livestock disembarking from a wagon.

i) Road transport in Kenya has recently witnessed an increase in new investors perceived to be wielding immense political clout. This view appears significant because of the sudden amount of business that such transport firms are offered in comparison to their older and more established counterpart firms with better delivery records. Some respondents suggested that it is strange for new firms to suddenly emerge and take business opportunities from a state corporation that has increased the efficiency of its services.

ii) The awarding of business opportunity is, at the end of the day, based on the law of supply and demand. One party has a service to offer while another one demands the same service.

Road transporters comprise numerous small fleets which are under independent management. This requires little consultation and authorisation before a business deal is struck. As a result, road transporters are able to negotiate for lucrative business with greater ease and venture into transport areas that appear to be in the domain of the railway, namely mass transportation.

A limited number of NC&PB depots have railway facilities. This situation implies that road transport will in the foreseeable future continue to be the dominant mode for transporting cereals in the country. The railway's role will be constrained to the few depots that lie along its network.

The following NC&PB depots are served by the railway.

i) Malaba - Eldoret line: Malaba, Myanga, Bungoma, Webuye, Lugari, Kipkaren, Turbo, and Kipkabus.

ii) Kitale - Eldoret line: Kitale and Moi's Bridge.

iii) Eldoret - Nakuru line: Eldoret, Marigat and Nakuru.

iv) Rongai - Solai line: Solai.

v) Butere - Kisumu - Nakuru line: Butere, Yala, Kisumu, Muhoroni, Kipkelion, Kedowa and Elburgon.

vi) Nakuru - Nairobi line: Naivasha, and Nairobi.

vii) Gilgil - Nyahururu line: Nyahururu and Ol Kalau.

viii) Nairobi - Nanyuki line: Thika, Sagana and Nanyuki.

ix) Nairobi - Mombasa line: Konza, Emali, Kibwezi, Voi, Changamwe and Mombasa.

The NC&PB has made great progress towards adopting bulk handling and storage. Bulk storage, mainly silo, facilities have been constructed at a number of depots served by the railway. Nairobi, Nakuru, Eldoret, Kitale, Kisumu and Bungoma depots have silos. Another silo is being constructed at Moi's Bridge. Depots with bulk storage can receive and dispatch produce by rail. The bulk transportation of cereals is rare in Kenya. Wheat often arrives in Mombasa *en bulk* but is not transported inland *en bulk*.

5.4 MINERAL EXPLOITATION

The primary condition for the occurrence of a mining industry is that mineral deposits to be mined must be in existence in economic quantities. Large scale mining is a capital intensive activity which is made possible only when substantial amounts of the deposits are available. On the other hand, mineral deposits may remain unworked in the absence of adequate transport facilities.

The occurrence of mineral deposits in Kenya is limited and unevenly distributed over the country. Few of the deposits are commercially exploited on a large scale. Magadi's soda ash and salt deposits are the most significant and extensively exploited mineral deposits in the country. The Magadi Soda mining factory was opened in 1919 after it had built a branch railway line from Konza to Magadi. The Magadi Soda Mining PLC constructed a road to Nairobi in 1976. The road was intended to ease the supply of basic township commodities.

The road to Nairobi is narrow and mainly used for passenger transport. The railway link from Nairobi is southward bound and often necessitates road transport. Incidentally, the Konza railway junction best exemplifies Kohl and Christaller's postulation that transport routes meet at angles that point towards the direction of the greatest traffic flow (page 6). Two Class 87 locomotives are sufficient for handling the traffic on the Magadi line. They can haul 17 hopper wagons each. The Class 87 locomotives have been in operation for a very long period of time and are prone to frequent

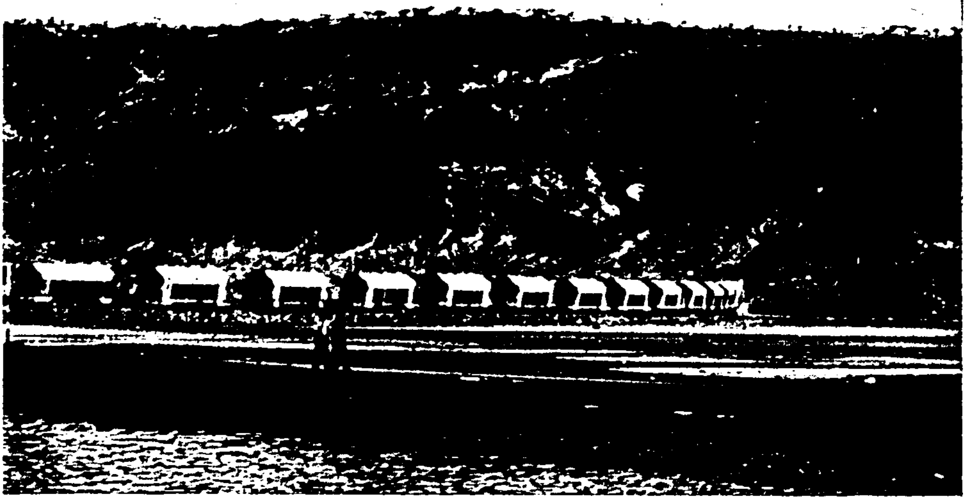


Plate 9 A block train leaving Magadi.

mechanical breakdown. This makes them to be highly unreliable and calls for urgent measures to improve the reliability of the locomotives in use on this important railway branch line.

Kenya Railways has dedicated 140 hopper wagons to serving the Magadi soda works. They operate between Magadi and Shimanzi terminal in Kilindini harbour. The hopper wagons are highly specialised and are speedily loaded and unloaded in bulk. This enhances the wagon turn round time. Soda ash accounts for approximately 85% of Magadi's output and is export orientated. It is railed to the Shimanzi terminal for storage and movement by a conveyor to a specialised berth for consideration of introducing a special block train to handle the soda ash traffic. Table 19 highlights the prominence of export orientated bulk soda ash that is railed using hopper wagons. Magadi is also the principal source of salt in Kenya. Salt traffic accounts for the bulk of Magadi's domestic traffic. The handling of salt traffic is more problematic than soda ash. Salt is not transported in specialised wagons.

Table 19 RAILED SODA ASH 1980-1986 (in tonnes)

YEAR	BULK	%	BAGS	%	INTERNAL	%	TOTAL
1980	114,292	52	82,581	38	23,342	10	220,215
1981	59,149	36	85,036	52	18,135	12	162,320
1982	98,454	58	53,739	31	18,542	11	170,735
1983	119,649	59	57,710	29	24,627	12	201,986
1984	113,990	51	89,489	40	21,999	9	225,478
1985	123,842	53	86,699	37	21,956	10	232,497
1986	133,565	56	94,437	40	9,520	4	237,522

Source: Costs and Statistics Office, Kenya Ports Authority.

Appendix II reveals a high preference for transporting salt using covered wagons. Covered wagons, which are suitable for transporting salt, are widely used in the transportation of other commodities and therefore easily prone to temporary shortages.

The Magadi Soda has efficient transport arrangements. The firm has shunting engines manned by its personnel and uses specialised bulk handling facilities to speedily load and unload hopper wagons. It is one of Kenya Railway's major clients with a high constant demand for mass transportation. The factory is scheduled to almost double its output in the next two years. This is an advantage for *Kenya Railways* and calls for the assignment of at least two block trains to handle the soda ash traffic.

Magadi lies in a marginal agricultural area of medium potential with limited prospects for economic progress. The government of Kenya intends to irrigate this part of Kajiado district using water from the Nguruman escarpment. If the planned irrigation scheme succeeds, Magadi's infrastructure may change significantly. Such a development may diversify traffic from the present mineral predominance. In the mean time, Magadi bound railway traffic will continue to be pegged on the soda ash and salt deposits.

Plate 10 Magadi Soda Depot at Shimanzi, Kilindini Harbour.

Magadi Soda has one shortcoming. The *trona* from which soda ash is obtained developed over a very long period of time, is purer and has very little gangue. Almost half of the highly concentrated *trona* has been extracted in less than 75 years. The firm is planning to expand its output. This will accelerate the rate at which the remaining well developed *trona* will be depleted. This is estimated to occur in the next forty years after which operations will begin from the site where *trona* was initially extracted - *trona* deposits are renewable.

The *trona* deposits that will be extracted from 2036, or there about, will have accumulated in less than 150 years. This will be impure *trona* with a high gangue ratio. The extraction costs of soda ash will therefore be high if the current technology will still be in use then. The efficiency and continuity of Magadi's soda extraction operation lies in future technological development. The other minerals that dependent on the railway are;

i) Limestone - extracted from Athi River and Bamburi, Mombasa.

ii) Fluorspar - extracted from the Kerio Valley.

iii) Diatomite - extracted from Kariandus, Gilgil.

iv) Vermiculite - extracted from Isiolo.

Of all these minerals, only limestone generates cement traffic that is in proportions that may be said to be similar to Magadi's mineral traffic.

5.5 DATA ANALYSIS II

The null hypothesis stating that "there is no significant relationship between the location of major economic activities in Kenya and the railway network" is tested in this section. Indices of district economic concentration namely; Area in Km^2 (V_1), Shape (V_2), Population (V_3), Arable Land[19] (V_4), Livestock (V_5), and Rural/Market/Urban Centres (V_6) are tested against the national railway network. The dependent variable is Railway Distance (Y).

19 Arable land represents the agricultural potential as a percentage of the district's total land area.

Table 20 INDICES OF DISTRICT RESOURCE POTENTIAL AND EXPLOITATION

DISTRICT	Y	V_1	V_2[20]	V_3	V_4	V_5	V_6
Kiambu	123	2451	5.8	1098112	529744	100	74
Kirinyaga	30	1437	2.6	439432	393210	87	86
Murang'a	88	3284	2.3	1020547	418604	100	80
Nyandarua	56	3528	4.7	347225	691181	93	63
Nyeri	94	2476	2.1	439432	444559	98	82
Kilifi	60	12523	1.9	695982	369114	46	46
Kwale	37	8257	1.3	449573	100933	93	42
Lamu	0	6814	2.7	75571	97259	13	33
Mombasa	18	275	1.8	529129	13862	70	40
Tana River	0	38694	3.2	162733	794909	18	41
Taita Taveta	261	16975	1.3	223492	333803	11	32
Garissa	0	43931	2.5	245515	1026000	2	38
Mandera	0	26470	1.7	141926	645913	3	13
Wajir	0	56501	2.1	242383	915314	8	19
Nairobi	51	684	5.7	2400000	41586	85	42
Embu	0	2714	3.2	421172	229384	90	42
Isiolo	0	25605	2.2	69008	559984	5	23
Kitui	0	31099	1.6	710084	954399	42	27
Machalos	301	14250	6.2	1662856	733947	42	29
Marsabit	0	78078	1.9	171620	1401053	4	34
Meru	0	9922	1.4	1289059	437967	66	38
Baringo	54	10949	2.5	325017	973350	31	45
E. Marakwet	0	2810	2.8	166102	520127	59	36
Kajiado	90	22106	3.4	261805	1582000	12	16
Kericho	70	4984	1.4	964273	1375400	71	10
Laikipia	10	9723	1.3	250890	809759	10	14
Nakuru	315	7200	2.5	932580	744365	55	41
Narok	0	2745	1.5	481899	395049	100	33
Nandi	0	18513	1.5	364066	3363000	65	58
Samburu	0	20806	1.9	99491	470582	40	32
Trans Nzoia	30	2468	2.0	488560	150000	95	21
Turkana	0	70000	3.1	144728	2172122	3	62
Uasin Gishu	124	3784	3.1	505834	487720	91	34
West Pokot	0	9100	3.9	284975	724749	25	24
Kisii	0	2196	1.7	1416515	90720	79	46
Kisumu	75	2660	2.5	736806	765031	59	52
Siaya	0	3528	1.6	759582	651269	71	49
South Nyanza	0	7778	1.3	1304736	1187871	70	64
Bungoma	87	3074	1.4	813378	799588	88	73
Busia	19	1776	4.5	420373	294986	91	33
Kakamega	65	3520	3.5	1527676	876454	100	46

20 Shape was measured by dividing the length of the longest axis by its perpendicular across a district at its mid-point after Garrison W.L. & Marble, D.F. "Graph Theoretic Indices" in Hurst, M.E.E. (Ed.), 1974, Transportation Geography: Concepts and Readings. New York: McGraw-Hill Book Company, pp 58-80.

Table 21: TRANSFORMED DISTRICT INDICES OF DEVELOPMENT

DISTRICT	Ln Y	Ln V_1	LnV_2	LnV_3	LnV_4	LnV_5	LnV_6
Kiambu	4.812	7.804	1.758	13.909	13.180	4.605	4.304
Kirinyaga	3.401	7.270	0.956	12.993	12.882	4.466	4.454
Laikipia	2.303	9.182	0.262	12.433	13.604	2.303	2.639
Murang'a	4.477	8.097	0.833	13.836	12.945	12.945	4.382
Nyeri	4.543	7.814	0.742	12.993	13.005	12.985	4.407
Kilifi	4.094	9.435	0.642	13.453	12.819	12.042	3.829
Kwale	3.611	9.019	0.262	13.016	11.522	11.450	3.738
Lamu	0.000	8.827	0.993	11.233	11.485	9.445	3.497
Mombasa	2.890	5.617	0.588	13.179	9.537	9.180	3.689
Tana River	0.000	10.563	1.163	12.000	13.568	11.871	3.714
Taita Taveta	5.565	9.739	0.262	12.317	12.718	10.511	3.466
Garissa	0.000	10.690	0.916	12.411	13.841	9.929	3.638
Mandera	0.000	10.184	0.531	11.863	13.378	9.872	2.565
Wajir	0.000	10.942	0.742	12.398	13.727	11.201	2.944
Nairobi	3.932	6.474	1.740	14.691	10.636	10.473	3.738
Embu	0.000	7.906	1.163	12.393	12.343	12.238	3.738
Isiolo	0.000	10.151	0.788	11.142	13.236	10.240	3.135
Kitui	0.000	10.435	0.470	13.473	13.769	12.901	3.296
Machakos	5.707	9.565	1.825	14.324	13.506	12.639	3.367
Marsabit	0.000	11.265	0.642	12.053	14.153	10.934	3.526
Meru	0.000	9.203	0.336	14.069	12.990	12.574	3.638
Baringo	3.989	9.301	0.916	12.692	13.788	12.617	3.807
E. Marakwet	0.000	7.941	1.030	12.020	13.162	12.634	3.584
Kajiado	5.247	10.004	1.224	12.475	14.274	12.154	2.773
Kericho	4.248	8.514	0.336	13.779	14.134	13.792	2.303
Nakuru	5.753	8.882	0.916	13.746	13.520	12.922	3.714
Nandi	0.000	7.918	0.405	13.085	12.887	12.887	3.497
Narok	0.000	9.826	0.405	12.805	15.028	14.598	4.060
Nyandarua	4.025	8.168	1.548	12.988	13.446	13.416	4.143
Samburu	0.000	9.943	0.642	11.508	13.062	12.145	3.466
Trans Nzoia	3.401	7.811	0.693	13.099	11.918	11.867	3.045
Turkana	0.000	11.156	1.131	11.883	14.591	11.085	4.127
Uasin Gishu	4.820	8.239	1.131	13.134	13.097	13.003	3.526
West Pokot	0.000	9.116	1.361	12.560	13.494	12.107	3.178
Kisii	0.000	7.694	0.531	14.164	11.416	11.180	3.829
Kisumu	4.317	7.886	0.916	13.510	13.548	13.020	3.951
Siaya	0.000	8.168	0.470	13.541	13.387	13.044	3.892
South Nyanza	0.000	8.959	0.262	14.082	13.988	13.631	4.159
Bungoma	4.466	8.031	0.336	13.609	13.592	13.464	4.290
Busia	2.944	7.482	1.504	12.949	12.595	12.500	3.497
Kakamega	4.174	8.166	1.253	14.239	13.684	13.684	3.829

Table 20 is transformed into natural logarithms (table 21) in order to approximate a normal distribution. This is achieved by equating the value of e to a power of X (where e is approximately 2.718282 and X is any entry in the data set). Table 21 is used to develop a multiple regression model for measuring the strength of the tested parameters. The SPSS stepwise method of multiple regression analysis is used. The results were based on step one involving Y against V_3 and produced the following results:

Table 22: R OUTPUT 4

Multiple R	.46528
R Square	.21648
Adjusted R Square	.19639
Standard Error	1.99666

Table 23: ANOVA OUTPUT 4

	DF	SUM OF SQUARES	MEAN SQUARE
Regression	1	42.95843	42.95843
Residual	39	155.48002	3.98667
F = 10.77553		Sign. F = .0022	

Table 24: t TEST OUTPUT 4

VARIABLE	B	SE B	BETA	T	SIG T
Variables in the Equation					
V_3	1.18541	.36112	.46528	3.283	.0022
Constant	-13.12134	4.69951		-2.794	.0080
Variables not in the Equation					
V_1	-.18929	-.18447	.74409	-1.157	.2545
V_2	.23838	.26809	.99098	1.715	.0944
V_4	-.03479	-.03886	.97744	-.240	.8119
V_5	-.10593	-.11710	.95746	-.727	.4718
V_6	3.2616E-03	.00351	.90871	.022	.9828

The derived multiple regression equation is:

$$\text{Log } \hat{Y} = -13.12134 + \text{Log } V_3^{1.18541} \quad \ldots\ldots\ldots\ldots \quad (5.1)$$

$$\text{Ln } \hat{Y} = -13.12134 + \text{Ln } V_3 1.18541 \quad (5.1)$$

Model (5.1) represents transformed rather than real values. It is made to reflect realistic conditions by antilogging. Since all variables in the model have been transformed into natural logarithms, its antilogged form is:

$$\hat{Y} = \exp -13.12134 + V_3^{1.18541} \quad (5.2)$$

Model (4.2) is simplified by getting the exponent of the regression constant [exp (-13.1213)] which is 0.00000. The obtained regression model is simplified as:

$$\hat{Y} = 0.00000 + V_3 1^{.18541} \quad (5.3)$$

The *t* test (table 24) indicates that all observed *t*-values (T) are greater than the critical *t* (SIG T). The obtained R^2 from R Output 3 (.21648) when multiplied by 100 suggests that 21.648% of the variation in the dependent variable (Y) is attributed to variation in the independent variables. It has been adjusted to .19639 which when multiplied by 100 suggests that 19.639% of the computed regression output is attributed to the variation in the independent variables.

Using the adjusted R^2 value, 80.361%[21] of the observed indices of district resource potential do not account for the observed district railway mileage. This is a very high unexplained portion which implies that the concentration of observed district indices of resource potential do not adequately account for the observed district railway mileage. Field observations suggest that the rapidly expanding national road network taps most of the increased traffic in contrast to the rigid railway with a restricted short term carrying capacity. Thus, railway traffic has over time registered a diminishing growth

[21] Derived using the formula (1 - adjusted R^2)x100

It was observed that the railway provides marginal benefits to most of the immediate area through which it passes. The railway is suitable for long distance mass transportation and therefore passes through large tracks of land without stimulating any significant economic activity. This is most distinct along sectors from Mombasa to Nairobi, Voi to Taveta and Konza to Magadi. The presence of a railway in large districts such Taita Taveta, Machakos and Kajiado appears to be of marginal benefit when compared to small districts without a railway such as Kisii, Nandi and Meru.

Table 25 CORRELATION OUTPUT 4

	Y	V_1	V_2	V_3	V_4	V_5	V_6
Y	1.000	-.3762*	.2804	.4653*	-.1039	-.0055	.1435
V_1	-.3762	1.000	-.1711	-.5059**	.6586**	-.0677	-.3253
V_2	.2804	-.1711	1.000	.0950	-.0468	.0621	.1601
V_3	.4653*	.5059**	.0950	1.000	-.1502	.2063	.3021
V_4	-.1039	.6586**	-.0468	-.1502	1.000	.2276	-.0744
V_5	-.0055	-.0677	.0621	.2063	.2276	1.000	.0883
V_6	.1435	.1435	.1601	.3021	-.0744	.0883	1.000

Number of cases: 41. 1-tailed Signif: * - .01 ** - .001

Let us suppose that Y is to be predicted from V_1, V_2, V_3, V_4, V_5 and V_6. Table 25 shows the correlation between all variables. V_3 has the highest correlation with $\hat{Y}$ and is awarded the highest weight by model 5.3. The regression model was re-run several times with the addition of an independent variable at a time. V_1, V_2, V_4, V_5 and V_6 were excluded from the analysis and thus regarded to be significant predictors of district railway density.

The analysis of variance show that F Critical is greater than Significant F. Both *t* and F tests show that there is a significant relationship between the independent and the dependent variables. The *t* and F tests therefore suggest that the observed is not significantly different from the expected.

Apart from V_3, the independent variables achieved weak correlations against Y. Table 25 suggests that there is a significant relationship between Y and V_3 and the existance of a moderate occurrence of multicollinearity involving V_1 against V_3 and V_1 against V_4 thus highlighting fears of statistical weaknesses (see 3.4)

Both the *t* and F Tests have shown that there is no significant relationship between the concentration of the indices of district resource potential and exploitation and the availability of railway facilities. The *t* Test revealed that all T Critical are greater than all Significant T. This is to say that all T Observed are not significantly different from T Critical. Table 23 shows that the observed (F Critical = 10.77553) is greater than the expected (Significant F = .0022). This is to say that F Observed is not significantly different from F Critical. Thus, the null hypothesis stating that "*there is no significant relationship between the location of major economic activities in Kenya and the railway network*" is rejected and the alternative hypothesis accepted.

The importance of railway transport is often obscured at the district (local) level thus creating the impression that there is no significant relationship between the location of major economic activities and the railway network. Field observations indicate that the railway rarely offers direct benefits to the immediate areas through which it passes. It is most suited to rendering long distance mass transport services. Thus, it passes through large tracks of land without stimulating any significant economic activity. Analysing the statistical causal effect of the concentration of any given set of the selected indices of district resource potential as a determinant of railway mileage produces different results based on the level of analysis, local or national. Railway transport is most significant at the national level and thus the rejection of the null hypothesis is internally consistent.

The testing of this hypothesis had a lot of measurement difficulty. Some districts such as Meru, Isiolo, South Nyanza and Nandi District rely on the railway indirectly through road connections to neighbouring districts with a railhead or station. Thus, whereas such districts are herein treated as lacking a railway line, they benefit from the railway services through road connections to the nearest railway point. In effect, such districts are served by the railway though lacking a railway within their boundaries. The results may have been different if an accurate index of railway connection was used. This was very difficult to develop and thus the use of available railway mileage.

```
HISTOGRAM 2 - STANDARDIZED RESIDUAL

NExp N      (* = 1 Cases,     . : = Normal Curve)
0  .03   Out
1  .06  3.00 *
1  .16  2.67 *
0  .37  2.33
0  .75  2.00 .
0 1.37  1.67 .
2 2.25  1.33 *:
2 3.31  1.00 **.
3 4.35   .67 ***.
3 5.14   .33 *** .
5 5.43   .00 ****:
9 5.14  -.33 ****:****
* 4.35  -.67 ***:******
4 3.31 -1.00 **:*
1 2.25 -1.33 *.
0 1.37 -1.67 .
0  .75 -2.00 .
0  .37 -2.33
0  .16 -2.67
0  .06 -3.00
0  .03   Out
```

Histogram 2 suggests that the sample values do not deviate significantly from the normal curve. This is in line with the fifth assumption of the multiple regression model which states that "both the dependent and the independent variables are normally distributed". There is a close relationship between the distribution of the observed and the expected values. The residual values do not significantly violate the first assumption of the multiple regression model, that is "the expected and the observed error of observation sum up to zero [$e_i = 0$ or $(\Sigma e_i) = 0$]". The obtained regression output is an accurate reflection of the expected distribution of the variables. Thus, the analysed sample is assumed to reflect reality.

5.6 SUMMARY

The current national linear spatial pattern of agriculture, manufacturing, mining, transportation and settlement begun to take shape after the railway was built. New horizons for economic production and/or consumption were created; feeder roads were built to promote and accommodate traffic increments; and urban centres emerged in the interior of the country. The volume, type and direction of traffic in Kenya was changed paving way for the introduction of modern economic practices. The railway still plays a leading supportive role in the maintenance of Kenya's spatial economic structure.

The demand for railway services is largely based on economic motives rather than spatial interaction *per se*. An analysis of the selected indices of district economic opportunities reveals that economic motives alone do not attract the railway to a location. Modern economic management appears to favour areal specialisation in the exploitation of the most productive local resources. This enhances spatial inter-dependence on a regional basis supported by the availability of transport facilities.

This chapter has indicated that Kenya's railway network is suitable for inter-regional traffic flows. However, the availability of railway facilities *per se* does not automatically create development opportunities. Railway facilities enable mass transportation which is a permissive rather than stimulant of regional development.

CHAPTER SIX

OVERLAND TRANSPORT IN KENYA

6.0 INTRODUCTION

This chapter attempts to highlight the role of railway transport by focusing attention on its unique features and how it relates to road transport in Kenya. It is based on the objective seeking "to analyse the relationship between railway and road transport services in Kenya".

Railway commuter services have been excluded because they do not feature as a national transport service. The immensity of the study area and limited financial backing did not permit the analysis of all modes of overland transport in Kenya. Road-rail competition for passenger traffic is not emphasised because of the comparatively small volume of passenger traffic along the railway network. The null hypothesis stating that "*Kenya's railway services are not influenced by the presence of other modes of transportation*" is tested.

6.1 PASSENGER TRAFFIC

The basic characteristics of any population are its size, distribution, composition and rate at which it is growing. The two most outstanding features of Kenya's population are its uneven distribution and the rapid rate at which it is growing. They bear heavily on the country's present and future needs for mass transportation. Rapid population increase which is unevenly distributed implies an increased volume of both freight and passenger traffic in future.

The control of passenger traffic has been less severe than in freight haulage. Bus and *matatu* operators offer a faster and more flexible service than the railways. As a result, they have been able to capture a leading proportion of passenger traffic in the country. Their services are more accessible to people both in terms of space and time. Field observations suggest that there appears to be emerging a trend whereby the demand for railway passenger services is increasing. This is most evident on the Eldoret - Kitale branch line where many respondents who were interviewed called for the reintroduction of the cancelled passenger service. This apparent resurgence of interest in railway passenger services appears to be based on the following reasons;

i) Kenyan roads have in the recent past witnessed spine chilling road accidents that have resulted in the loss of human life, inflicted great injury and destruction of a lot of personal property.

ii) The research was conducted during the *Gulf Crisis* and its subsequent war when there was a temporary escalation of oil prices. Road operators took advantage of this situation by raising their tariffs. making their clients to regard the railway as a suitable alternative.

iii) The Eldoret - Kitale road is narrow and has many potholes which reduce the speed of vehicles plying between the two towns. Many respondents in Kitale were of the opinion that the re-introduction of railway passenger services would go a long way in alleviating their transport problems.

It was observed that people in Central Province are not interested in railway passenger services although it has witnessed nasty road accidents during the recent past. The province is well served by a large fleet of country buses and *matatus.* Its people

Plate 11 Passengers dinning in the buffet car.

do not appear to be interested in seeking for an alternative safe mode of transport. They are so engrossed with being in contact with Nairobi, the nation's prime economic centre, that their personal safety appears not to be a leading priority issue.

Passenger coaches are classified into first, second and third class. First and second class coaches are also called upper class coaches. Upper class coaches are luxurious and have additional amenities such as a buffet car, bar, cabins and bedding facilities. They are patronised by people with a high income. Third class coaches are mainly patronised by people with a low income and lack the additional amenities offered in the upper class coaches. They are served by train hawkers who are a nuisance. Third class coaches

Plate 12 Queen Elizabeth the Second waving from her royal coach.

are often overloaded, noisy, dirty and congested.

Third class passengers are more price elastic than upper class passengers. Third class passengers are in general financially handicapped. They are most sensitive to price changes and would accept any mode of transport that offers lower tariffs. Whenever road transporters increase or temporarily hike their tariffs, a significant increase in third class passengers is often noted especially in the service to Western Kenya during the christmas holiday season.

People from western Kenya have very strong ties with their ancestral homeland. Those who work in towns make annual trips to

Plate 13 A passenger train departing from a railway station.

their rural homes thus resulting in a heavy passenger turnout. Road operators tend to cash in from this passenger boom by temporarily hiking their rates. Those who find the hiked rates in addition to the expenses incurred during the christmas period unaffordable resort to third class coaches as suitable alternative since their rates are fixed and are often about fifty percent of the normal road tariffs.

Upper class respondents travel by train because they prefer to travel in safety and comfort. A bus leaving, say from Nairobi to Mombasa at 9:00 pm reaches its destination between 3:00 and 4:30 am. This is after a taxing and gruelling trip on the narrow and bumpy road. Such travelling conditions are not suitable to business travellers who are interested in reaching their destination with a fresh and clear mind ready to engage in their business endeavour. On the other hand, two trains leave Nairobi at 6:00 and 7:00 pm for Mombasa and arrive at 8:00 and 9:00 am, respectively. This is suitable to business travellers who arrive at their destination safe and after a sound sleep.

Kisumu is 928 km from Mombasa. It takes 38 hours for a passenger to travel between Kisumu and Mombasa by rail. This includes a 12 hour break at Nairobi. This is certainly a long period of time for a time pressed travellers. Thus, there is little passenger traffic over long distances such as between Mombasa and Kisumu or Malaba and Mombasa.

Passengers need low rates, convenient arrival and departure times, minimised congestion and courteous treatment while on board. Low rates are particularly significant to third class passengers who are financially handicapped and lack ready access to additional amenities aboard trains. Passengers to/from wayside stations[24] are inconvenienced by train arrival/departure between 10:00pm and 5:00 am. The first Nairobi-Mombasa train reaches Voi at approximately 4:00 am. This is when Voi-Mombasa passengers board can train.

Field observations indicate that many upper class passengers were not pleased with the attention and services rendered to them by the railway attendants. There was a strong feeling that such attendants should be taken for training in catering and public relations. The catering personnel take orders for meals using an impolite language particularly to Africans and sometimes ignore to give them the menu until it is demanded. Passengers are called for meals by means of hitting two metals and shouting that the food for

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24 Wayside station refers to any railway station that is located between two origin and destination stations for example Voi Railway Station along the Nairobi - Mombasa railway sector.

Table 26 PASSENGER TRAFFIC AT OBSERVATION POINTS 1987/88 & 1989/90

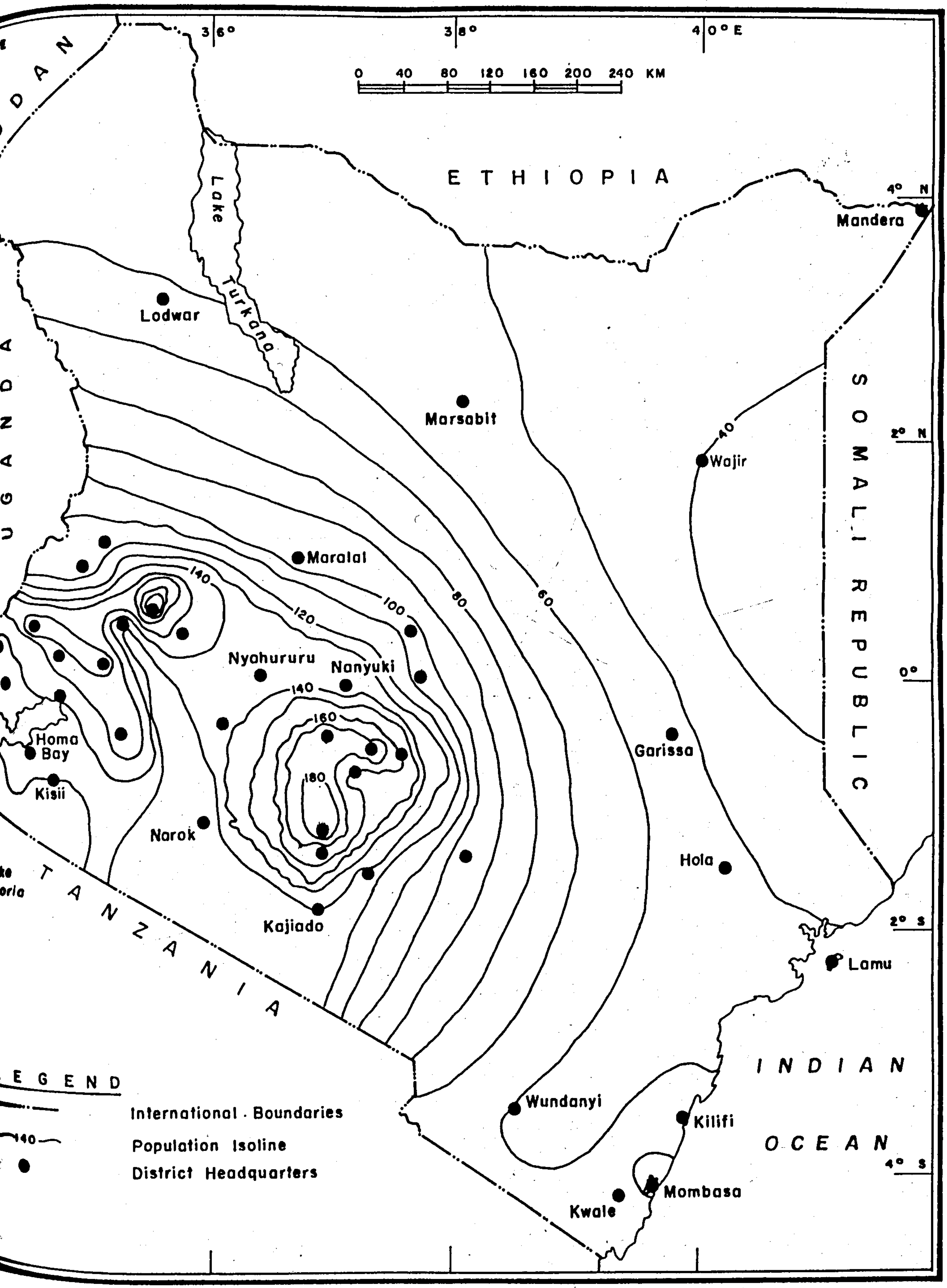
STATION	1988/89	1989/90
Mombasa	1,970,880	2,168,638
Changamwe	74,454	62,710
Voi	597,316	498,451
Nairobi	8,352,767	4,506,384
Magadi	21,703	10,570
Nanyuki	67	130
Nyahururu	431	66
Gilgil	102,690	69,560
Nakuru	712,942	497,396
Molo	89,033	88,991
Kipkelion	73,895	66,145
Muhoroni	206,808	138,174
Kisumu	2,303,402	1,587,495
Butere	515,684	431,667
Bungoma	327,683	264,996
Malaba	330,841	231,037
Taveta	340,981	248,822
Dagoretti	25,317	10,721
Limuru	155,592	128,835
Webuye	216,093	193,486
Eldoret	203,981	180,486
Kitale	509	582
Turbo	42,089	33,888
Rongai	12,919	7,890
Athi River	133,841	199,994
Konza	50,336	69,606
ICD[25]	224	74
Kibwezi	64,736	55,196
TOTAL		

Source: Costs and Statistics Office, *Kenya Railways* Headquarters

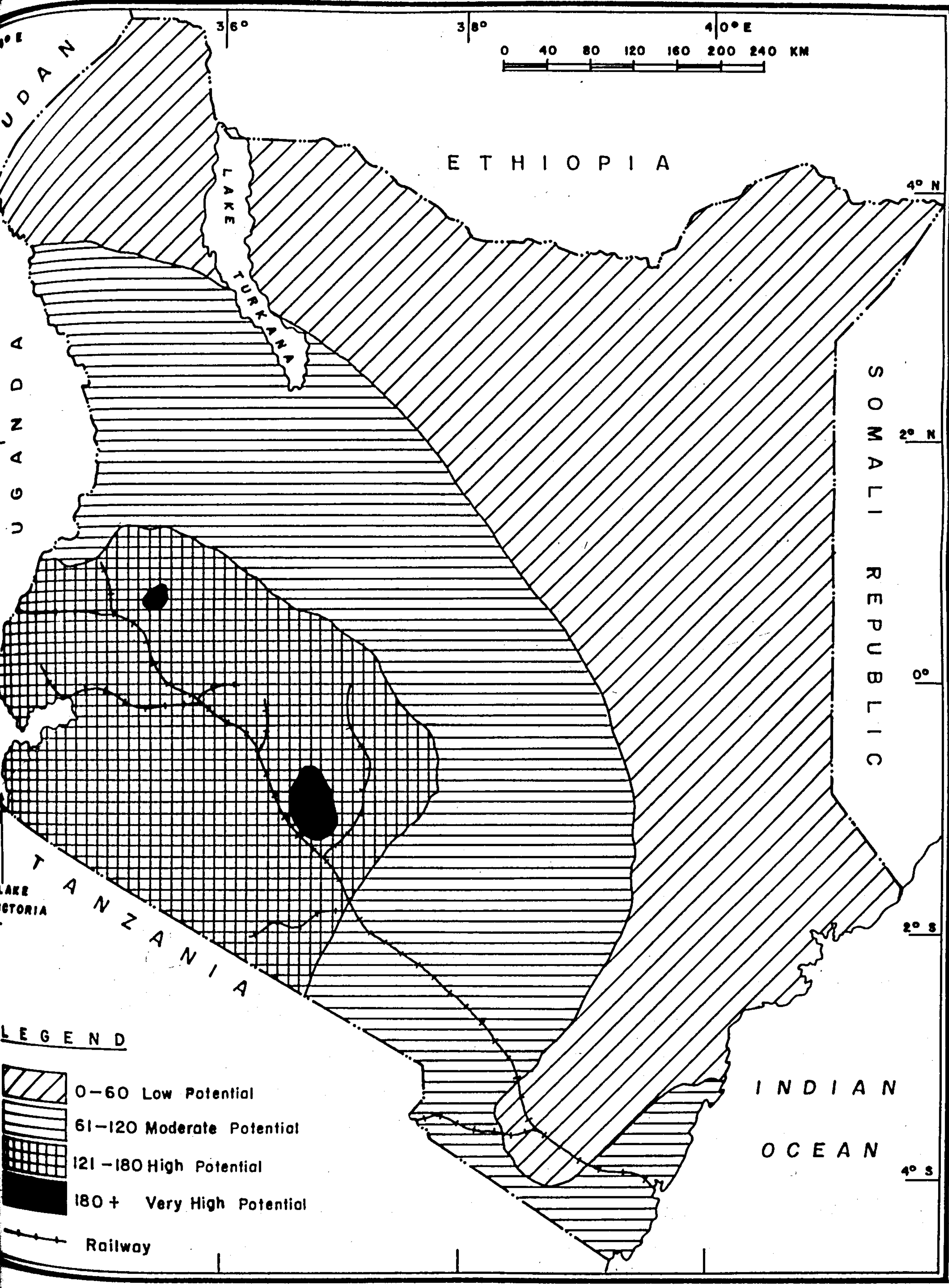
passengers from a certain coach is ready. This kind of service really offends many passengers who end up loosing their appetite.

Appendix IIa shows that the railway is an important mode of passenger transport. There is a high number of monthly trips exceeding 100 km. This is attributed to the incidence of periodic markets along the railway. The regular mode of transportation is

25 Inalnd Container Depot, Embakasi.



MAP 8 : KENYA'S POPULATION POTENTIAL



MAP 9 : SIMPLIFIED POPULATION POTENTIAL

identified as the railway. This response is attributed to the fact that the interviewees were railway clients. Most respondents indicated that they have remained faithful to the railway despite significant developments in road passenger services.

Appendix IIb reveal a strong dependence on both railway (95.7%) and road (87%) in the transportation of goods. The observed response favours the railway because only railway clients were willing to be interviewed. However, the strong response in favour of road transport indicates that railway clients also depend on road transport. The dependence on road transport is both for local and long distance haulage in cases where railway wagons are not readily available. Perceived low rates and mass transportation are identified as the main attraction of the railway.

6.2 THE CO-EXISTENCE OF ROAD AND RAILWAY TRANSPORT

The building of the *Uganda Railway* introduced to the Kenyan scene a unprecedented and revolutionary mode of transport. It constituted the principal mode for the movement of passengers, mail and commodities as road and air transport were unknown. This situation prevailed for most of the early part of this century. Then the advent of modern highways, faster and large capacity tracks emerged and is now changing the position of the railway in the national transport market.

Kenya's railway network was established before her road network. The development of Kenya's road network picked up at a significant pace after World War II when large scale utilization of motor vehicles in commerce begun. Prior to this period, motor vehicles used to be regarded as luxury items and play machines at the disposal of colonial authorities and wealthy settlers, especially some of the World War II soldiers particularly from British South Africa who were settled in the country by the British colonial authorities. Moreover, some African couriers during World War II also got the opportunity to learn driving motor vehicles. Thus, the post World War II conditions were ripe for the development of a road transport sector in Kenya.

Road transporters enjoy certain advantages that give them greater operational freedom. These include the following;

i) The operating units are small and require a small investment of capital.

ii) Road transport permits the use of a great variety of transport equipment making it to easily meet the varied needs of shippers.

iii) High speeds and adaptability have resulted in increased frequencies of rendering services and created ample scope for specialization.

iv) Road transport is flexible and suits door-to-door deliveries.

v) Truck-trailers have increased the carrying capacity of road hauliers.

vi) Roads can be developed gradually by upgrading the quality of their surfaces. This facilitates the easy expansion of the road network unlike the railway which must be constructed on a piecemeal basis.

These advantages have enabled road transporters to be easily adaptable to market requirements. Road transporters have often been accused of frequently relying on unorthodox methods in the observance of regulations. They have increasingly performed a leading role in freight traffic as a result of many shippers preferring their speedy and highly flexible services.

The predominant and largely unrestricted road transport enables road operators to limit their activities to high paying traffic in one direction and the best return load available. Railway transport on the other hand is under the common carrier obligation to indiscriminately carry all traffic offered without considering its paying capacity but on a first come first served basis. Thus, the railway being a common carrier is unable to freely and easily select the traffic to carry and the one not to carry.

Tables 27 and 28 highlight the degree of competition between road and railway transport. Roads serve the entire country, are very flexible and render local Mombasa based transportation to and from Kilindini Harbour. The railway is not suitable for handling local traffic though petroleum is occasionally railed from Shimanzi to Changamwe. The rates for local haulage are so high that road transporters who are faster and more flexible have a clear cut advantage. The railway would require lengthy shunting sessions.

Table 27 KILINDINI HARBOUR: DISPATCHES & RECEIPTS IN METRIC TONNES (1986)

MONTH	DISPATCHES		RECEIPTS	
	ROAD	RAIL a/c[26]	ROAD	RAIL a/c
January	102,212	84,094	35,167	2,447
February	85,170	46,423	39,620	5,672
March	64,181	44,984	41,813	6,290
April	79,621	45,934	61,968	7,622
May	53,060	43,819	49,476	6,049
June	87,878	35,002	67,064	9,370
July	113,337	42,945	104,239	11,293
August	97,918	33,115	47,322	7,147
September	157,002	33,115	65,510	10,445
October	145,388	41,705	97,592	7,881
November	138,432	29,385	50,499	8,082
December	93,644	34,554	35,376	3,737
TOTAL	12,178,430	459,075	695,646	87,038

Source: Costs and Statistics Office, Kenya Ports Authority.

Table 28 VALUE OF TRANSPORT OUTPUT IN KENYA (1982-1988 in K£ million)

	1982	1983	1984	1985	1986	1987	1988[27]
Railway	49.97	52.16	62.2	57.7	59.5	60.7	60.3
Road	172.30	172.20	196.1	252.8	282.3	343.9	372.7
Water	54.63	67.48	81.8	89.2	73.2	77.4	74.30
Air	48.37	69.10	73.8	86.8	102.2	131.3	155.0
Total	323.27	360.94	413.9	486.5	515.4	613.3	662.3
Services incidental to							
Transport	40.31	42.50	36.4	45.2	55.6	59.1	75.5
Pipeline	18.50	17.10	21.0	23.4	23.9	26.8	27.7
Total	58.81	59.60	57.4	68.6	79.5	85.9	103.2
TOTAL	382.08	420.54	471.3	555.1	594.9	699.2	765.5

Source: Central Bureau of Statistics, Nairobi.

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26 a/c refers to up country traffic. There was no railing to local sidings from Kilindini Harbour in 1986. Road values include local and upcountry traffic.

27 The 1988 figures are provisional.

Kenya's vehicle population has continued to increase in terms of size, speed and numbers without a commensurate improvement in the quality of roads. Road foundation is weak, surfaces rough, and widths are narrow. Roads are very costly in terms of capital investment and land consumed but are very flexible in circumventing these shortcomings. They can be constructed under varied conditions of surface, gradient and curvature and in a step-wise manner through gradual upgrading. Capital investment in road building can be matched with traffic levels. An adequate road can be built for limited traffic and the network upgraded as its traffic expands.

CONTAINERISATION

Containerisation is the process of using large boxes of standardised dimensions to transport consignments. It provides an essential infrastructural base for external trade facilitating the development of a multi-modal transport system for handling cargo. Containerisation requires a string of inland container depots at which containers can be deposited and collected. These inland container depots should be equipped with special facilities for handling containers such as cranes and fork lifts. Containers are good for transporting unit loads. They offer a cheap means for inter-modal transfer of freight; reduce breakage, damage and pilferage and eliminate the need for warehouses by permitting the storage of goods in yards. Their use increased worldwide since 1965.

Kenya Railways runs a block train service for handling container traffic. The train rendering this service is code named *railtainer*. The *railtainer* is an express train that hauls containers between Kilindini Harbour and the Inland Container Depot (ICD) at Embakasi, Nairobi. It offers special contract rates that are lower

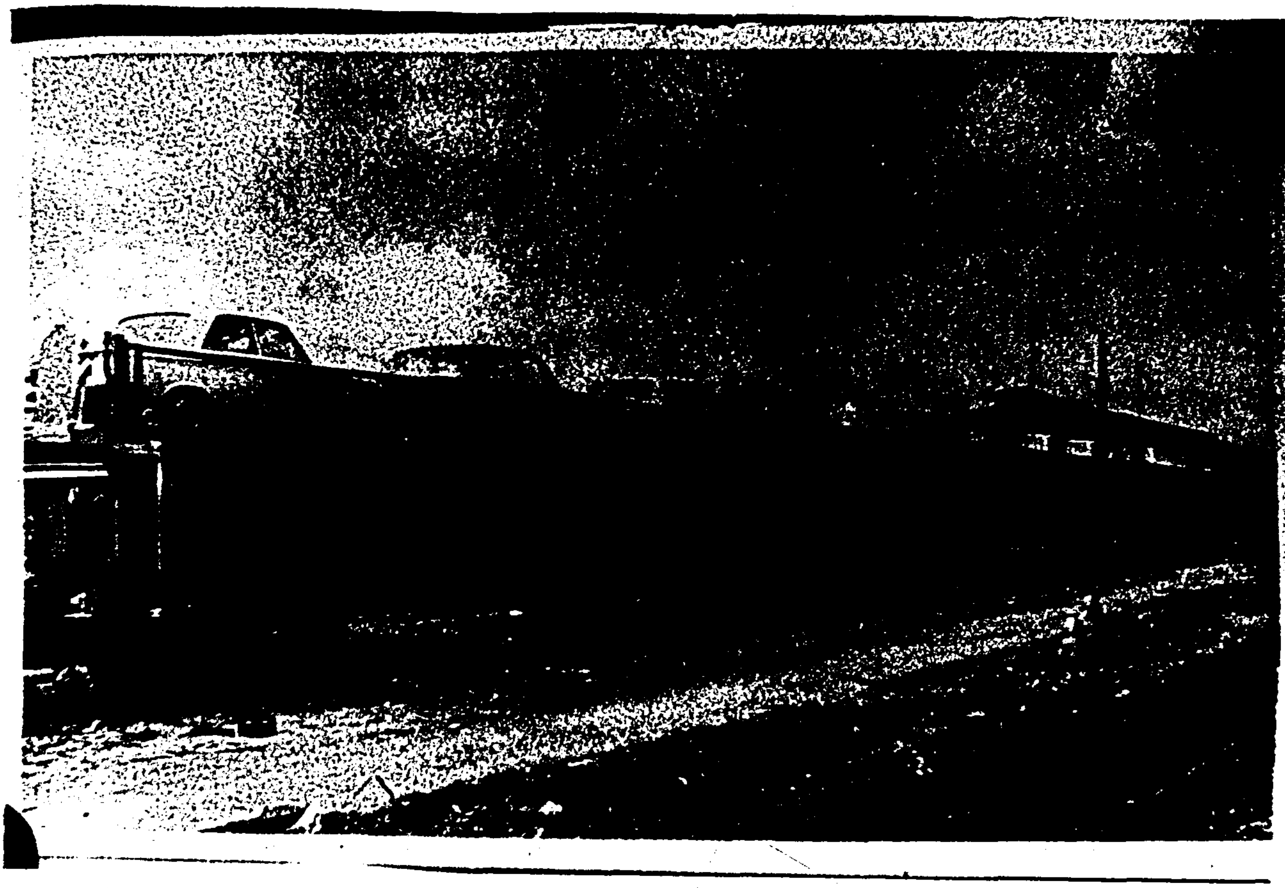


Plate 14 A loaded double decker wagon at Nairobi Station.

than normal railway tariffs. Containers are destined for Nairobi and beyond. There is no container traffic for the area between Mombasa and Nairobi. Containers are often loaded directly from ships onto train wagons. In some cases, a ship may be ready to off-load containers when railway wagons are not available. The containers are on such occasions unloaded and stacked at a container yard at Kipevu to await their collection by trains.

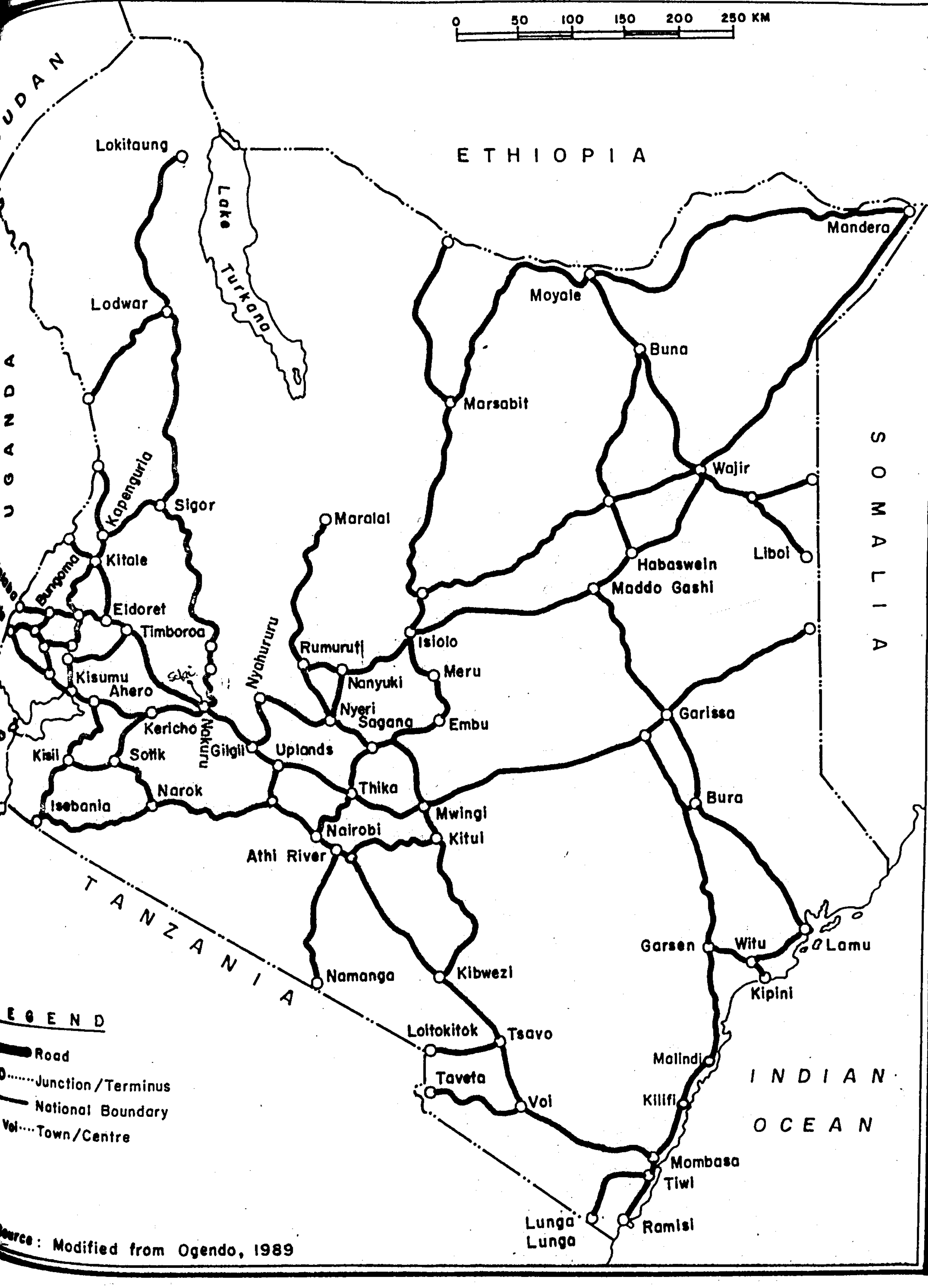
ICD (Embakasi) has been Kenya's only dry port during the course of conducting this study. Others are being built at Eldoret, Kisumu and Malaba. The ICD is entirely owned by the Kenya Ports Authority and relies entirely on the railway for its carriage of import and export containers. The ICD-*railtainer* arrangement is the area of greatest liaison between the Kenya Ports Authority and *Kenya*

Railways. This liaison has facilitated the speedy and generally efficient handling of container traffic. The depot is served by daily *railtainers* that operate between Kilindini Harbour and Embakasi. All upcountry destined containers going beyond Nairobi are transfered to ordinary cargo trains and normal *Kenya Railways* tariff book rates become effective thereafter. Some containers are deliverd to sidings around Nairobi.

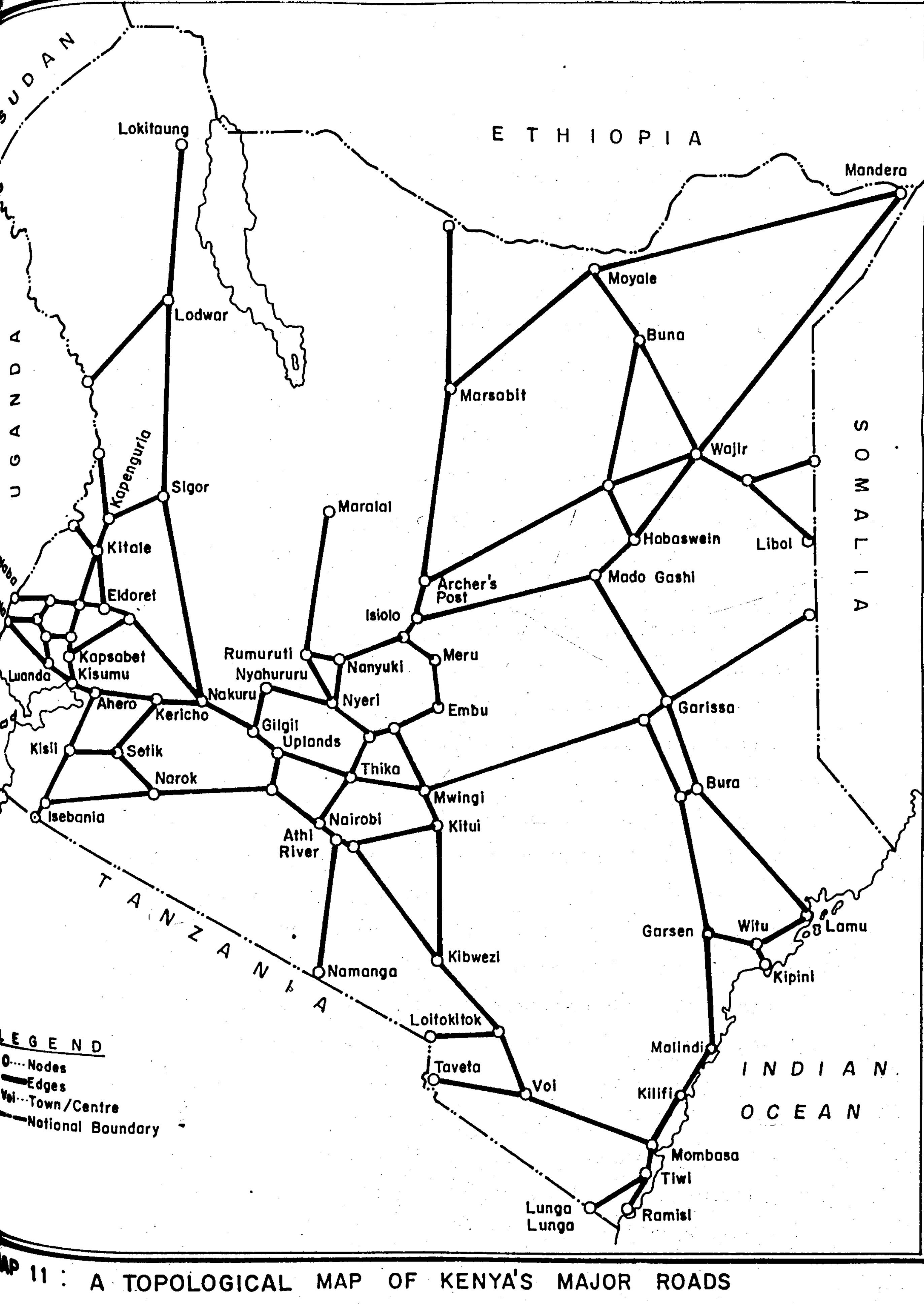
Domestic container traffic has been limited by lack of locally owned containers. The containers used in Kenya belong to foreign firms and are handled locally by their agents. These containers are speedily processed and returned to their owners abroad. Thus, the containers are not readily available for domestic traffic. They may be used in the carriage of return traffic if it is readily available. Kenya Railways has a few twist lock wagons for carrying containers. This is however not a serious problem because open low sided boggies are easily improvised in the carriage of containers. The containers are fastened on to the body of such wagons using steel cables.

All containers railed to or from ICD are cleared by customs officials at Embakasi. Road transport also handles container traffic. The containers hauled by road are cleared by customs officials at Kilindini Harbour. Containers cleared at Kilindini Harbour can also be railed but not by the *railtainer.*

Container services provide the most visible link between water and railway transport in Kenya. The expansion of inland container depots will enhance the growth of container traffic on a nationwide scale. Over 98 containers are railed from Kilindini Harbour to the ICD at Embakasi on a daily basis as opposed to 38 in the past (Tradeways, 1990:8).



MAP 10 : KENYA'S MAJOR ROADS



MAP 11 : A TOPOLOGICAL MAP OF KENYA'S MAJOR ROADS

REGULATION

Specific tariff structures and transport legislation (based on the British transport legislation of the 1930s) are used to protect the railway from undue competition from road transporters. This state of affairs has in theory enabled the railway to grant preferential rates to certain classes of traffic. It seeks to promote domestic agriculture by granting of low transport rates that enable them to have a competitive price on the world market. Agricultural produce is railed at a cheaper rate than imported manufactured goods. Road hauliers have also adopted the trend of adopting lower tariffs for transporting commodities to the coast than from the coast to the interior of the country.

The protectionist approach and common carrier obligation have resulted in the shifting to road transport by high value goods. The difference between road and rail rates is so small that high income generating goods easily find road transport to be suitable as a result of faster delivery times. This means that the railway is denied access to income needed to cross-subsidise agricultural traffic. As a result, there have been frequent presidential and ministerial directives and restrictions seeking to control certain traffic along routes parallel to the railway.

Kenya needs a good and efficient traffic allocation policy that will enable the railway to carry commodities which are most suited to its services while according the same opportunity to road hauliers. The railway is efficient in long distance bulk transportation while road transport is suitable for hauling small quantity goods over short distances. A single goods train can haul 1000 metric tonnes from Nairobi to Mombasa within 18 hours at a modest cost. The same tonnage will require a 50 tonne track to make 20 trips each costing more than railway tariffs and over a longer duration of time.

The gradual shift from a predominantly subsistence economy to a market based economy has enhanced the need for a dense road network. The functions of roads in Kenya include; facilitating the marketing of agricultural goods, accessibility to a railhead, facilitating the movement of people and providing access to rural and remote areas. The government has in recent times placed greater priority on the development and expansion of rural access and feeder roads. Major roads link key industrial, business and/or population centres or provide access to neighbouring states and regions.

The building of the railway was probably the most revolutionary act by the colonialists. Road construction followed soon after, initially beginning as murrum and seasonal roads and gradually being improved to modern all weather roads. Tarmac begun to appear in Nairobi during the 1930s while bitumenised trunk roads begun to be constructed in the 1950s. The Nairobi-Mombasa highway was bitumenised in the immediate post-independence period.

During the colonial period, feeder and branch roads were constructed either for administrative purposes or to link settler farms to the railway network. African reserves were largely neglected on the pretext of economic inviability especially during the period before the implementation of the Swynnerton Plan of 1954. Thus, African reserves lacked the necessary infrastructure for venturing into commercial activities based on the deliberate production of a surplus.

Immediately after independence, the urgency to expand the network of country roads was found to be a suitable means for rehabilitating displaced indigenous people by providing an economic infrastructure that would enable them to take their agricultural goods to markets. The role of transportation in stimulating economic activity is often discussed in the context of transport costs. This

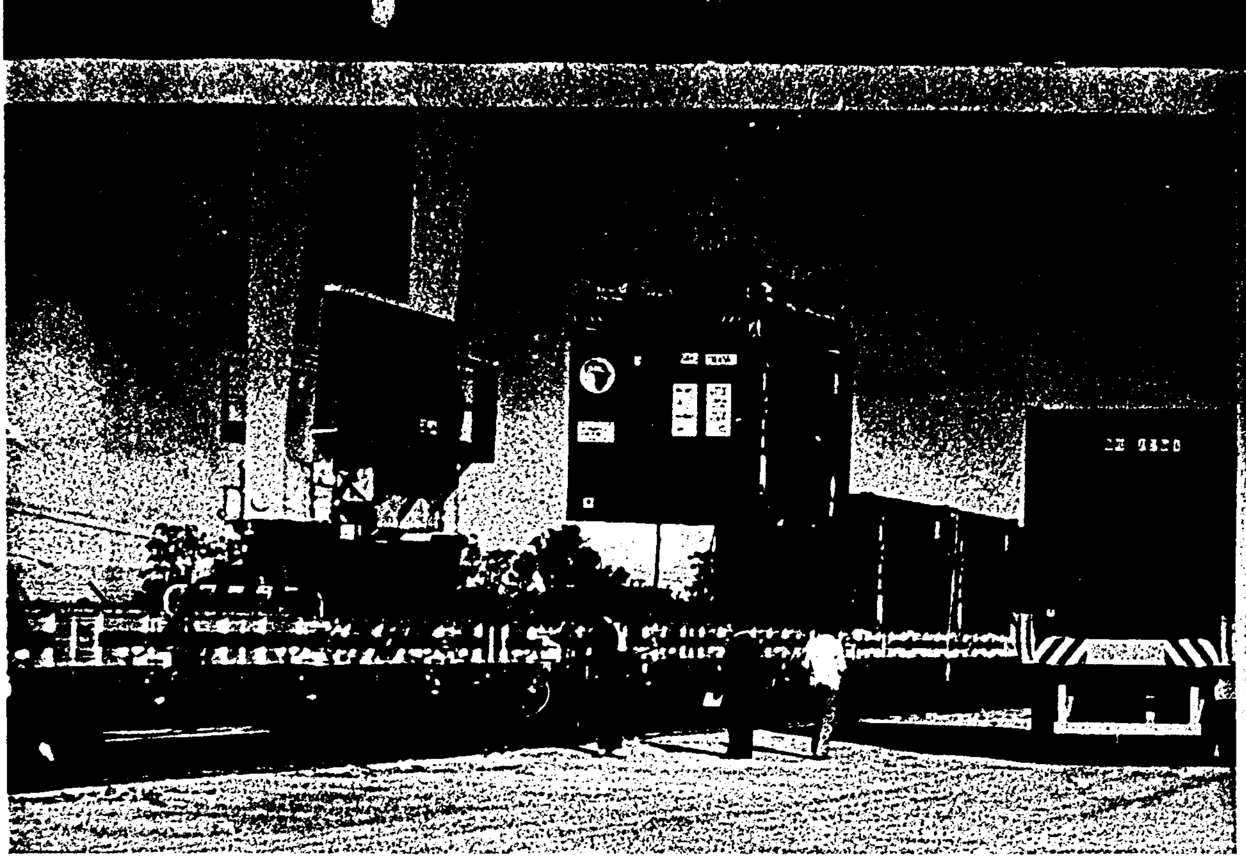


Plate 15 Unloading containers from the railtainer at ICD, Embakasi.

tends to overlook other essential transport related advantages such as speed verses quantity. Field observations indicate that railway transport is best placed to offer speedy mass transport.

There is a strong case for the creation of a public institution charged with the responsibility of overseeing and guiding the general conduct of overland modes of transportation in Kenya. Such an institution should not seek to eliminate or stifle inter-modal competition. It should strive to create conditions that enhance the complementary role of all modes of transport by encouraging them to transport their most suited traffic.

One of the tasks that is related to the future of railway transport in Kenya is how the adverse impact of the development and construction of new transport facilities will be contained. Kenyans need orderly development and a much higher quality of life. The

Plate 16 The railtainer on its way to the Inland Container Depot, Embakasi.

development and construction of new transport facilities may be seen as providing a base for organised change, a quest that is summarised by Irving (1969:4) as *"... we are in the eternal business of building a nation - a people."*

Planners should note that contemporary problems can in the long run cease to be the most important issues however urgent their short term solution may be. There is a need to avoid policies and projects that prolong problems. Government intervention in the transport sector is thus made worthwhile. State intervention in transportation is based on three grounds;

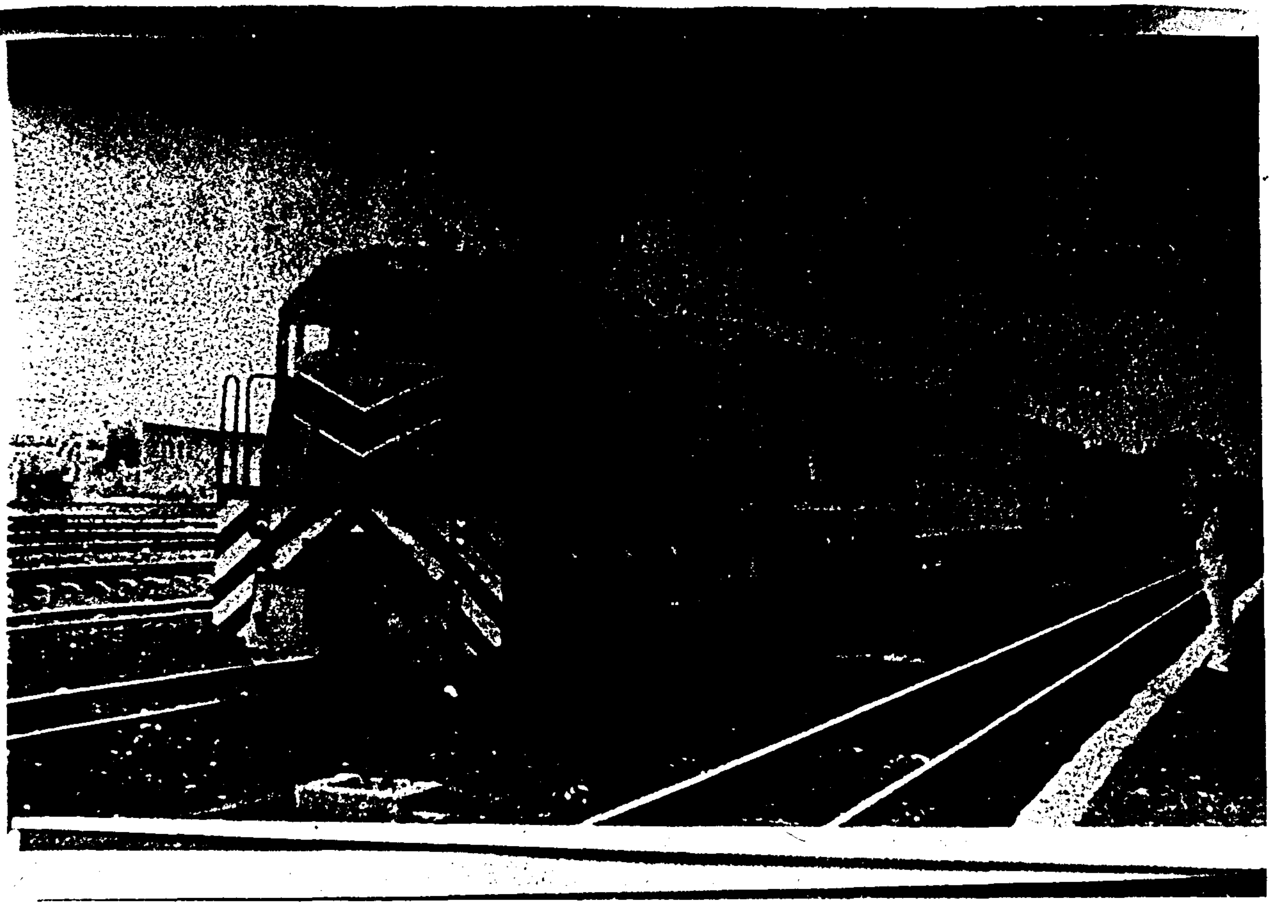


Plate 17 A Nairobi bound goods train leaving Dagoretti Station.

i) The quality of private decision making in terms of the information at its disposal, the time scale to be adopted and the motives of decision makers is such that public interests can best be protected when the government regulates transport activities.

ii) The demand for transport is indirect and affects the manner a community organises its space.

iii) The state is the principal supplier of transport infrastructure. As a result, it has vested interests in overseeing how its facilities are utilised for the common good of the society at large.

6.3 RAILWAY FREIGHT SERVICES

CAPACITY DETERMINANTS

The carrying capacity of locomotives is determined by several factors. These include; locomotive power; strength of the rails, bridges and ballast; passing loops; length of marshalling yards; number of tracks; junction capacity; signalling technology; and the ruling gradient. The width of the rails (gauge) affects train speed rather than the carrying capacity. Train speed features prominently in the circulatory capacity of locomotives and bears heavily on the network's carrying capacity. This condition is enhanced by the fact that Kenya operates a single track railway network based on a block system.

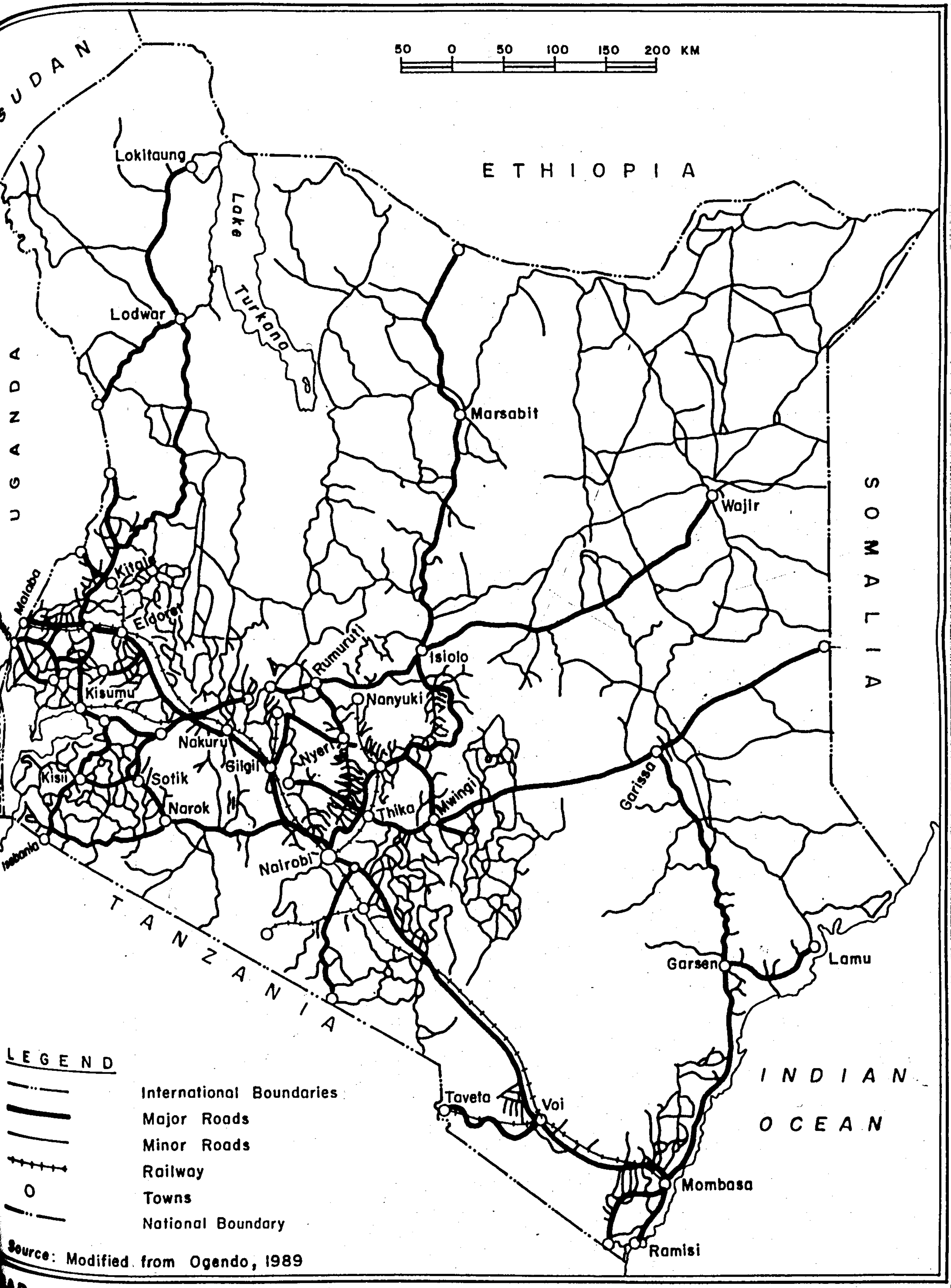
The block system involves the segmentation of the railway network into a series of blocks. Access to a block by a train or motorised railway trolley is gained by the collection of a token or key. The token/key is carried to the end of the block where it is availed for a return trip. The use of tokens and keys does not work easily for unbalanced traffic flows in opposite directions especially when the traffic is heavy and not scheduled. This system can be replaced with electronic signalling and still maintain the block principle.

The number of train paths as defined by block occupation depends on the scheduling of traffic. Passing loops may be utilised for on-coming traffic when train movement is homogeneous. However, if speeds are heterogeneous, the loops must also be made available for overtaking purposes. Kenya's railway traffic speeds are heterogeneous and involve the sharing of a single track by passenger and goods trains.

Kenya's railway network faces these constraints because it is a single track. There is a need for careful time tabling of train movements seeking to avoid momentary delays. *Kenya Railways* has a train timetable for both freight trains and passenger trains. However, the timetable for goods trains is often not followed (say the Nyahururu service). There appears to be a logistic problem resulting in the timetable not being honoured and railway clients not knowing when to expect a train. The Nyahururu timetable is not honoured because the route does not generate sufficient traffic to warrant a regular train. The timetable should be updated every three to six months so as to reflect current traffic flow patterns. There is need for great caution in time tabling to avoid excessive concentration of traffic along a single line railway network because this can lead to extensive time loss in the event of any mishap within the network.

Operating speed is among other factors determined by safety requirements, network design, nature of traffic, amount of traffic and waiting time at wayside stations. The first Nairobi-Kisumu passenger train has to halt at Njoro for a while in order to facilitate the by-pass of the first Kisumu-Nairobi passenger train. Goods trains are often delayed *en route* because of limited marshalling capacity and shunting locomotives. These events reduce the turn round time and in effect limit the temporal carrying capacity of the network. Regular detachment of boggies and logistic delays related to shunting favour the use of block trains. Kenya Railways has sufficient data to be statistically analysed and used as a basis for decision making in the allocation of block trains to speed up freight services to minimise the incidence of logistic delays due to limited shunting facilities and marshalling yards.

Technological progress is not equitably achieved by all modes of transport. Progress is often realised through sporadic occurrences of significant break-throughs. These may give a



Source: Modified from Ogendo, 1989

MAP 12 : KENYA'S ROAD AND RAIL NETWORK

particular mode a competitive advantage, which may be temporary. The balance of advantage is always changing and these changes have considerable geographical consequences to the relationship between modes of transportation. As a factor, technology has an important bearing on the comparative cost structure of the various modes of transportation. It has a very important bearing on how each mode of transport relates to terrain and other physical features of the earth's surface.

The tonnage that can be hauled by a single train depends on the line being used. The recommended tonnage capacity is heaviest along the main line from Mombasa to Malaba and lowest along the branch lines. It varies between 600 and 900 tonnes per train for most lines. The Eldoret-Kitale and Gilgil-Nyahururu have the lowest tonnage capacities along the railway network, namely 350 tonnes.

6.4 THE FUTURE OF RAILWAY TRANSPORT IN KENYA

The shift of traffic from rail to road in recent times appears to have been enhanced by the relatively small size of the country. The difference in transport costs between road and railway is small enough to warrant the use of road transport so as to save time. A case in mind, for example, involves Voi Sisal Estates. It was indicated to the researcher that the slow speed of trains combined with the difficulties related to wagon supplies at wayside stations often resulted in processed sisal reaching Mombasa after an average of seven days. The Estate switched to road transport, and sisal is now delivered in Mombasa within six hours after processing.

Railway transport in advanced countries has in the recent past witnessed far reaching technological improvements and innovative developments. The modernisation of their railway transport has greatly influenced its competitive position *vis-a-vis* other modes of transport. Such modernisation programmes ought to be encouraged by domestic policy changes. The sooner this happens, the sooner will Kenya Railways be able to rise to the current challenges posed by the far reaching developments that have been achieved in road transport.

The immediate future of the railway in Kenya is not likely to be easy. Kenya's economy is increasingly being liberalised thus unleashing new market forces whose effect on the national transport scene is yet to be determined. However, the railway will continue to play a vital role in Kenya's economic development. The effectiveness of its performance will depend on its ability to adopt new innovations. This is what has been happening with respect to other modes of transport.

The area between Butere and Bungoma is vital for sugar production. Kenya Railways intends to construct a railway extension linking Butere to Bungoma via Mumias (the home of the leading sugar factory in Kenya). There is an apparent need for three extensions in this zone, namely; Maseno to Siaya, Bungoma to Mumias and Bungoma to Nambale. The suggested extension pattern takes into consideration the facts that there are two sugar factories scheduled for construction in Busia and Siaya Districts.

The current expansion plan was drafted long before these schemes were mooted and therefore appear to ignore them. These factories are going to increase the demand for fertilizers in their immediate environs and generate a lot of sugar traffic. One of the justifications of the Butere - Bungoma extension was that the line was expected to serve the then proposed fuel alcohol plant at Kisumu (Kisumu Molasses Plant). The plant was expected to use molasses in the production of fuel alcohol. The Kano sugar belt does not produce sufficient amounts of molasses to meet the projected demand of the fuel alcohol plant. It was therefore felt that the railway connection between Butere and Bungoma would facilitate the cheap mass transportation of molasses from Mumias and Nzoia Sugar Factories to Kisumu.

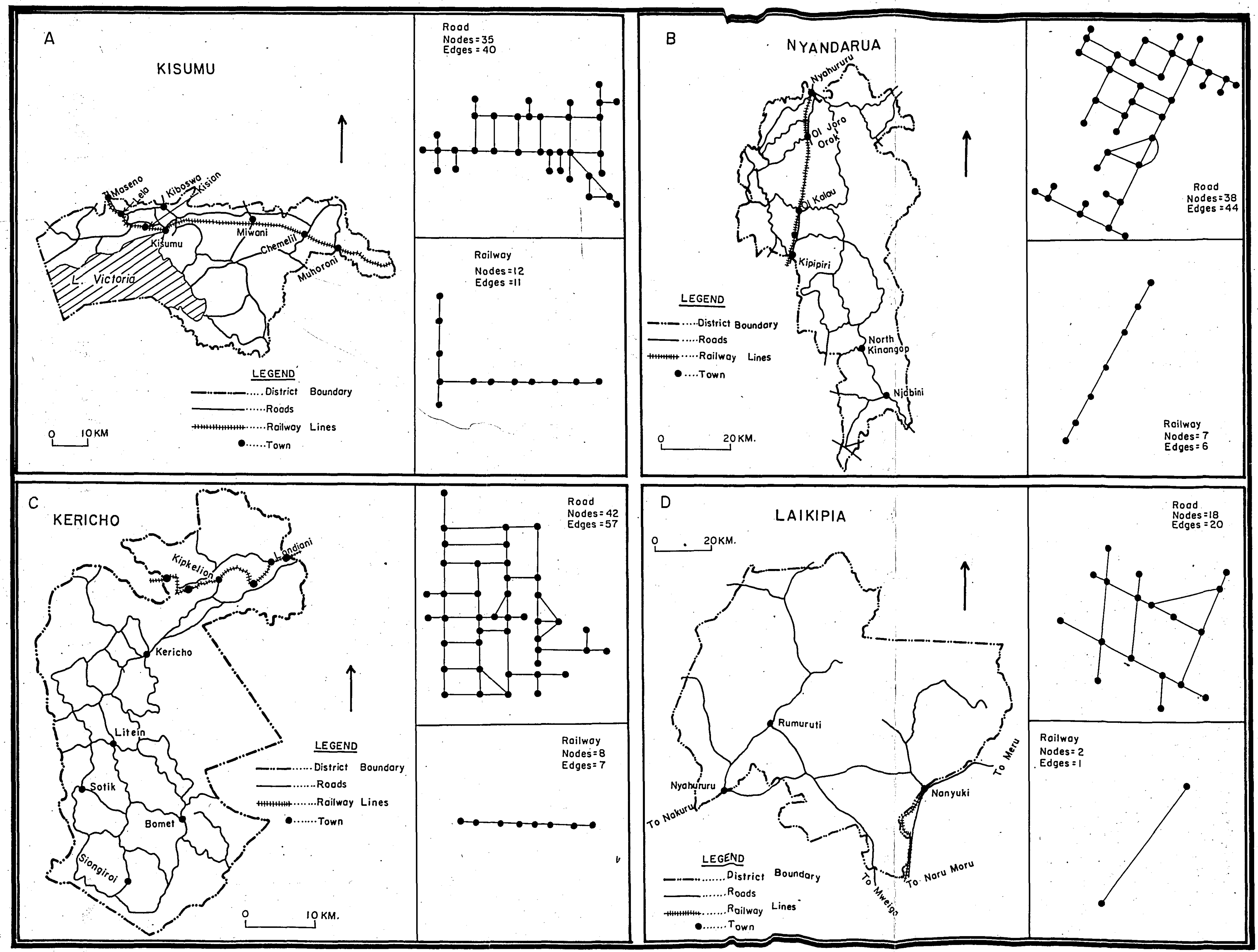
The inability of the fuel alcohol project to take off appears to raise questions regarding the expected volume of traffic along such an extension. Thus, although railway extensions in this area have already been mooted, they should now be considered on the basis of a new orientation. Such an extension could best be planned on the basis of current developments rather than relying on a stalled controversy prone project. One advantage of the proposed extension that still holds is that the Butere to Bungoma link would facilitate the easy re-routing of Uganda bound traffic in the event of extreme congestion at Kisumu Pier. Such traffic may be diverted to Malaba for transit to Uganda. This is an important advantage but apparently of marginal benefit to national development interests.

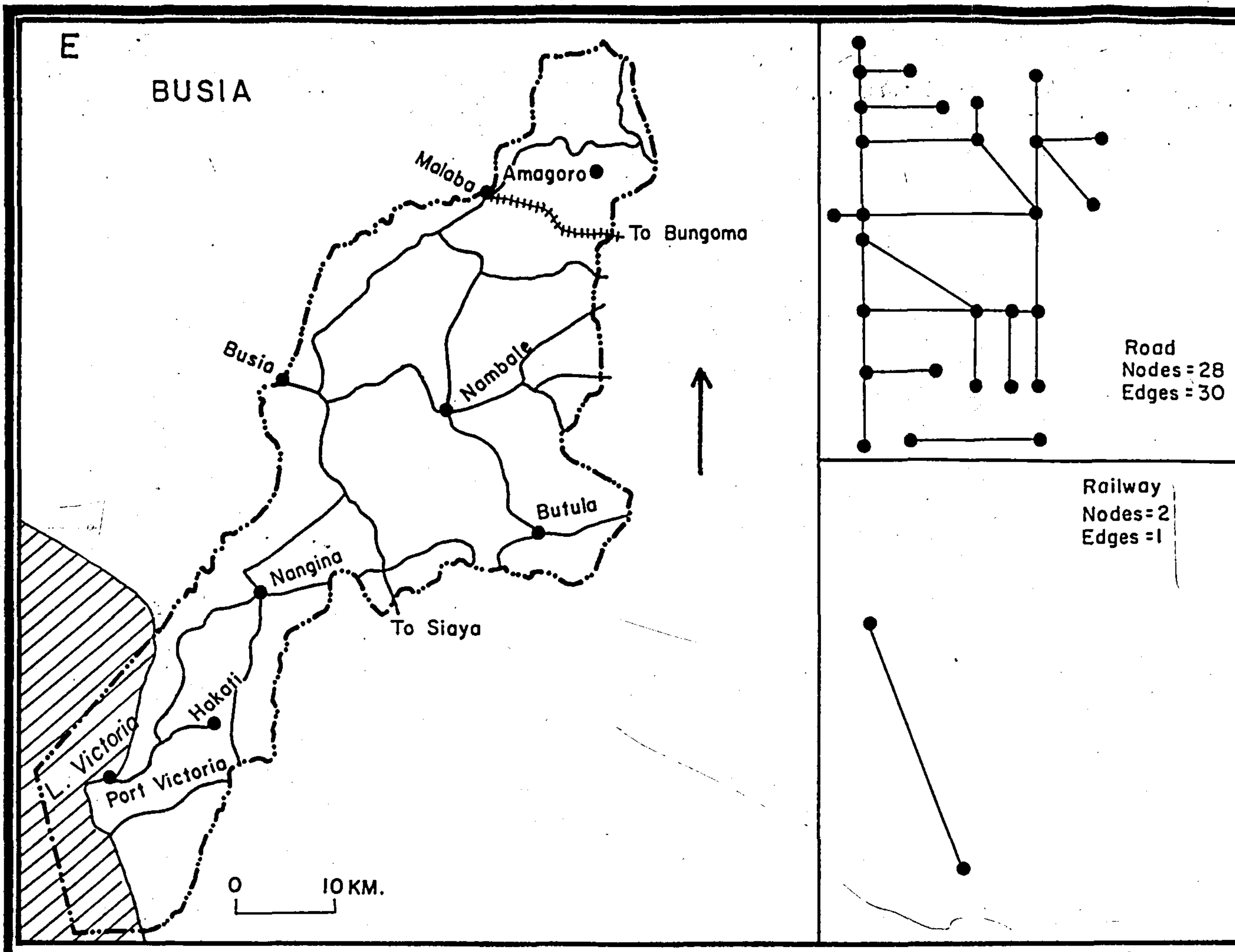
The successful development of the Kerio Valley hydro-electric power supply scheme and fluorspar mining activities can justify the proposed Solai to Sigor extension. However, the devastating effects to our economy of *white elephant* projects such as the now stalled molasses plant in Kisumu call for second thoughts on the implementation of the proposed extension to the Kerio Valley. Progress on the Kerio Valley hydro-electric scheme appears to have stalled. This indicates that the advent of irrigation agriculture which could have increased railway traffic in the region has been delayed. Attention should now focus on assessing the feasibility of establishing an irrigation based agricultural sector in the area and the possible threat to railway interests by road operators considering the implementation of the proposed extension.

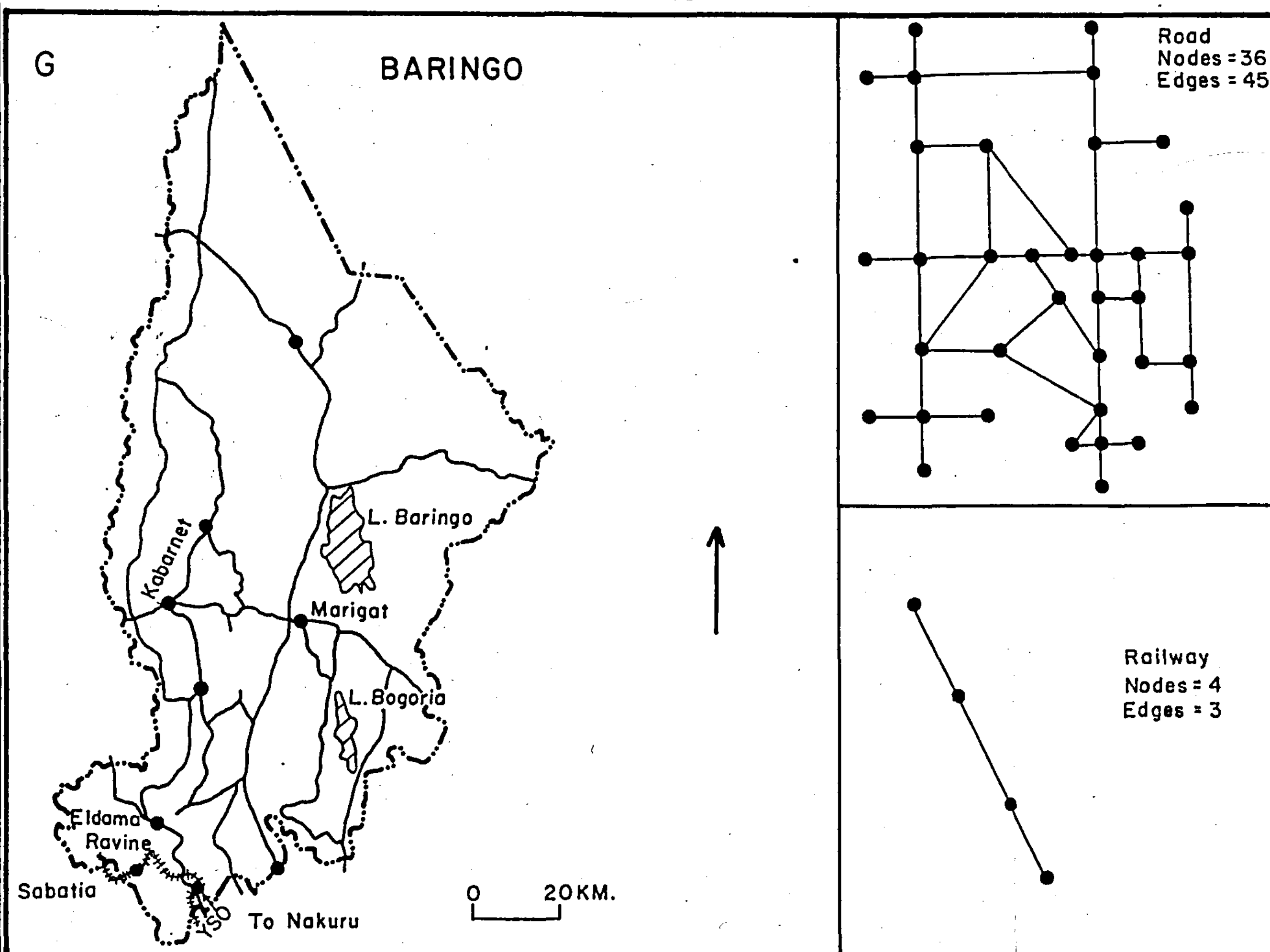
Field observations indicate that individual mobility levels and the volume of freight traffic are likely to increase significantly in the near future especially over medium and long distances. The expected continued growth of the transport market in Kenya is both a challenge to Kenya Railways' competitive position *vis-a-vis* other modes of overland transportation and an opportunity for it to expand its service capacity.

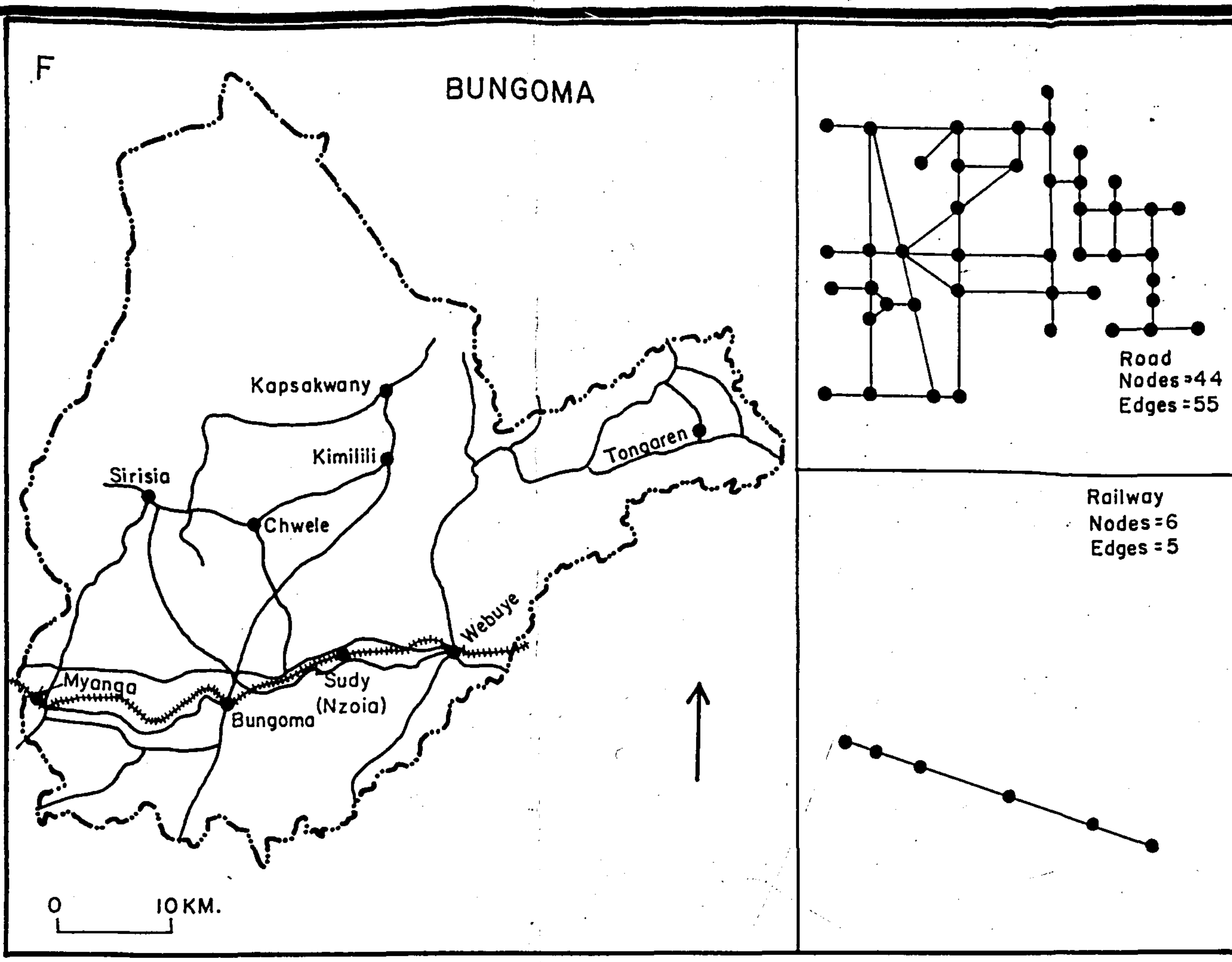
6.5 DATA ANALYSIS III

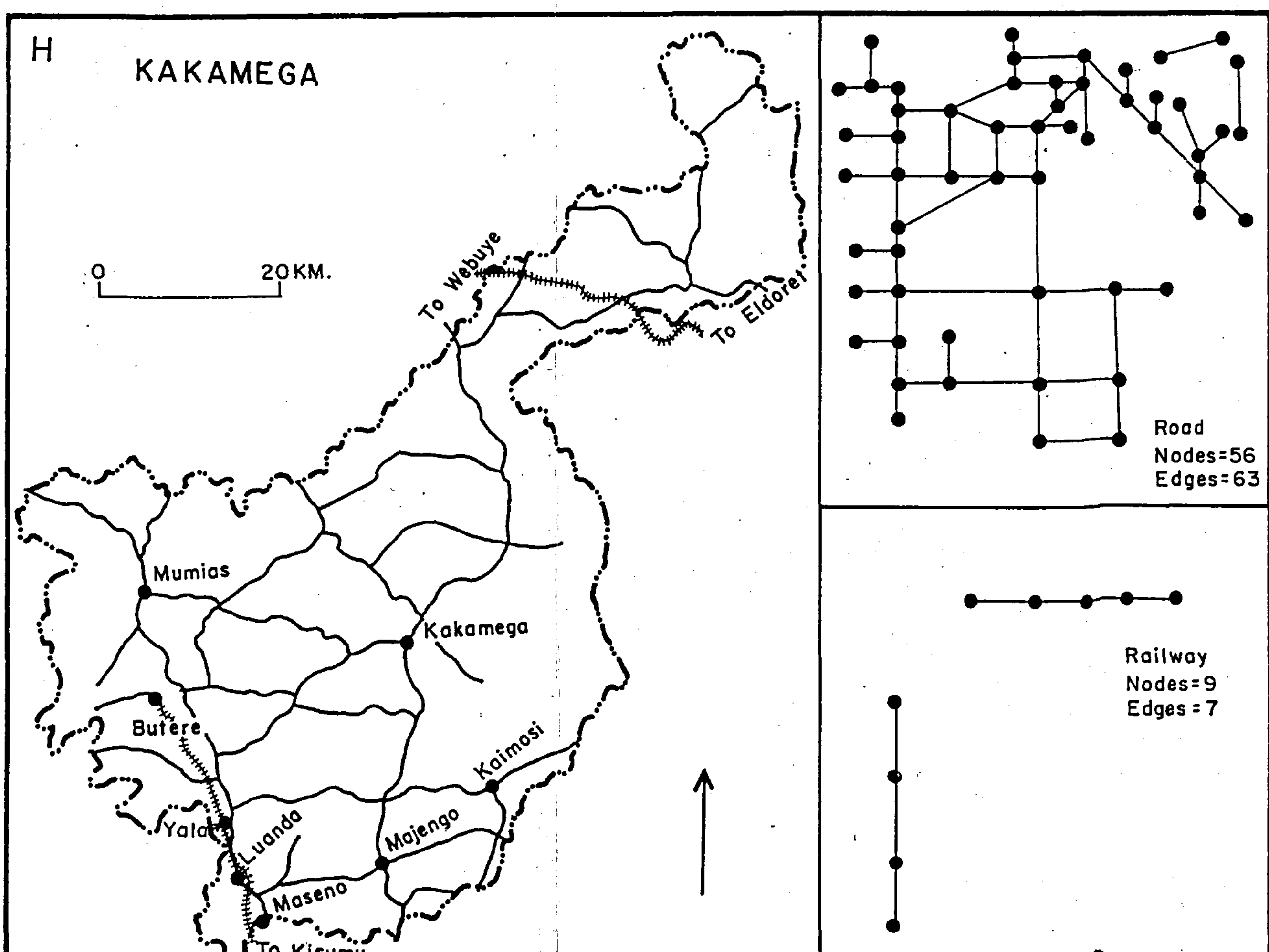
Attention is focused on the statistical evaluation of the null hypothesis stating that "Kenya's railway transport services are not influenced by the presence of other modes of transportation". Absolute and surrogate district road and railway indices have been analysed statistically. The topological properties of road and rail networks are used to represent morphological attributes of district transport infrastructure which are correlated with a view to establishing the existence of any association between them. The variables to be analysed are are: Y - Rail Density (km/km^2), V_1 - Beta Index (rail), V_2 - Gamma Index (rail), V_3 - Cyclomatic Number (rail), V_4 - Alpha Index (road), V_5 - Beta Index (road), V_6 - Gamma Index (road), and V_7 - Cyclomatic Number (road).

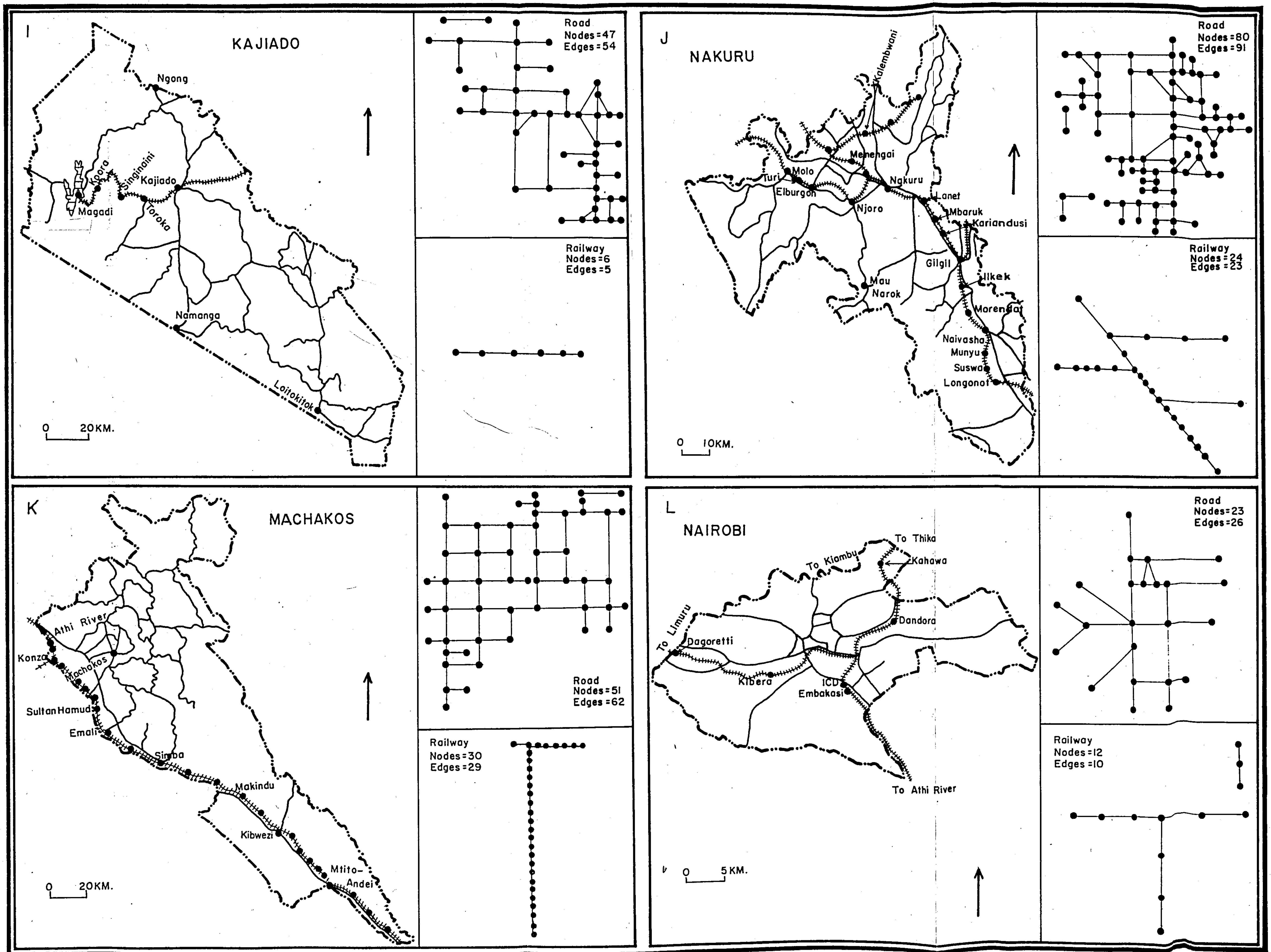

A
KISUMU
Moseno
Lela
Kiboswa
Kision
Kisumu
Miwani
Chemelil
Muhoroni
L. Victoria
LEGEND
District Boundary
Roads
Railway Lines
Town
0 10 KM
Road
Nodes = 35
Edges = 40
Railway
Nodes = 12
Edges = 11
B
NYANDARUA
Nyahururu
Ol Joro Orok
Ol Kalau
Kipipiri
North Kinangop
Njabini
LEGEND
District Boundary
Roads
Railway Lines
Town
0 20 KM.
Road
Nodes = 38
Edges = 44
Railway
Nodes = 7
Edges = 6
C
KERICHO
Kipkelion
Londiani
Kericho
Litein
Sotik
Bomet
Siongiroi
LEGEND
District Boundary
Roads
Railway Lines
Town
0 10 KM.
Road
Nodes = 42
Edges = 57
Railway
Nodes = 8
Edges = 7
D
LAIKIPIA
0 20 KM.
Rumuruti
Nyahururu
To Nakuru
Nanyuki
To Meru
To Mweiga
To Naru Moru
LEGEND
District Boundary
Roads
Railway Lines
Town
Road
Nodes = 18
Edges = 20
Railway
Nodes = 2
Edges = 1

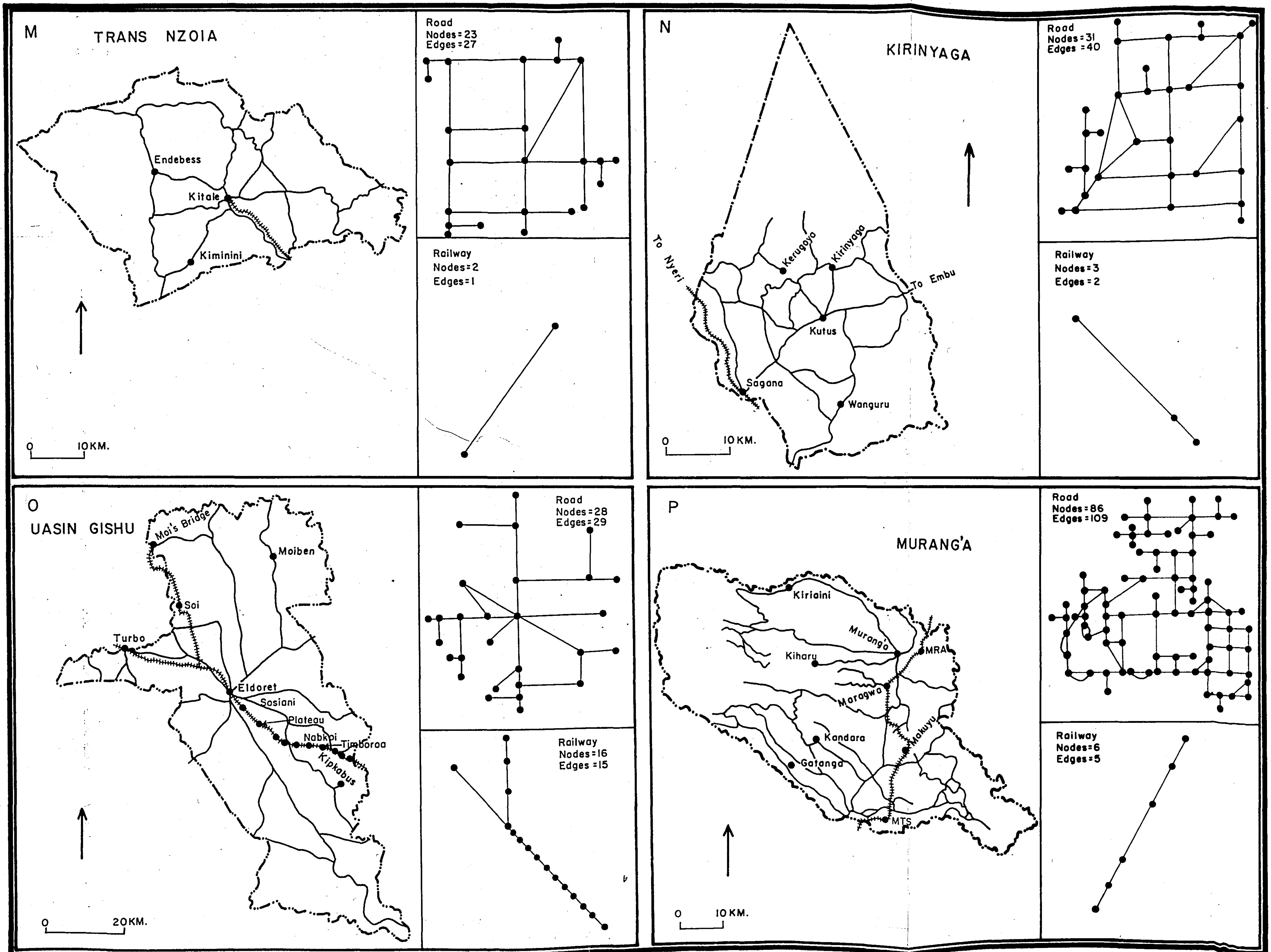

E
BUSIA
Malaba
Amagoro
To Bungoma
Busia
Nambale
Butula
Nangina
To Siaya
Hakati
L. Victoria
Port Victoria
0 10 KM.
Road
Nodes = 28
Edges = 30
Railway
Nodes = 2
Edges = 1


G
BARINGO
L. Baringo
Kabarnet
Marigat
L. Bogoria
Eldama Ravine
Sabatia
To Nakuru
0 20 KM.
Road
Nodes = 36
Edges = 45
Railway
Nodes = 4
Edges = 3

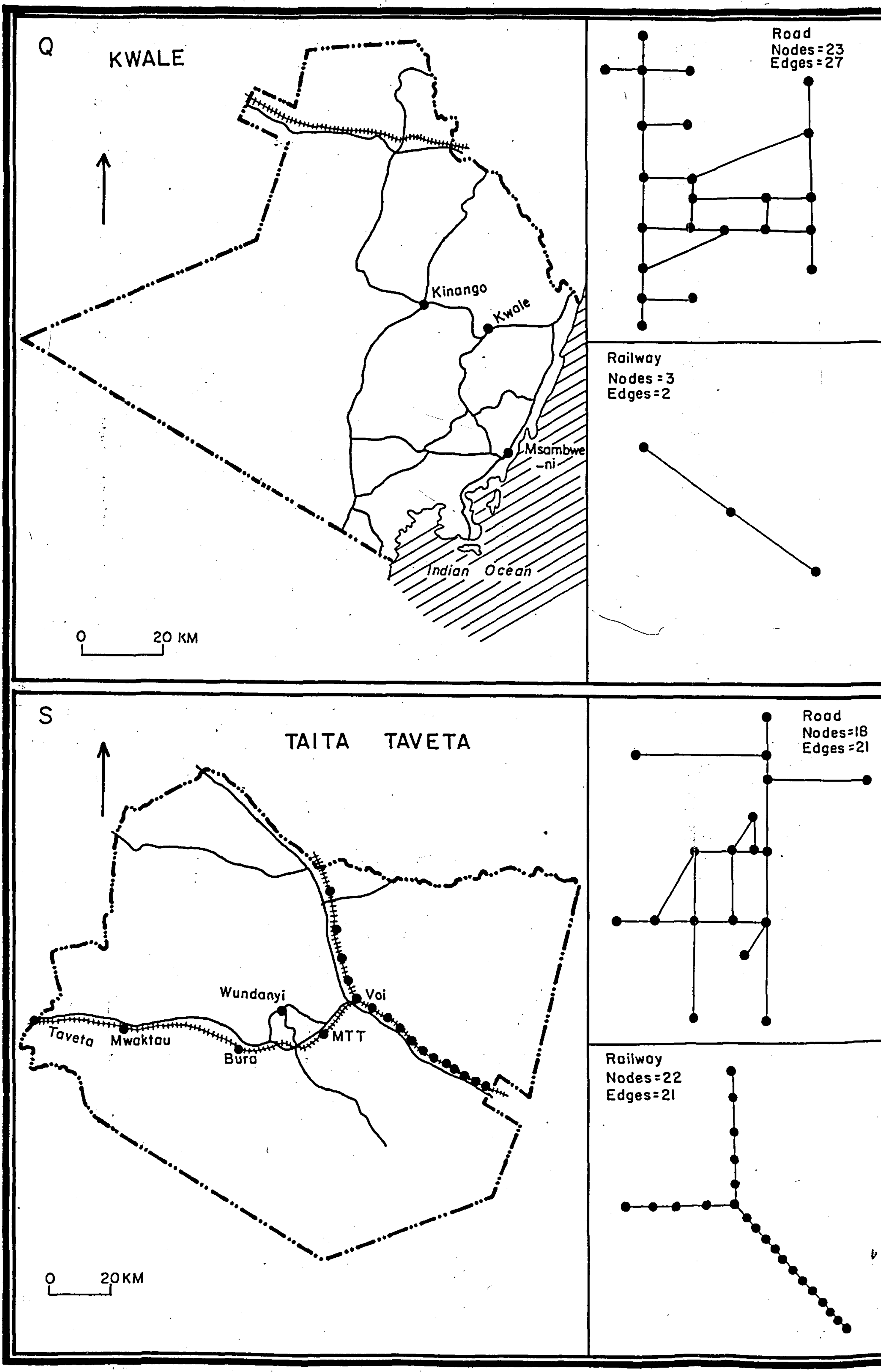

F
BUNGOMA
Kapsakwany
Kimilili
Sirisia
Chwele
Tongaren
Webuye
Myanga
Sudy
(Nzoia)
Bungoma
0 10 KM.
Road
Nodes =44
Edges =55
Railway
Nodes =6
Edges =5


H
KAKAMEGA
0 20 KM.
To Webuye
To Eldoret
Mumias
Kakamega
Butere
Kaimosi
Yala
Luanda
Majengo
Maseno
To Kisumu
Road
Nodes=56
Edges=63
Railway
Nodes=9
Edges=7

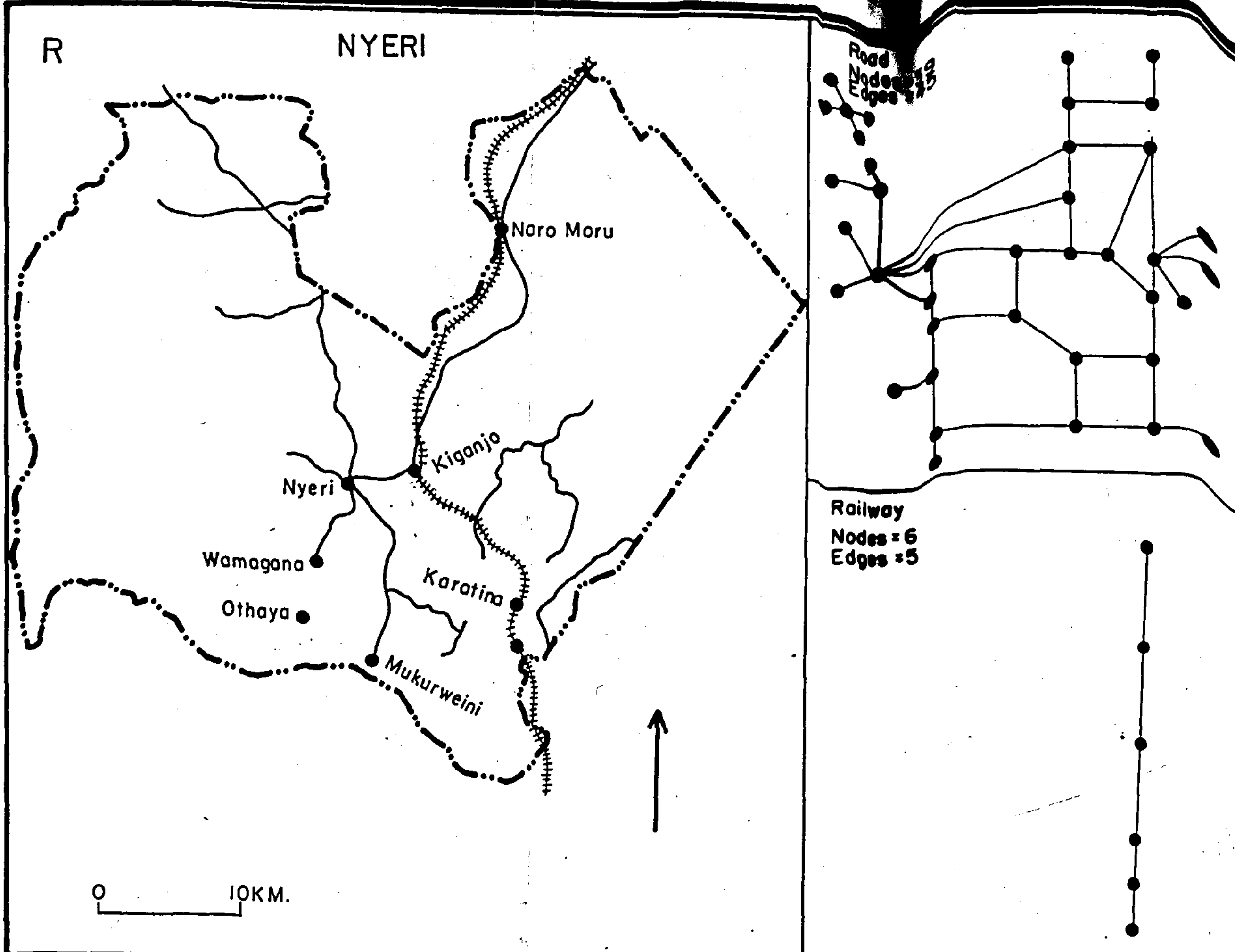

I
KAJIADO
Ngong
Koora
Singinaini
Kajiado
Magadi
Toroka
Namanga
Loitokitok
0 20KM.
Road
Nodes=47
Edges=54
Railway
Nodes=6
Edges=5
J
NAKURU
Kalembwani
Menengai
Turi
Molo
Elburgon
Nakuru
Lanet
Njoro
Mbaruk
Kariandusi
Gilgil
Ilkek
Mau
Narok
Morendat
Naivasha
Munyu
Suswa
Longonot
0 10KM.
Road
Nodes=80
Edges=91
Railway
Nodes=24
Edges=23
K
MACHAKOS
Athi River
Konza
Machakos
Sultan Hamud
Emali
Simba
Makindu
Kibwezi
Mtito-Andei
0 20KM.
Road
Nodes=51
Edges=62
Railway
Nodes=30
Edges=29
L
NAIROBI
To Thika
To Kiambu
Kahawa
To Limuru
Dagoretti
Dandora
Kibera
ICD
Embakasi
To Athi River
0 5KM.
Road
Nodes=23
Edges=26
Railway
Nodes=12
Edges=10

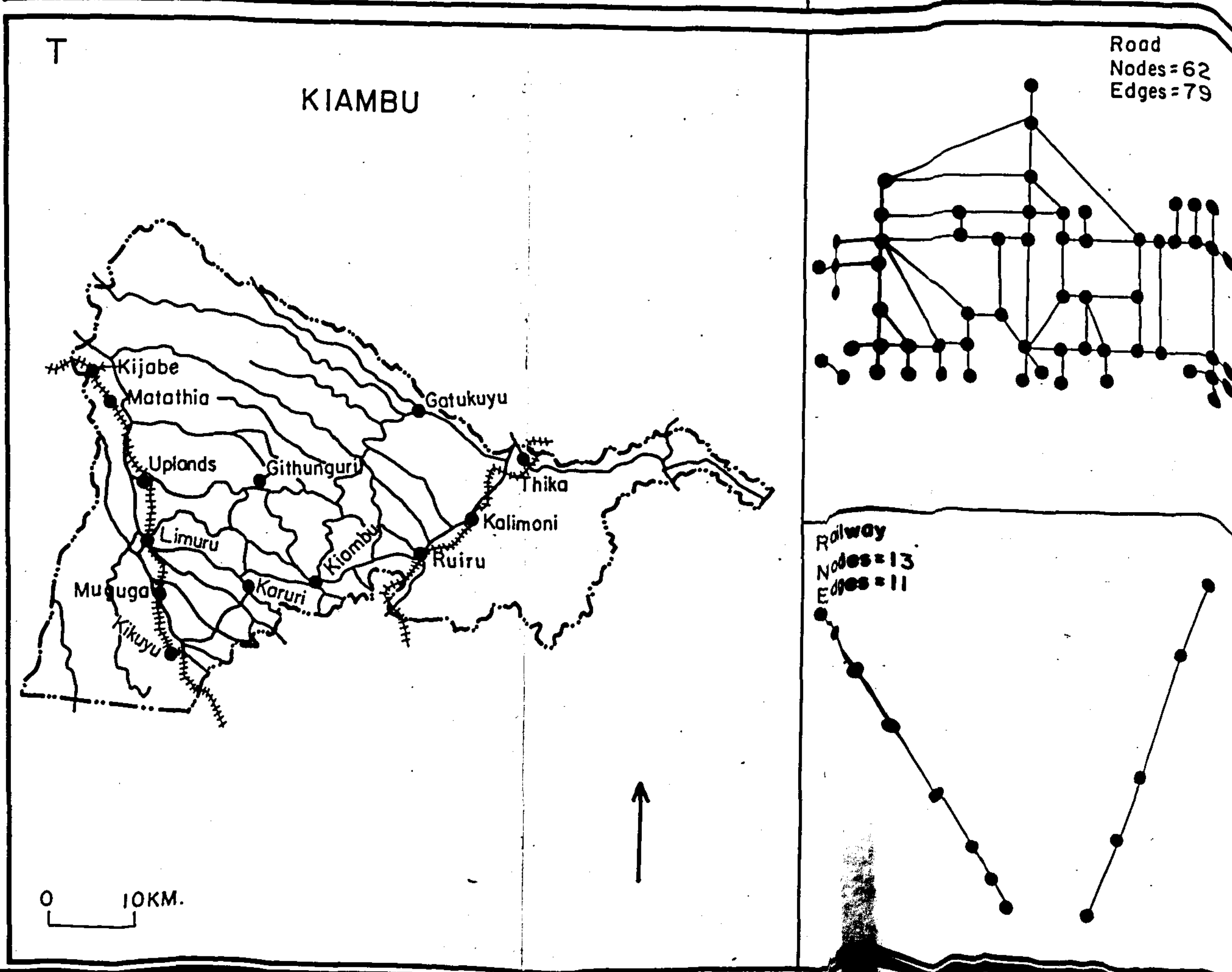


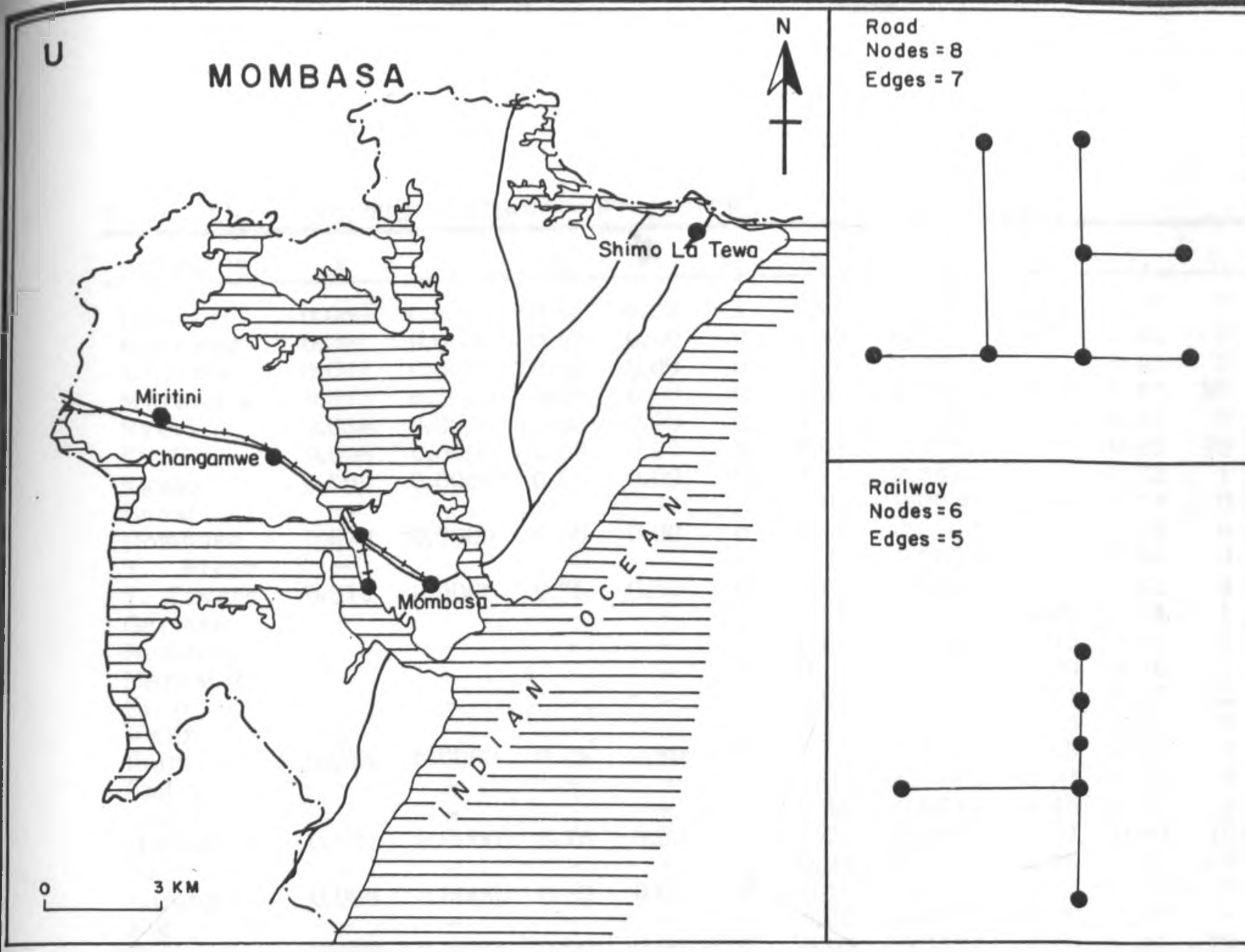
M
TRANS NZOIA
Endebess
Kitale
Kiminini
0 10KM.
Road
Nodes = 23
Edges = 27
Railway
Nodes = 2
Edges = 1
N
KIRINYAGA
To Nyeri
Kerugoya
Kirinyaga
To Embu
Kutus
Sagana
Wanguru
0 10 KM.
Road
Nodes = 31
Edges = 40
Railway
Nodes = 3
Edges = 2
O
UASIN GISHU
Moi's Bridge
Moiben
Soi
Turbo
Eldoret
Sosiani
Plateau
Nabkoi
Timboroa
Kipkabus
0 20KM.
Road
Nodes = 28
Edges = 29
Railway
Nodes = 16
Edges = 15
P
MURANG'A
Kiriaini
Murang'a
MRA
Kiharu
Maragwa
Makuyu
Kandara
Gatanga
MTS
0 10 KM.
Road
Nodes = 86
Edges = 109
Railway
Nodes = 6
Edges = 5



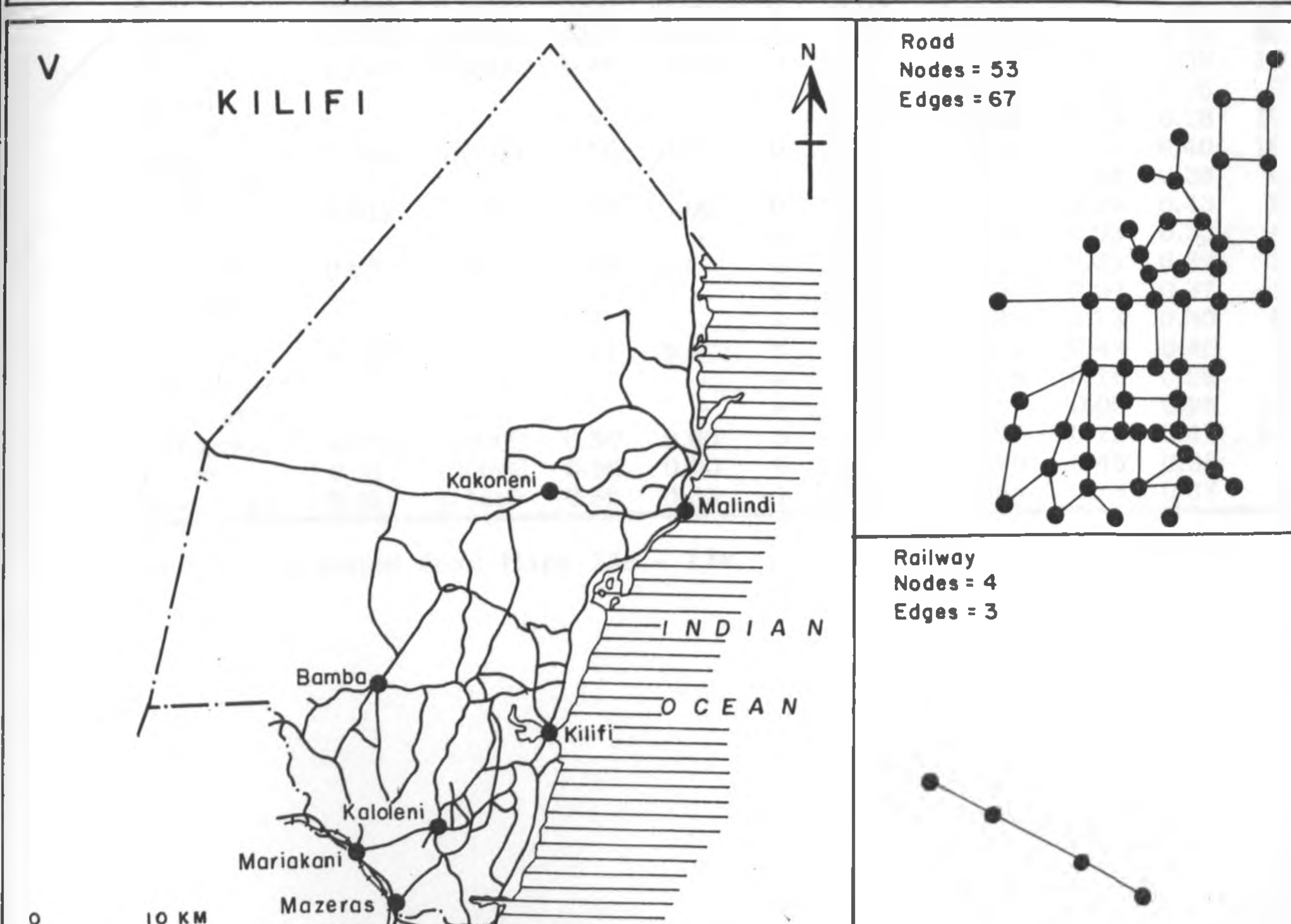
Q
KWALE
Kinango
Kwale
Msambwe-ni
Indian Ocean
0 20 KM
Road
Nodes=23
Edges=27
Railway
Nodes=3
Edges=2
S
TAITA TAVETA
Wundanyi
Voi
Taveta
Mwaktau
Bura
MTT
0 20KM
Road
Nodes=18
Edges=21
Railway
Nodes=22
Edges=21


R
NYERI
Naro Moru
Kiganjo
Nyeri
Wamagana
Othaya
Karatina
Mukurweini
0
10KM.
Road
Railway
Nodes=6
Edges=5


T
KIAMBU
Kijabe
Matathia
Uplands
Githunguri
Gatukuyu
Thika
Kalimoni
Limuru
Kiambu
Ruiru
Muguga
Karuri
Kikuyu
0
10KM.
Road
Nodes=62
Edges=79
Railway
Nodes=13
Edges=11



U
MOMBASA
N
Shimo La Tewa
Miritini
Changamwe
Mombasa
INDIAN OCEAN
0
3 KM
Road
Nodes = 8
Edges = 7
Railway
Nodes = 6
Edges = 5



V
KILIFI
N
Kakoneni
Malindi
INDIAN
OCEAN
Bamba
Kilifi
Kaloleni
Mariakani
Mazeras
0
10 KM
Road
Nodes = 53
Edges = 67
Railway
Nodes = 4
Edges = 3

Table 29 DISTRICT TRANSPORT INDICES

DISTRICT	Y	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9
Kiambu	0.050	0.0909	0.50	0.33	-1	0.65	0.0588	1.08	0.37	7
Kirinyaga	0.021	0.0000	0.50	0.00	0	0.42	0.1525	1.25	0.44	9
Laikipia	0.001	0.0000	0.50	0.00	0	0.66	0.0968	1.11	0.42	3
Murang'a	0.023	0.0000	0.50	0.00	0	0.30	0.1198	1.22	0.42	20
Nyeri	0.038	0.0000	0.50	0.00	0	0.71	0.1258	1.18	0.42	9
Kilifi	0.005	0.0000	0.50	0.00	0	0.41	0.1782	1.34	0.46	18
Kwale	0.005	0.0000	0.50	0.00	0	0.13	0.0976	1.13	0.72	4
Lamu	-	-	-	-	-	0.06	0.0000	0.95	0.39	0
Mombasa	0.070	0.0000	0.50	0.00	0	0.64	0.0000	0.88	0.39	6
T. River	-	-	-	-	-	0.04	0.0000	0.94	0.40	0
T. Taveta	0.015	0.0000	0.75	0.50	0	0.07	0.0968	1.11	0.42	3
Garissa	-	-	-	-	-	0.06	0.0196	1.00	0.24	1
Mandera	-	-	-	-	-	0.05	0.0730	1.09	0.33	3
Marsabit	-	-	-	-	-	0.02	0.0175	1.00	0.36	1
Kitui	-	-	-	-	0	0.08	0.1302	1.24	0.27	22
Wajir	-	-	-	-	-	0.03	0.0000	1.95	0.37	0
Nairobi	0.075	0.0000	0.75	0.50	0	0.65	0.1220	0.65	0.43	5
Embu	-	-	-	-	-	0.31	0.0612	0.31	0.33	3
Isolo	-	-	-	-	-	0.45	0.0444	0.45	0.35	2
Machakos	0.021	0.0000	0.75	0.50	0	0.21	0.1031	0.21	0.40	10
Meru	-	-	-	-	-	0.20	0.1970	0.20	0.27	13
Baringo	0.005	0.0000	0.50	0.00	0	0.15	0.1231	0.15	0.35	8
Elgeyo M.	-	-	-	-	-	0.20	0.0225	0.20	0.37	-
Kajiado	0.009	0.0000	0.50	0.00	0	0.09	0.1124	0.09	0.41	10
Kericho	0.014	0.0000	0.50	0.00	0	0.58	0.1728	0.58	0.46	14
Nakuru	0.044	0.0000	0.88	0.39	0	0.21	0.0701	0.21	0.38	11
Nandi	-	-	-	-	-	0.32	0.0377	0.32	0.35	2
Narok	-	-	-	-	-	0.09	0.0920	0.09	0.28	15
Nyandarua	0.016	0.0000	0.50	0.00	0	0.12	0.2542	0.12	0.40	16
Samburu	-	-	-	-	-	0.04	0.0000	0.04	0.36	0
T. Nzoia	0.012	0.0000	0.50	0.00	0	0.29	0.1220	0.29	0.43	5
Turkana	-	-	-	-	-	0.03	0.0480	0.03	0.33	4
U. Gishu	0.033	0.0000	0.50	0.00	0	0.25	0.0612	0.25	0.39	3
W. Pokot	-	-	-	-	-	0.07	0.0009	0.07	0.37	-1
Kisii	-	-	-	-	-	0.73	0.0706	0.73	0.30	6
Kisumu	0.028	0.0000	0.67	0.67	0	0.43	0.0923	0.43	0.40	6
Siaya	-	-	-	-	-	0.16	0.1636	0.16	0.28	9
S. Nyanza	-	-	-	-	-	0.00	0.1867	0.00	0.26	14
Bungoma	0.028	0.0000	0.50	0.00	0	0.28	0.1687	0.28	0.45	14
Busia	0.011	0.0000	0.50	0.00	0	0.45	0.0196	0.45	0.35	1
Kakamega	0.019	0.1667	0.50	0.33	-1	0.53	0.0865	0.53	0.38	9

Source: Calculated from Maps 13a - 13v.

Table 30 CORRELATION OUTPUT 3

	Y	V_1	V_2	V_3	V_4	V_5	V_6	V_7
Y	1.000	.3744	-.6444**	.3578	.1684	.2023	-.3441	.0063
V_1	.3744	1.0000	-.8129**	.0361	.0784	-.1378	-.1557	.2371
V_2	-.6444**	-.8129**	1.0000	-.3641	-.0327	.0452	.2314	-.2541
V_3	.3578	.0361	.3641	1.0000	-.0872	-.0284	-.0963	.1176
V_4	.1684	.0784	-.0327	-.0872	1.0000	.1759	-.0412	-.1223
V_5	.2023	-.1378	.0452	-.0284	.1759	1.0000	-.1476	-.8582**
V_6	-.3441	-.1557	.2314	-.0963	-.0412	-.1476	1.0000	-.0139
V_7	.0006	.2371	-.2541	.1176	-.1223	-.8582**	.0139	1.0000

Dependent variable is Y (Rail Density)

With the exception of V_2, the independent variables obtain weak correlations against Y. The correlation result reveals that Gamma Index (Rail) has a significant association with the observed railway density. Road transport indices (V_4, V_5, V_6 and V_7) achieved low correlations against the observed district railway density.

Table 31 t TEST OUTPUT 5

VARIABLE	B	SE B	BETA	T	SIG T
Variables in the Equation					
V_2	-1.78777	.47444	-.64435	-3.768	.0012
Constant	-5.46019	.40323		-13.541	.0000
Variables not in the Equation					
V_1	-.44033	-.33535	.33921	-1.552	.1372
V_3	.14199	.17292	.86741	.765	.4535
V_4	.14752	.19281	.99893	.856	.4024
V_5	.23192	.30296	.99796	1.386	.1819
V_6	-.20607	-.26216	.94647	-1.184	.2510
V_7	-.16834	-.21290	.93541	-.950	.3541

The derived regression equation is;

$$Y = -5.46019 - V_2 - 1^{78777} \quad \ldots\ldots (6.1)$$

The *t* **test** was carried out at the 0.05 significance level. The *t* **test** excludes V_1, V_3, V_4, V_5, V_6 and V_7 from the regression model. The following R output was obtained;

Table 32 R OUTPUT 5

Multiple R	.75233
R Square	.56601
Adjusted R Square	.34901
Standard Error	.82591

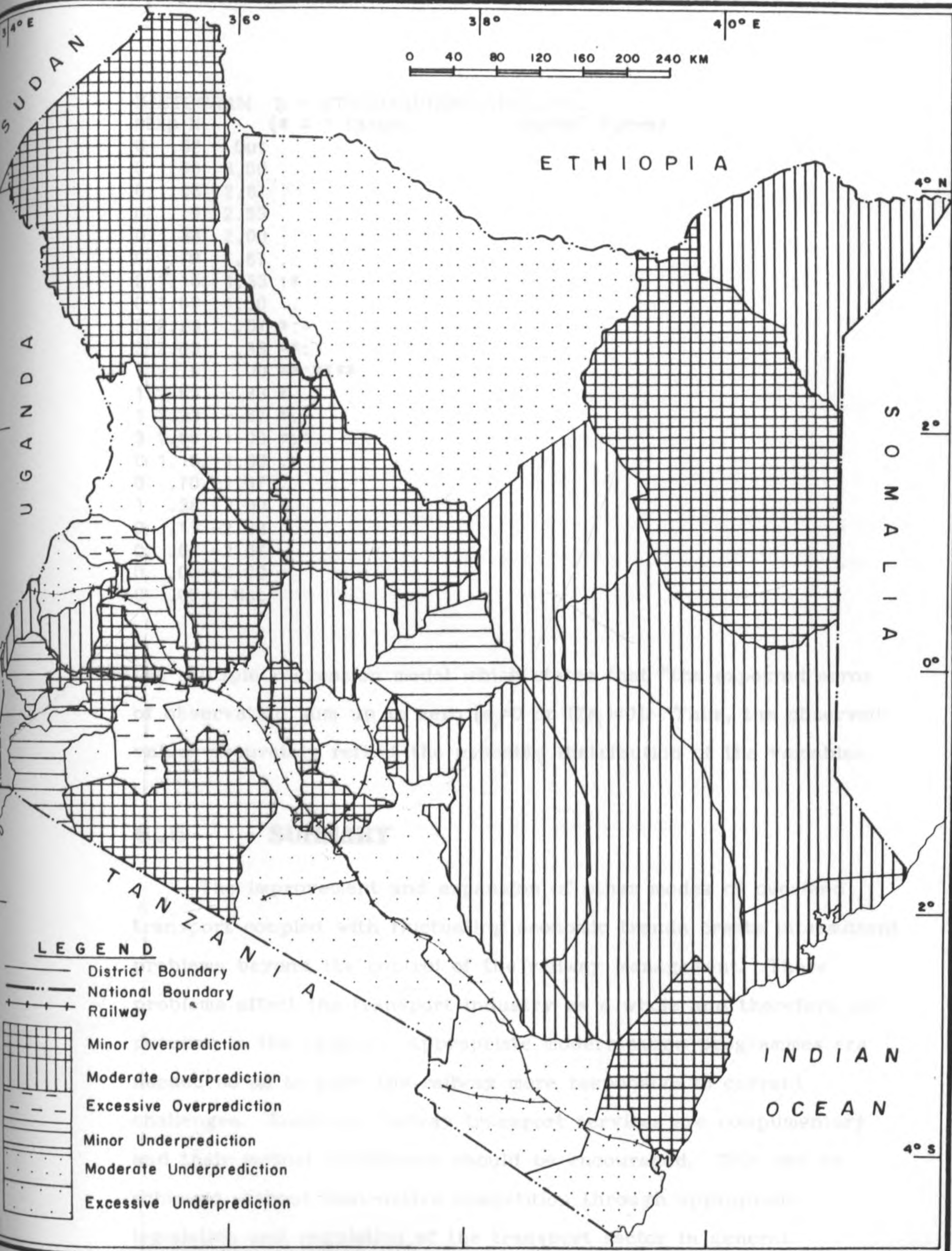
The R^2 value when multiplied by 100 suggests that 56.601% of the observed relationships are strongly related to district railway density. It has been adjusted to .34901 which when multiplied by 100 suggests that 34.901% of the obtained relationship is related to district railway density. This finding suggests that districts with higher railway densities tend to have a more infrastructure. The analysis of variance yielded the following output;

Table 33 ANOVA OUTPUT 5

	DF	Sum of Squares	Mean Squares
Regression	7	12.45478	1.77925
Residual	14	9.54983	.68213
F = 2.60838		Significant F = .0601	

Both the *t* and *F* Tests indicate that there exists a significant relationship between railway and road indices. In the *t* Test, all calculated *t* values (T Critical) are greater than all expected (Significant T). The calculated F Critical (2.60838) is greater than Significant F (.0601) suggesting that F Observed is not significantly different from F Critical. On the basis of these two tests, the null hypothesis stating that "*Kenya's railway services are not significantly influenced by the presence of alternative modes of transport*" is rejected and the alternative hypothesis accepted.

Histogram 3 indicates a close relationship between the distribution of observed and expected values. This distribution of residual values does not significantly violate the first assumption of



AP 14 : RESIDUAL VALUES

```
HISTOGRAM  3 - STANDARDIZED RESIDUAL
NExp N      (* = 1 Cases,    . : = Normal Curve)
0  .02   Out
0  .03  3.00
0  .08  2.67
0  .19  2.33
0  .38  2.00
0  .70  1.67 .
2 1.15  1.33 :*
0 1.69  1.00  .
3 2.23   .67 *:*
3 2.63   .33 **:
7 2.78   .00 **:****
1 2.63  -.33 * .
1 2.23  -.67 *.
3 1.69 -1.00 *:*
0 1.15 -1.33 .
0  .70 -1.67 .
1  .38 -2.00 *
0  .19 -2.33
0  .08 -2.67
0  .03 -3.00
0  .02   Out
```

the multiple regression model which states that "the expected error of observation sum up to zero [e_i=0 or (Σe_i)=0]. Thus, the observed values accurately reflect the expected distribution of the variables.

6.6 SUMMARY

The improvement and expansion of other modes of overland transport coupled with fluctuating economic trends create intermittent problems beyond the control of the railway management. These problems affect the transport industry as a whole and therefore not peculiar to the railway. Appropriate modernisation programmes are needed so as to make the railway more responsive to current challenges. Road and railway transport services are complimentary and their mutual coexistence should be encouraged. This can be achieved without destructive competition through appropriate legislation and regulation of the transport sector in general.

CHAPTER SEVEN

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

7.0 INTRODUCTION

This chapter provides a summary of findings and conclusions based on the core chapters and makes suggestions and recommendations arising from this study. The study attempts to analyse the relationship between the railway and national development in Kenya while using four broad approaches, namely: conceptual, descriptive, organisational and infrastructural.

The conceptual approach outlines a theoretical basis that evaluates railway transport in terms of its contribution and relevance to national development. The descriptive approach focuses attention on basic aspects of the railway such as network structure, scheduling, capacity allocation, and equipment combination.

The organisational approach focuses attention on the structural and organisational circumstances that govern railway transport in Kenya. Of particular interest is the actual layout of the railway network, the policy framework within which railway services are rendered in Kenya and the operational efficiency of a complex *multimodal* national transport system. Finally, the infrastructural approach attempts to assess how the myriad of transport equipment relate to human aesthetic feelings while focusing attention on passenger traffic.

7.1 FINDINGS

The first null hypothesis states that *'Railway traffic does not decline significantly as distance increases'* and formed the basis of discussions and analyses conducted in chapter four. The main objective of this hypothesis was to determine empirical estimates of the effect of distance decay exponent. Model 4.3 suggests that the distance decay exponent for passenger traffic is ($V_7^{0.62706}$). This high value of the distance decay exponent is attributed to third class passengers who are the majority and often make numerous short journeys. The null hypothesis was rejected and the alternative one accepted.

The second null hypothesis states that *'There is no significant relationship between the location of major economic activities and the railway network'*. It formed the basis of the discussions in chapter five. Data was statistically tested with a view to achieving the objective seeking to establish the relationship between the railway and levels of economic development. Selected indices of economic development were analysed. The null hypothesis was rejected and the alternative one accepted.

Field observations indicated that there is a strong spatial relationship between the railway and economic development. It was also observed that the railway does not offer direct benefits to most of the places through which it passes while other areas benefit from railway services by means of road connections to railheads and railway stations. The railway is most suited for long distance mass transportation and therefore causes marginal benefits to most of the areas through which it passes. The observed spatial association between the railway and economic development is thus attributed to geographical inertia rather than the current status of the railway in

Kenya's transport scene.

The third null hypothesis states that '*Railway services are not significantly influenced by the presence of alternative modes of transport*'. It formed the basis of chapter six which discusses the objective seeking to establish the relationship between road and railway transport in Kenya. District transport indices based on topological attributes of railway and road networks have been statistically analysed using multiple regression and correlation analyses. Railway facilities represented by observed district railway mileage comprise the independent variable. The null hypothesis was rejected and the alternative accepted.

The following observations were made in the field, namely;

i) The railway tends to pass on the outskirts of towns.

ii) Almost all large scale commercial and industrial enterprises in towns served by the railway are either sited less than 1 km from the railway station or have a siding line.

iii) A dense population along the railway network in Nairobi (Eastlands and Kibera areas) makes the sector suitable for railway commuter services.

iv) The Magadi-Konza and Voi-Taveta branch lines have minimal competition from road transport.

v) Sidings at most warehouses can accommodate about two long wagons.

vi) Trucks are off loaded faster than wagons yet they lack demurrage charges.

Some constraints that restrict the effective operation of Kenya's railway freight services are;

i) The railway network is served by numerous mixed trains[28] and locomotive fleet. A mixed locomotive fleet is prone to delays *en route.* Wagons have to be detached and switched between trains while in transit.

ii) Kenya's railway network lacks a uniform permissible train load. Different sectors of the railway have different permissible train loads. These depend on the capacity of the rails, the ruling gradient and bridges along a sector. Variation in permissible train loads causes frequent relay and transhipment of freight traffic between trains and wagons. Heavy trains either detach light wagons or their cargo is transhipped to light wagons for hauling using light locomotives.

iii) Kenya Railways has a wagon fleet that is varied in terms of age and spatial availability. Old wagons are prone to frequent breakdown and repair. This leads to intermittent reduction in the short term carrying capacity and high maintenance costs. The spatial availability of wagons is a major constraint to the smooth operation of railway services. Traffic requirements change rapidly throughout the network while the supply of wagons is often slow.

iv) Most wayside stations are inconvenienced by the logistic limitations in the supply of wagons, for example, Voi station is supplied with wagons from Mombasa or Nairobi, the leading source stations a long this sector.

v) The supply of wagons is also restricted by clients who retain wagons for long as they unload their consignment. In effect, this removes wagons from active circulation.

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28 This is a train comprising wagons to different stations and consignees. They carry different commodities and sometimes haul both freight wagons and passenger coaches.

7.2 CONCLUSIONS

The complementary, transferability and intervening opportunity principles have underlain the observed flows in the present study. It is concluded that the existence of a resource in an area is not a sufficient condition for the existence of a railway transport service. The resource must be required elsewhere while the railway has to compete other forms of transportation, particularly road transport.

The distance decay exponent can be used to identify traffic that is suitable for long distance mass transportation. The smaller the distance decay exponent is the more suitable the traffic is for long distance mass transportation. Passenger traffic was found to be unsuitable for long distance mass transportation by rail in Kenya. However, field observations revealed that the handling of passenger traffic is a sensitive political issue. This calls for minimal passenger services while concentrating on the more suitable freight traffic. The numerical superiority of short distance and low paying third class passengers make the overall passenger service unsuitable for railway transport because it has greater possibility of ticketless passengers, numerous short trips and prone to over crowding.

This study indicates that there is a strong spatial relationship between the railway and economic development in Kenya. The railway has been found to be suitable for long distance mass transportation and therefore causes marginal benefits to most of the areas through which it passes. Road connections enable the railway to extend its influence to areas that it does not reach. As a result, the railway network outlines Kenya's chief transport corridor which is externally orientated and based on a colonial design. Most of the observed spatial association between the railway and economic development in Kenya is attributed to geographical inertia rather than the current status of the railway in Kenya's transport scene.

This study has established that railway density tends to be inversely proportional to road density at the district level. This observation suggests that the less likely it is to find a railway in a district, the more likely one can find a road. The development of Kenya's road transport network begun from the need to create a network of feeders to the railway. In this regard it was natural that roads would tend to be most dense in districts served with the railway. However, post independence policies view the development of a dense road network as a more effective way of stimulating economic activity and enhancing national integration. Thus district railway density tends to be inversely proportional to district road density.

It was observed that the railway management in Kenya appears to be rigid and does not respond quickly to the rapidly changing needs of their clients or speedily adopt new innovations. This rigidity is attributed to financial limitations, need to train a large section of the staff, the unwillingness to engage in heavy financial and infrastructural outlays needed to facilitate change in the network and bureaucratic procedures that slow the process of making and implementing decisions. Whatever the justification for this rigidity, one fact is clear, for as long as the railway management remains rigid, it will continue to lag behind road transport in terms of improved facilities and ability to satisfy clients.

Passenger services are the most problematic to render. Their problems include;

- Trains arriving and departing from wayside stations during the wee hours of the morning.
- Third class coaches have many hawkers, ticketless passengers, excess luggage and are often so congested that ticket

examiners cannot operate with ease.

- Passenger traffic engage locomotives in low revenue generating activities yet receive transit priority and require many staff members.

The railway is the most environment friendly mode of transport and has an attractive safety record. It conveys more traffic per unit space than road transport, generates minimal pollution to the environment and uses less per unit energy. However, the railway's inherent advantages *per se* are insufficient to re-initiate its former predominance in Kenya's overland transport scene. This calls for urgent steps seeking to make the railway conform to modern economic and business realities. One area that certainly needs great attention is the need to shorten the delivery period. Many cargo shippers tend to be interested in speed rather than environmental considerations or costs especially when the difference in costs between road and rail is so low.

7.3 RECOMMENDATIONS

RESEARCHERS

a) This study is essentially geographical and focuses attention on the spatial aspects of available facilities, services rendered and traffic characteristics. The study therefore leaves a lot of room for researchers from other academic disciplines to venture further into the analysis of other aspects of railway transport such as management practices, economic conditions, and engineering requirements among others.

b) The *Uganda Railway* was initially meant to provide accessibility to Uganda from the Kenyan coast and constituted the basic infrastructure that initiated significant structural transformations in the country's space economy during the 20th century. The following questions may be raised.

- Is the historical spatial association between development and the railway in Kenya accidental?
- Did the railway pass through high potential areas by chance and thus easily able to stimulate mass production?
- What is the future of Kenya's railway services in view of changing technological, political and economic conditions?

These questions require careful consideration and must be looked at in the context of the numerous basic factors that determine the exploitation of economic opportunities. The relationship between transport and development is very dynamic and depends on a multitude of factors. It is therefore recommended that more research work must be conducted with a view to updating the status of our transport infrastructure in general. A beginning point may be a comprehensive analysis of Kenya's water transport focusing attention at oceanic and lacustrine traffic.

c) This work suggests that the gravity model is not a strong predictor of railway traffic in Kenya. Upper class passenger service and bulk commodities are most suitable to long distance mass transportation as seen along the Nairobi-Mombasa railway sector. There is need for more analyses in this area seeking to clearly identify categories of railway traffic and the strength of their conformity with the gravity model. Such analyses will isolate traffic that is not suitable to railway operations in terms of long distance mass transportation.

THE GOVERNMENT

a) The railway performs a significant role in the development of Kenya. Its future depends largely on the policy measures governing transportation that will be adopted and the number of corporate contracts that will be secured. Kenya urgently needs an overall national transport policy if she expects her transport system to develop in an orderly manner. This study recommends that work in this area should commence without further delay.

b) Railway operations will in future depend on conditions that are different from those that existed during its formative years and which, apparently, still prevail today. However, exclusive access to some sectors of the transport market is diminishing as road transport gains more freedom of access to attractive traffic. This study recommends that a careful plan of action seeking to effectively incorporate Kenya's railway network in the promising Preferential Trade Area (PTA) transport system should commence without further delay. Reviving the East African railway services would serve as a usefull starting point.

c) Kenya subscribes to the ideals of a liberal economy. Commitment to the principles of a liberal and competitive economy must also protect the society's common good. Kenya's transport system has become complex, administratively ritualistic and intensely intertwined. The country appears to be heading for a situation where the transport system will create more complex problems while not solving the basic problem, namely, enhance mobility. Roads are damaged by overweight vehicles while recording an alarming death rate at a time when there is an apparent shift of traffic from the railway, an important alternative. This study recommends that the state should urgently institute measures to regulate the transport industry with a view containing and reversing this trend.

d) This study favours the establishment of a multidisciplinary university-based transport 'think-tank' in Kenya. The institution should form the pinnacle of transport research and information in the country while providing a framework for generating useful information on transport issues for the careful analysis by trained experts.

KENYA RAILWAYS CORPORATION

a) This study recommends that Kenya Railways should strive to improve transit time by making train movement more frequent and optimising traffic flows. Modern communication facilities feature prominently in this regard. A computer based traffic monitoring system may lead to the easy location of wagons on the network and speedy assessment of available capacity based on the availability and location of empty wagons.

b) This study also recommends that Kenya Railways should examine the modalities of improving the carrying capacity of the network by strengthening the rails and using more powerful standardised locomotives. This will reduce the number of trains in use and alleviate the incidence of congestion caused by numerous trains operating a single track railway network. Such an arrangement will facilitate the speedy transportation of cargo along busy branch routes by minimising the reliance on a mixed locomotive fleet as is now the case.

c) Developing a transport system consistent with the liberal principles of a national transport policy is not an issue. What

Kenya needs is a form of liberalism that guarantees equitable opportunity of success by all modes of transport. In this context, this study recommends that railway authorities should, in addition to outlining their grievances, endeavour to be a source of concrete suggestions of suitable solutions.

d) This study recommends further that *Kenya Railways* develops a data bank within the framework of a computerised geographical information system (GIS) for monitoring, analysing and predicting railway traffic in a spacio-temporal framework. Such a data bank could be installed with multi-criteria evaluation techniques and should be able to carry out cost-benefit analyses of the corporation's performance. The data bank should be monitored by a permanent traffic based research team whose primary duty would be to evaluate frequently *Kenya Railways'* traffic trends.

e) The current strategy of relying on *ad hoc* state directives to guide Kenya's transport sector creates an extremely hazardous planning base. Directives issued in public interest often conflict with private business interests and end up being rescinded as a matter of political expediency. *Ad hoc* state directives are based on short term goals and affect relationships that have evolved over a long period of time and intended to be long lasting. Kenya needs a clear transport planning framework that is long term in nature and all encompassing. This can only be achieved through a well entrenched national transport policy. This study recommends that *Kenya Railways* should start lobbying for the facilitation of such a policy.

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APPENDICES

APPENDIX 1(A) **QUESTIONNAIRE I** **CONFIDENTIAL**

A SURVEY OF RAILWAY PASSENGER SERVICES 1990/91

A RESPONDENT'S IDENTITY

1. Date of interview ______________________
2. Place of interview ______________________
3. Name ______________________
4. Residence ______________________
5. Place of birth ______________________
6. Occupation ______________________
7. Age in years ______________________
8. Sex Male ____________ Female ____________
9. Marital status Married ____________ Single ____________
10. Citizenship ______________________

B TRAVELLING HABITS

11. Do you travel frequently? (check one)

    1 ☐ Yes 2 ☐ No

12. How many trips exceeding 100 km do you make in a month? (check one)

    1 ☐ 0-4 2 ☐ 5-9 3 ☐ 10-14

    4 ☐ 15-19 5 ☐ Others (specify) ____________

13. What is your most regular mode of transportation for trips exceeding 100km? (check one)

    1 ☐ Bus 2 ☐ Aeroplane 3 ☐ Train

    4 ☐ *Matatu* 5 ☐ Private Vehicle 6 ☐ Bicycle

    7 ☐ Other (specify) ____________

14. If 13.3 is relevant to your case, state the following in relation to your last trip by train:

    Month ____________ Year ____________
    Your Origin ____________ Your destination ____________
    Train Origin ____________ Train destination ____________

15. What was the reason(s) for your last trip by train? (check where applicable).

    1 ☐ Commuting 2 ☐ Private 3 ☐ Leisure

    4 ☐ Business 5 ☐ Other (specify) ____________

16. Did you travel with your family? (check one)

    1 ☐ Yes 2 ☐ No

1956
95
96

17a. Why did you travel by train? (check one)

1 ☐ Free ticket 2 ☐ School trip 3 ☐ No Choice

4 ☐ Cheap 5 ☐ Safe 6 ☐ Adventure

7 ☐ Other (specify) ______________________________

b. In your opinion, was railway transport the most suitable form of transportation within the circumstances? ______________________________

____

c. Given similar circumstances today, what would you consider to be the most appropriate mode of transportation? (check one)

1 ☐ Train 2 ☐ Bus 3 ☐ Donkey 4 ☐ *Matatu*

5 ☐ Camel 6 ☐ Taxi 7 ☐ Private car 8 ☐ Bicycle

9 ☐ Other (specify) ______________________________

18a. During what hours would you prefer to travel by Train? (check where appropriate)

1 ☐ 00:00-06:00 2 ☐ 06:00-12:00 3 ☐ 12:00-18:00

4 ☐ 18:00-00:00 5 ☐ Other (specify) ______________________________

b. Why do you prefer to travel by train during the selected hours? ______

____

19a. Do you intend to travel by train again? (Check one)

1 ☐ Yes 2 ☐ No 3 ☐ Do not Know

b. Why? (Check where appropriate)

1 ☐ Comfortable 2 ☐ Safe 3 ☐ Cheap 4 ☐ Slow

5 ☐ No alternative 6 ☐ Enjoyable 7 ☐ Other (specify) __________

c. What class did you travel in? (Check one)

1 ☐ First 2 ☐ Second 3 ☐ Third

C COMMUTING

20. Is there a railway linking your place of residence to your place of daily occupation? (Check one)

1 ☐ Yes 2 ☐ No

21. If the answer to Question 20 is yes, are there railway commuter services? (Check one)

1 ☐ Yes 2 ☐ No

22a. What mode of transport do you use most frequently when commuting to and from your place of daily occupation? (Check where appropriate)

1 ☐ Bus 2 ☐ Foot 3 ☐ Private vehicle

4 ☐ Train 5 ☐ *Matatu* 6 ☐ Official car

7 ☐ Bicycle 8 ☐ Taxi 9 ☐ Other (specify) ____

b. Reasons ______________________________

D GENERAL

23. What advantages does railway transport offer? (check where appropriate)

1 ☐ Safety 2 ☐ Comfort 3 ☐ Low rates

4 ☐ Efficient 5 ☐ Right of way 6 ☐ Adventure

7 ☐ Other (specify) ______________________________

24 a. Have you ever been inconvenienced while travelling by train? (check one)

1 ☐ Yes 2 ☐ No

b. If the answer to 24a is yes, state the inconvenience(s) ______________
____

c. Suggest solutions to these inconveniences? ______________________
____

APPENDIX 1(B) QUESTIONNAIRE II CONFIDENTIAL

A SURVEY OF RAILWAY FREIGHT SERVICES 1990/91

A IDENTITY OF FIRM

1. Date of Interview ______________________
2. Name of firm ______________________
3. Place of business operation ______________________
4. Description of business activities (check where appropriate)

   1 ☐ Retail 2 ☐ Wholesale 3 ☐ Manufacturing

   4 ☐ Storage 5 ☐ Others (specify) ______________

5. What is the nature of the commodities that you handle? (check where appropriate)

   1 ☐ Consumer goods 2 ☐ Producer goods 3 ☐ Raw materials

   4 ☐ Capital goods 5 ☐ Others (specify) ______________

B DEMAND FOR TRANSPORT FACILITIES

6a. Select from the list below factors which account for the location of your firm.

   1 ☐ Storage 2 ☐ Roads 3 ☐ Railway

   4 ☐ Raw materials 5 ☐ Major markets 6 ☐ Personal

   7 ☐ Others (specify) ______________

b. Was there an alternative location? (Check one)
   - In the neighbourhood 1 ☐ Yes 2 ☐ No
   - Elsewhere 1 ☐ Yes 2 ☐ No
   - If yes, elaborate ______________________

7a. Do you have subsidiaries and/or branches? (Check one)

   1 ☐ Yes 2 ☐ No

b. If yes, please account for their location(s) ______________

8. Where do you receive from or send your goods? ______________
9. What do you regularly use to transport your commodities? (Check where appropriate)

   1 ☐ Pickup 2 ☐ Train 3 ☐ Lorry 4 ☐ Tractor

   5 ☐ Cart 6 ☐ Porters 7 ☐ Others (specify) ______________

b. If 9(a) 2 is relevant to your case, why do you opt to transport by train? (Check where appropriate)

   1 ☐ Cheap 2 ☐ Bulky 3 ☐ Safe 4 ☐ No option

   5 ☐ Others (specify) ______________________

10. Name of your nearest railway station ____________

11. What is the approximate distance from your business premises to your nearest railway station? (Check one)

1 ☐ 0-4km 2 ☐ 5-9km 3 ☐ 10-14km 4 ☐ 15-19km

5 ☐ Others (specify) ____________

12. How do you dispatch or receive goods to or from the railway station (check where appropriate)

1 ☐ Lorry 2 ☐ Handcart 3 ☐ Porters 4 ☐ Pickup

5 ☐ Others (specify) ____________

13a. Does the station provide sufficiently for your business obligations? (check one)

1 ☐ Yes 2 ☐ No 3 ☐ Don't Know

b. Explain ____________

14a. What is the weight (kgs) of the smallest consignment that you have received or dispatched by rail? (Check one)

1 ☐ 0-499 2 ☐ 500-999 3 ☐ 1000-1499

4 ☐ 0-499 5 ☐ Others (specify) ____________

b. What is the weight (kgs) of the largest consignment that you have received or dispatched by rail? (Check one)

1 ☐ 0-499 2 ☐ 500-999 3 ☐ 1000-1499

4 ☐ 0-499 5 ☐ Others (specify) ____________

15a. Would you prefer an alternative mode of transport? (check one)

1 ☐ Yes 2 ☐ No 3 ☐ Indifferent

b. Why? ____________

16. Which of the following railway freight services is most suitable to the operations of your firm? (check one)

1 ☐ Containers 2 ☐ Open Wagons 3 ☐ Refrigeration

4 ☐ Closed Wagons 5 ☐ Piggy Back 5 ☐ Tankers

7 ☐ Others (specify) ____________

APPENDIX 1(C) QUESTIONNAIRE III CONFIDENTIAL

A SURVEY OF KENYA RAILWAYS' SERVICES 1990/91

A INTRODUCTION

1. Official rank ______________________

2. Station ______________________

3. Line ______________________

4. Years in railway transport ______________________

5a. What was the original reason for building this line? (Check where appropriate)

1 ☐ Mineral interests 2 ☐ Livestock interests

3 ☐ Agricultural interests 4 ☐ Industrial interests

5 ☐ Commercial interests 6 ☐ Passenger interests

7 ☐ Others (specify) ______________________

b. What interests is the line serving now? (Check where appropriate)

1 ☐ Mining 2 ☐ Livestock 3 ☐ Agricultural

4 ☐ Industrial 5 ☐ Commercial 6 ☐ Passenger

7 ☐ Others (specify) ______________________

B SERVICES AT STATION

6a. Fill below the relevant information related to the services offered at your station during the last financial year.

SERVICE	YEAR LAUNCHED	MAJOR DESTINATION	MAJOR SOURCE	QUANTITY		
				IN	OUT	TRANSIT
PASSENGER						
COMMUTER						
FREIGHT (KG)						
LIVESTOCK						
CONTAINER						
REFRIGIRATION						
PIGGY BACK						

b. Briefly discuss any of the services in 6a that may have been discontinued and state when and why? ______________________

C PASSENGERS

7. Who are your MOST regular passenger clients? (Check one)

a. 1 ☐ Adults 2 ☐ Minors

b. 1 ☐ Males 2 ☐ Females

c. 1 ☐ Arrivals 2 ☐ Departures 3 ☐ Transit

8a. Does the number of passengers using your station fluctuate significantly? (Check one)

1 ☐ Yes 2 ☐ No

b. If 8a is yes, indicate the following:

INTENSITY	MONTH	ARRIVAL	DEPARTURE	TO	FROM	TANSIT
HIGHEST						
LOWEST						

9a. Are commuter services available at your station? (Check one)

1 ☐ Yes 2 ☐ No

b. If 9a is no, why? ______________________________

c. If 9a is yes, indicate the following:

i. Origin ______________________________

ii. Destination ______________________________

iii. Rate structure (check where appropriate)

1 ☐ Discriminate (age/sex) 2 ☐ Fixed

3 ☐ Tapered 4 ☐ Others (specify) ____________

10a. What is the busiest commuter sector?

From ____________________ To ____________________

b. Can you account for it? ______________________________

c. Comment on railway commuter services *vis-a-vis* normal passenger services. ______________________________

D FREIGHT SERVICES

11. What is the dominant cargo handled at your station? (check where appropriate)

1 ☐ Produce 2 ☐ Minerals 3 ☐ Manufactured goods

4 ☐ Imports 5 ☐ Exports 6 ☐ Inputs

7 ☐ Others (specify) ______________________________

12. Who are your leading clients? (Check where appropriate)

1 ☐ National Cereals & Produce Board
2 ☐ Kenya Grain Growers Cooperative Union
3 ☐ Kenya Tea Development Authority
4 ☐ Kenya Planters Cooperative Union
5 ☐ Kenya National Trading Corporation
6 ☐ East Africa Industries
7 ☐ Pan Paper Mills
8 ☐ Nzoia Sugar Co.
9 ☐ Unga Limited
10 ☐ Magadi Soda PLC
11 ☐ Bamburi Portaland
12 ☐ Other (Specify) ________________

13. What is the warehouse capacity of this station in ft^3? (Check one)

1 ☐ None   2 ☐ <1,000   3 ☐ 1001-5000
4 ☐ 5001-10000   5 ☐ Others (specify) ______________

14a. Are there private godowns near this station? (Check one)

1 ☐ Yes   2 ☐ No

b. If 14a is Yes, how many of them have siding lines? ________________

15a. Does the freight quantity fluctuate by a significant margin? (Check one)

1 ☐ Yes   2 ☐ No

b. If 15a is Yes, indicate the following?

INTENSITY	MONTH	ARRIVAL	DEPARTURE	TO	FARM	TRANSIT

16a. What is the average number of days by which goods arriving in your station remain in the train wagons? (Check one)

1 ☐ <1   2 ☐ 2-5   3 ☐ 6-10   4 ☐ 11-15
5 ☐ 16-20   6 ☐ 21-25   7 ☐ Others (specify) ______

b. Do you have a demurrage charge? (Check one)

1 ☐ Yes   2 ☐ No

c. If 16a is no, why? ________________________________

17. What measures have you taken, at this station, to reduce:

Handling Costs ________________________
Pilferage ________________________
Delays ________________________

E GENERAL

18. Who determines your rates? (Check one)

1 ☐ Government 2 ☐ Kenya Railways 3 ☐ Market Forces

3 ☐ Cliebts 4 ☐ Others (specify) ______________________

19a. What factors are considered when determining rates for:
Passengers ____
Freight ____

b. Are the rates fixed? (Check one)

1 ☐ Yes 2 ☐ No

20a. Are the rates equal for both directions between two stations? (Check one)

1 ☐ Yes 2 ☐ No

b. If 20a is No, elaborate ____________________________________

21. What has been the long term relationship between the demand and supply of railway services at your station? (Check one)

1 ☐ Equal 2 ☐ Demand is greater 3 ☐ Supply is greater

4 ☐ Eratic 5 ☐ Others (specify) ______________________

22. How does your station disseminate and receive information regarding railway traffic demand and available capacity along the line? (Check where appropriate)

1 ☐ Phone 2 ☐ Telegraph 3 ☐ Mose code

4 ☐ Fax 5 ☐ Radio Call 6 ☐ Compter Reservation

7 ☐ Others (specify) ______________________________________

23a. What are the major problems experienced at this station with respect to:
Passenger services ______________________________________
Freight Services ______________________________________

b. Suggest solutions to these problems: __________________________

APPENDIX 1(D) QUESTIONNAIRE IV CONFIDENTIAL

A SURVEY OF KENYA RAILWAYS' POLICIES

1. Please state the tenets of Kenya's domestic transport policy:
   a ______________________________
   b ______________________________
   c ______________________________
   d ______________________________
   e ______________________________
   f ______________________________

2. How does the government's policy on transportation relate to railway transport in terms of:
   Route Network ______________________________
   Passenger Transport ______________________________
   Tariffs charged ______________________________
   Modernization ______________________________
   Regulation ______________________________
   Forms of carriage, namely;
   Piggy back ______________________________
   Containerization ______________________________
   Refrigerated wagons ______________________________
   Sealed wagons ______________________________
   Livestock wagons ______________________________
   Passenger coaches ______________________________
   Form(s) of motive energy ______________________________
   Speed ______________________________

3a. Are there abandoned railway tracks in Kenya? ____________

b. If the answer to 3a is Yes, please give the following details:

FROM	TO	BUILT IN	CLOSED IN	REASON

4. What do you plan to do with the abandoned lines? (Check one)

   1 ☐ Dismantle 2 ☐ Nothing 3 ☐ Sell as scrap metal

   4 ☐ Revive them 5 ☐ Others (specify)______________________

5. What are the causes of delayed adoption of new innovations in railway transport? (Check where appropriate)

   1 ☐ Less funds 2 ☐ Less Manpower 3 ☐ Culture

   4 ☐ Demand 5 ☐ Infrastructure 6 ☐ Red Tape

   7 ☐ Others (specify) ______________________

6a. What modernization programmes do you have in mind? ______________

b. Are there plans to expand Kenya's railway network?

1 ☐ Yes 2 ☐ No

c. If 6b is Yes, give the following details:

From	To	Starting	Ending

d. Why were the proposed railway extensions to Sigor, Meru and the Butere-Bungoma link not implemented? ______________

7. Comment on the business performance of the Kenya Railways since the break of the East African Community. ______________

8. Which of the following are the leading constraints to railway services in Kenya? (Check where appropriate)

1 ☐ Rigidity 2 ☐ Speed 3 ☐ Road Competition

4 ☐ Low rates 5 ☐ Fuel costs 6 ☐ No subsidies

7 ☐ Aged Tracks 8 ☐ Old engines 9 ☐ Other (specify) ______________

9. In your opinion, does Kenya Railways publicise their services adequately? ______________

10a. Why do most people in the transport sector accept regulation? ______________

b. Can public interest be protected within a framework of minimised regulation? (Check one)

1 ☐ Yes 2 ☐ No

c. Do you think that Kenya's transport sector is over regulated? (Check one)

1 ☐ Yes 2 ☐ No

d. If 19c is Yes, suggest three regulations that should be done away with?

i. ______________
ii. ______________
iii. ______________

e. If 19c is no, suggest three areas which should be regulated.

i. ______________
ii. ______________
iii. ______________

11a. Is Kenya Railways a common carrier? (check one)

1 ☐ Yes 2 ☐ No

b. If 11a is Yes, does Kenya Railways have the common carrier obligation to serve without discrimination? (Check one)

1 ☐ Yes 2 ☐ No

c. Are there occasions when Kenya Railways cannot carry certain goods? (Check one)

1 ☐ Yes 2 ☐ No

d. Can you mention some of the goods you don't carry? ____________________

____

e. Does the common carrier obligation make Kenya Railways engage in unremunerative traffic? ____

12. Could you comment on the effect of improved road conditions to railway services (give preference to the Nairobi-Kisumu and Nairobi-Eldoret sectors). ____

13. What problems do you anticipate in the near future? ____________________

14. How do you intend to contain them? ______________________________

APPENDIX 1(E) QUESTIONNAIRE V CONFIDENTIAL

RAILWAY AND PORT SERVICES IN KENYA (1990-91)

A INTRODUCTION

1. Date of interview ______________________________
2. Respondent's official title ______________________________
3. Name of Port ______________________________
4. Location of Port (Town) ______________________________
5. How old is this port ______________________________

B GENERAL LOCATION FACTORS

6a. Was this port ever located at another site? (Check one)

1 ☐ Yes 2 ☐ No

b. If 6a is Yes, please state the previous site(s) and the year(s) of relocation.

SITE	YEAR OR RELOCATION

c. What factor(s) underlie the decision to relocate a port? ____________

7. What factors led to the location of the port at its present site? (Check where appropriate)

1 ☐ Deep water 2 ☐ Rich hinterland 3 ☐ Strategic

4 ☐ Colonial 5 ☐ Sheltered harbour 6 ☐ Sea route

7 ☐ Others (specify) ______________________________

8. State, if any, the role of railway services in determining the current location of the port. ______________________________

9. What is the area and current estimated population of this port's hinterland?
Area ____________________ Km^2 Population ______________

10. What are the dominant modes of overland transport that serve this port? (Check where appropriate)

1 ☐ Train 2 ☐ Trucks 3 ☐ Handcarts 4 ☐ Pipelines

5 ☐ Porters 6 ☐ Pickups 7 ☐ Others (specify) __________

11. What proportion of the commodities railed to/from this port?

YEAR	OFF LOADED (%)	LOADED (%)
1985		
1986		
1987		
1988		
1989		

12a. What railway support facilities are available at this port? (Check where appropriate)

1 ☐ Cranes 2 ☐ Forklifts 3 ☐ Loading bay

4 ☐ Conveyor belts 5 ☐ Godowns 6 ☐ Marshalling Yard

7 ☐ Train ferries 8 ☐ Sidings 9 ☐ Others (specify)_____

b. Should the port's railway sidelines should be increased? (Check one)

1 ☐ Yes 2 ☐ No

c. Why? ________________________________

13a. What has been your cargo handling capacity over the last five years?

YEAR	IMPORTS		EXPORTS	
	POTENTIAL	ACTUAL	POTENTIAL	ACTUAL
1985				
1986				
1987				
1988				
1989				

b. Comment, on the basis of the above figures, on the port's handling capacity over the last five years. ________________

c. Do railway services affect KPA's ability to handle goods? (Check one)

1 ☐ Yes 2 ☐ No

d. Elaborate ________________________________

14a. What has been your total goods storage capacity over the last five years?

1985	1986	1987	1988	1989

b. Do these figures suggest that the port's storage capacity differs significantly from its cargo handling capacity? (Check one)

1 ☐ Yes 2 ☐ No

c. What role do private godowns in the vicinity of the port play in compromising the difference between the port's cargo handling and storage capacity? ________________

d. What percentage of the imports handled at this port are stored in godowns outside the port?

1985	1986	1987	1988	1989

e. What is the dominant mode of transportation to these godowns? (Check where appropriate)

1 ☐ Train 2 ☐ Trucks 3 ☐ Handcarts

4 ☐ Porters 5 ☐ Pipelines 6 ☐ Pickups

7 ☐ Others (specify) ____________________

f. What percentage of the goods handled were transported by rail to the godowns for the last five years?

1985	1986	1987	1988	1989

g. Could you account for this? ____________________

C POLICIES

15a. What are the broad objectives of Kenya's national transport policy? ____________________

b. To what extent would you say that these broad objectives have been attained? ____________________

16a. What are the objectives of the Kenya Ports Authority? ____________________

b. How do the objectives of the Kenya Ports Authority relate to Kenya's railway transport services? ____________________

17a. Does the national transport policy provide for the co-ordination of port and railway services in Kenya? (check one)

1 ☐ Yes 2 ☐ No

b. If 17a is Yes, what is the desired relationship between port and railway services in Kenya? ____________________

c. If 17a is no, how are the benefits of such a relationship taken advantage of? ____________________

18a. In your own opinion, are port and railway services in Kenya effectively co-ordinated? ____________________

b. How can the co-ordination of port and railway services in Kenya be made more efficient? ____________________

c. Why was the managing of railways and harbours separated after the collapse of the East African Community? ____________________

APPENDIX 2A RESPONSE TO QUESTIONNAIRE I

		Remarks
Average Age		
Males	30 (46.9%)	Most regular travellers are middle age adults.
Females	34 (54.1%)	
Sex		
Males	35 (58.3%)	Contradicts field observations that the most
Females	25 (41.7%)	passengers are female adults.
Marriage		
Married	15 (25%)	Most co-operative respondents were in upper
Single	35 (75%)	class coaches. They are more educated and
Married Men	11 (18.3%)	marry late. Young couples are tend to have
Single Men	23 (38.3%)	young families which limit their movement.
Married Women	4 (6.7%)	
Single Women	22 (36.7%)	
Travelling Frequency		
Frequently	36 (60%)	Adults travel regularly. Only two teenagers
Rarely	24 (40%)	claimed that they travel regularly.
Monthly Trips Over 100km		
0 - 4	28 (46.7%)	These figures highlight weekly trips based
5 - 9	29 (48.3%)	on the incidence of periodic markets along
10 - 14	1 (1.7%)	rge railway.
15 - 19	1 (1.7%)	
Others	1 (1.7%)	
Regular Mode of Transportation		
Bus	11 (18.3%)	The apparent attractiveness of railway
Plane	2 (3.3%)	transport reflects the tendency by some
Train	35 (58.3%)	passengers to remain faithful to a particular
Matatu	7 (11.7%)	mode of transportation.
Private Vehicle	4 (6.7%)	
Others	1 (1.7%)	
Cause of Last Trip By Train		
Private	18 (30%)	Railway commuter services are limited. Most
Leisure	7 (11.6%)	urban centres in Kenya are small and a large
Business	17 (28.3%)	proportion of their population resides in the
Others	18 (30%)	central business district.
Travelled With Family on Last Trip by Train		
Yes	12 (18.3%)	Most passengers are single adults making
No	48 (81.7%)	private, business or official trips.
Reason for Travel by Train		
Free Ticket	5 (8.3%)	Most respondents appear to have been
School Trip	5 (8.3%)	attracted to railway transport by cheap rates
Cheap	28 (46.7%)	and a good safety record.
Safe	15 (25%)	
Adventure	1 (1.7%)	
Others	6 (10%)	
Appropriate Mode of Transportation Today		
Train	56 (93.3%)	Fear of oil prices escalating as a result of
Others	4 (6.7%)	the Gulf War and the recent spate of nasty,
		fatal and brutal accidents on Kenyan roads.
Preferred Departure/Arrival Hours		
00:00-06:00	6 (16.7%)	Passangers at wayside stations complained
06:00-12:00	36 (60%)	about odd hours of train arrival/departue
12:00-18:00	7 (11.7%)	The Voi-Taveta service inconveniences
18:00-00:00	28 (46.7%)	travellers to/from Nairobi and Mombasa.

Intention to Travel by Train Again		
Yes	58 (96.6%)	See 'appropriate mode of transportation today'.
Indifferent	29 (3.3%)	
Reason for Intention to Travel by Train Again		
Slow	10 (16.7%)	Safety, cheapness and comfort are the leading attractions to railway transport.
Safe	41 (68.3%)	
Cheap	43 (71.7%)	
Comfortable	24 (40%)	
Enjoyable	8 (13.3%)	
Others	4 (6.7%)	
Class of Travel		
First	11 (18.3%)	Many respondents interchange between second and third class coaches depending on financial and booking conditions.
Second	12 (20%)	
Third	37 (61.7%)	
Availability of Commuter Facilities		
Yes	9 (15%)	Commuter services are available in between Dagoretti and Kahawa. Passenegsr also commute along Koru-Kisumu and Mombasa-Mariakani sectors.
No	40 (66.7%)	
Abstained	11 (18.3%)	
Availability of a Commuter Train		
Yes	8 (13.3%)	See 'availability of commuter facilities' above.
No	31 (51.7%)	
Abstained	21 (35%)	
Regular Mode for Commuting		
Bus	10 (17%)	*Matatus*, footing and buses are the dominant modes for commuting. The low values for the railway reflect the limited network of railway commuter facilities in Official Kenya.
Foot	15 (25%)	
P. Vehicle	3 (5%)	
Official Car	2 (3.3%)	
Matatu	28 (46.7%)	
Train	1 (1.7%)	
Bicycle	1 (1.7%)	
Advantages of Railway Transport		
Safety	41 (68.3%)	Safety, comfort and low rates are the greatest attractions to railway transport.
Comfort	30 (50%)	
Low Rates	39 (65%)	
Efficiency	7 (11.7%)	
R. of Way	2 (3.3%)	
Adventure	4 (6.7%)	
Others	10 (17%)	
Inconvenienced		
Yes	37 (61.7%)	There is a lot of inconvenience at wayside stations and train connecting points such as Voi and Nairobi involving long hours of waiting for trains.
No	14 (23.3%)	
Abstained	9 (15%)	

APPENDIX 2B RESPONSE TO QUESTIONNAIRE II

Business Activities		Remarks
Retail	3 (13%)	Wholesale and storage businesses rely on rail services a lot.
Wholesale	7 (30.4%)	
Manufacturing	4 (17.4%)	
Storage	7 (30.4%)	
Others	6 (26.1%)	
Goods Handled		
Consumer	15 (65.2%)	Consumer goods are the leading freight commodity probably due to the availability of a nationwide market.
Producer	6 (26.1%)	
Raw Materials	5 (21.7%)	
Capital	7 (30.4%)	
Location Factors		
Storage Points	12 (52.2%)	Storage facilities, proximity to the railway and major markets are the leading determinents of industrial location in Kenya.
Good Roads	8 (43.8%)	
Proximity to rail	18 (78.3%)	
Raw Materials	4 (17.4%)	
Major Markets	14 (60.9%)	
Personal Reasons	1 (4.5%)	
Others	3 (13.5%)	
Alternative Locations		
Neighbourhood		
Yes	9 (39.1%)	See 'location factors' above.
No	14 (60.9%)	
Elsewhere		
Yes	8 (34.8%)	See 'location factors' above.
No	15 (65.2%)	
Subsidiaries/Branches		
Yes	18 (78.3%)	Many subsidiaries/branches indicate a high potential for intra-firm transfer of shipments.
No	5 (21.7%)	
Regular Mode of Transportation		
Pickup	4 (17.4%)	Domestic cargo shippers use both road and rail transport. The railway appears dominant because railway clients returned questionnaires.
Train	22 (95.7%)	
Lorry	20 (87%)	
Why Opt for Train		
Cheap	16 (69.6%)	Low rates of transportation and the ability to transport in bulk are the leading attractions to railway transport.
Bulky	15 (65.2%)	
Safe	9 (39.1%)	
No Option	2 (8.9%)	
Others	3 (13%)	
Distance to the Nearest Railway Station		
0-4km	23 (100%)	Proximity to the railway determins the location of industrial/commercial firms (railway clients returned questionnaires).
Mode of Transportation to/from the Railway Station		
Lorry	5 (21.7%)	Others refers to the availability of railway sidings which means that the respondents receive/dispatch commodities by railway from their premises.
Pickup	4 (17.4%)	
Others	17 (73.9%)	
Effectiveness of the Nearest Railway Station		
Yes	22 (95.7%)	Most respondents indicated that railway freight services are rendered efficiently.
No	1 (4.3%)	

Smallest Consignment		
0-499kg	7 (30.4%)	Consignments railed to/from major firms are
1500-1999kg	2 (8.7%)	in wagon loads thus weigh over two tones.
Others	14 (60.9%)	
Largest Consignment		
Others	23 (100%)	See 'smallest consignment' above.
Need for Alternative Mode of Transport		
Yes	6 (26.1%)	Railway transport is most suitable firms that
No	15 (65.2%)	handled massive consignments.
Indifferent	2 (8.9%)	
Appropriate Wagons		
Open	1 (4.3%)	Closed wagons are convenient while
Closed	19 (82.6%)	specialised freight facilities are in limited
Tankers	5 (21.7%)	use.
Others	1 (4.3%)	

APPENDIX 2C RESPONSE TO QUESTIONNAIRE III

Construction Interests		Remarks
Mineral	2 (6.7%)	Agricultural and colonial interests were the major factors behind the construction and spread of Kenya's railway network.
Livestock	5 (16.7%)	
Agricultural	19 (63.3%)	
Commercial	4 (13.3%)	
Passenger	5 (16.3%)	
Others	20 (66.3%)	
Maintenance Reasons		
Mineral	10 (33.3%)	Agricultural, commercial and passenger interests are the main reasons behind the continuous maintenance of Kenya's railway network.
Livestock	17 (56.7%)	
Agriculture	23 (76.7%)	
Industry	16 (53.3%)	
Commerce	26 (86.7%)	
Passengers	20 (66.7%)	
Others	3 (10%)	
Passenger Characteristics		
Adults	21 (70%)	Most railway passengers are adults. There are many female vegetable hawkers in third class coaches. Transit passengers are many because of few passengers to/from wayside stations.
Abstained	9 (30%)	
Male	4 (13.3%)	
Females	17 (56.7%)	
Abstained	9 (30%)	
Arrivals	1 (3.3%)	
Departures	6 (20%)	
Transit	14 (46.7%)	
Abstained	9 (30)	
Volume of Passengers		
Steady	2 (6.7%)	The incidence of passengers varies according to market days along or near the network, public and school holidays.
Changing	19 (63.3%)	
Abstained	9 (30%)	
Availability of Commuter Services		
Yes	4 (13.3%)	Railway commuter services are available in Nairobi alone.
No	26 (86.7%)	
Commuter Rate Structure		
Fixed	4 (13.3%)	The rates are fixed by Kenya Railways. Only third class coaches are used by commuters.
Tapered	4 (13.3%)	
Discriminated	4 (13.3%)	
Dominant Cargo		
Agricultural	21 (70%)	Agricultural and manufactured products are the leading commodities railed rail in Kenya followed by imports and exports. Imports and exports are distinguished so as to show the origin or destination of cargo.
Mineral	7 (23.3%)	
Manufactured	20 (66.7%)	
Imports	13 (43.3%)	
Exports	12 (40%)	
Raw Materials	7 (23.3%)	
Others	6 (20%)	
Leading Clients		
N.C.& P.B.	18 (60%)	Major public and private sector organisations use the railway for bulk transportation. N.C.& P.B., K.G.G.C.U., K.N.T.C., E.A.I, Magadi Soda and Pan Paper have many distributors. K.N.T.C. is the sole distributor of cement and sugar in Kenya.
K.G.G.C.U.	12 (40%)	
K.T.D.A.	4 (13.3%)	
K.P.C.U.	9 (30%)	
K.N.T.C.	17 (56.7%)	
E.A.I.	8 (26.7%)	
Magadi Soda	11 (36.7%)	
Pan Paper	8 (26.7%)	
Nzoia	4 (13.3%)	

Unga Ltd	5 (16.7%)	
Bamburi	12 (40%)	
Others	20 (66.7%)	
Station's Warehouse Capacity		
None	1 (3.3%)	Many stations have goods sheds are over 10,000ft^3. These are mainly used to store parcels and small quantity consignments.
1,001-5,000ft^3	1 (3.3%)	
5,001-10,000ft^3	1 (3.3%)	
Others	27 (90%)	
Availability of Private Godowns at Station		
Yes	21 (70%)	The storage space at stations in towns is boosted by private godowns some of which are built on land leased from Kenya Railways.
No	9 (23.3%)	
Fluctuations in Freight Quantity		
Yes	23 (76.7%)	The freight handled at most stations varies seasonally. Fertilizer distribution, harvesting and fluctuations in import/export traffic cause variations in freight traffic.
No	7 (23.3%)	
Duration of Goods in Wagons at Stations		
<1 day	22 (73.3%)	Wagons are off loaded speedily at most stations indicating the effectiveness of demurrage charges.
2-5 days	7 (23.3%)	
6-10 days	1 (3.3%)	
Demurrage Charges		
Yes	30 (100%)	Demurrage are charged at all stations where goods remain in the wagons for more than 24 or 48 hours, depending on the circumstances prevailing at the station.
Relationship Between Supply and Demand of Railway Services		
Equal	7 (23.3%)	The supply and demand of railway services at a station varies depending on whether its predominant function is to send, receive or tranship freight.
Demand>	8 (26.7%)	
Supply>	8 (26.7%)	
Erratic	7 (23.3%)	
Communication System Along the Network		
Public Phone	30 (100%)	Public and control phones are the dominant modes of communication. Computers have been introduced at Railway District Headquarters, namely Eldoret, Kisumu, Nairobi and Mombasa.
Computers	5 (16.7%)	
Telegraph	16 (53.3%)	
Radio Call	6 (20%)	
Others (C/Phone)	28 (93.3%)	

APPENDIX 3a CHARGEABLE RAIL DISTANCE FROM NAIROBI (KM)

Ainabkoi,	Asembo Bay, 491	Athi River, 30	Bachuma, 413	Bungoma, 505
Bura, 402	Butere, 467	Changamwe, 523	Chemelil, 321	Dagoretti, 19
Dandora, 12	Darajani, 251	Elburgon, 222	Eldoret, 385	Emali, 143
Embakasi, 14	Equator, 286	Fort Tenan, 321	Gilgil,	Homa Bay,
Ikoyo,	Ilkek,	Irima,	Kahawa,	Kajiado,
Kalembwani,	Kalimoni,	Kampi-ya-moto,	Kanga,	Kapiti Plains, 61
Kaptagat, 350	Karatina, 159	Kariandus, 151	Karungu Bay, 556	Kathekani, 259
Kedowa, 276	Kenani, 293	Kendu Bay, 429	Kibera, 10	Kibigori, 362
Kiboko, 175	Kibos, 290	Kibwezi, 215	Kiganjo, 183	Kijabe, 10
Kikumbulyu, 225	Kikuyu, 31	Kilindini, 530	Kima, 114	Kipkabus, 339
Kipkaren River,	Kipkelion, 292	Kisiani, 409	Kisumu, 398	Kisumu Pier, 398
Kitale, 467	Kiu, 99	Kivati, 154	Konza, 74	Koora, 195
Kuru, 332	K'Ouor, 453	Kyulu, 306	Lanet, 174	Lela, 427
Limuru, 47	Londiani, 263	Longonot, 87	Luanda, 439	Lugari, 454
Lukenya, 42	Luseru, 402	Mackinon Rd, 433	Magadi, 220	Maji Mazuri, 254
Maji-ya-chumvi, 497	Makadara, 5	Makindu, 193	Maktau, 429	Makutano, 266
Makuyu, 92	Malaba, 522	Manjewa, 469	Maragua, 104	Mariakani, 492
Marimbeti, 24	Maseno Hault, 432	Masongaleni, 233	Matathia, 66	Mau Summit, 249
Maungu, 394	Mazeras, 506	Mbaruk, 163	Mbita, 482	Mbololo, 329
Mbuinzau, 206	Menengai, 201	Mfangano, 497	Miritini, 517	Mitubiri, 74
Miwani, 369	Mohoru Bay, 556	Moi's Bridge, 444	Molo, 238	Mombasa, 530
Morendat, 120	Mtito Andei, 267	Muguga, 39	Muhoroni, 343	Munyu, 104
Murang'a, 119	Murka,	Mwanatibu, 421	Mwatate, 390	Mwembeni, 456
Myanga, 528	Naivasha, 112	Nakuru, 181	Namasoli Hault,	Nanyuki, 235
Naro Moru,	Ndara, 383	Ndi, 345	Ngwata, 239	Njoro, 201
Nyahururu, 218	Ol Joro Orok, 205	Ol Kalau, 182	Oleolondo, 166	Olpunyata, 240
Plateau, 368	Rongai, 214	Ruiru, 32	Sabatia, 242	Sagana, 131
Samburu, 463	Simba, 161	Singiriani, 164	Solai, 256	Sosian, 397
Soy, 414	Stony Athi, 52	Sudi, 489	Sultan Hamud, 130	Suswa, 95
Taru, 446	Taveta, 486	Thika, 57	Timboroa, 301	Toroka, 140
Tsavo, 316	Tumeiyo, 329	Tunnel, 311	Turbo, 425	Turi, 230
Ulu, 86	Uplands, 57	Visoli, 225	Voi, 366	Wangata, 405
Webuye, 473	Yala, 450			

Source: Kenya Railways' Chargeable Kilometre Table C.M.T. Branch page 117.

APPENDIX 3b RAILWAY STATIONS IN KENYA

Ainabkoi, NBK	Asembo Bay, ASB	Athi River, ATR	Bachuma, BMA	Bungoma, BGM
Bura, BRA	Butere, BTW	Changamwe, CMW	Chemelil, CML	Dagoretti, DGT
Dandora, DDR	Darajani, DJN	Elburgon, ELB	Eldoret, ELD	Emali, EML
Embakasi, EKS	Equator, EQA	Fort Tenan, FTN	Gilgil, GGL	Homa Bay, HMA
Ikoyo, IYO	Ilkek, ILK	Irima, RMA	Kahawa, KAA	Kajiado, KJD
Kalembwani, KBN	Kalimoni, KMO	Kampi-ya-moto, KBM	Kanga, KGA	Kapiti Plains, KPP
Kaptagat, KPG	Karatina, KRT	Kariandus, KRD	Karungu Bay, KGU	Kathekani, KHK
Kedowa, KDW	Kenani, KNI	Kendu Bay, KEN	Kibera, KBE	Kibigori, KBG
Kiboko, KBK	Kibos, KBS	Kibwezi, KWZ	Kiganjo, KJO	Kijabe, KJB
Kikumbulyu, KIK	Kikuyu, KYU	Kilindini, KLI	Kima, KMA	Kipkabus, KKB
Kipkaren River, KPR	Kipkelion, KPN	Kisian, KIS	Kisumu, KSM	Kisumu Pier, KSP
Kitale, KTL	Kiu, KIU	Kivati, KVT	Konza, KZA	Koora, KRA
Koru, KRU	K'Ouor, KWR	Kyulu, KYL	Lanet, LNT	Lela, LEL
Limuru, LMU	Londiani, LDI	Longonot, LON	Luanda, LUA	Lugari, LGR
Lukenya, LKY	Luseru, LSU	Mackinnon Rd, MAK	Magadi, MGA	Maji Mazuri, MZR
Maji-ya-Chumvi, MCV	Makadara, MKR	Makindu, MKU	Maktau, MKT	Makutano, MTN
Makuyu, MYU	Malaba, MLB	Manjewa, MJW	Maragua, MRG	Mariakani, MKI
Marimbeti, MMI	Maseno Halt, MSN	Masongaleni, MSL	Matathia, MIH	Mau Summit, MST
Maungu, MGU	Mazeras, MRS	Mbaruk, MRK	Mbita, MBX	Mbololo, MOL
Mbuinzau, MBZ	Menengai, MNG	Mfangano, MFO	Miritini, MTI	Mitubiri, MTB
Miwani, MWN	Mohoru Bay, MOB	Moi's Bridge, MBO	Molo, MLO	Mombasa, MSA
Morendat, MRT	Mtito Andei, MTO	Muguga, MUG	Muhoroni, MNI	Munyu, MUY
Murang'a, MRX	Murka, MRA	Mwanatibu, MTU	Mwatate, MTT	Mwembeni, MWI
Myanga, MYG	Nairobi, NRB	Naivasha, NSA	Nakuru, NRO	Namasoli Halt, NAL
Nanyuki, NUK	Naro Moru, NMR	Ndara, NDR	Ndi, NDI	Ngwata, NWA
Njoro, NJO	Nyahururu, NHR	Ol Joro Orok, OJK	Ol Kalau, OKU	Oleolondo, OND
Olpunyata, OPA	Plateau, PLT	Rongai, RNG	Ruiru, RIU	Sabatia, SBT
Sagana, SGA	Samburu, SBU	Simba, SIM	Singiriani, SGI	Solai, SOL
Sosiani, SSN	Soy, SOY	Stony Athi, STA	Sudi, SUD	Sultan Hamud, SMD
Suswa, SSW	Taru, TRU	Taveta, TVT	Thika, TKA	Timboroa, TMB
Toroka, TRO	Tsavo, SVO	Tumeiyo, TUM	Tunnel, TNL	Turbo, TBO
Turi, TRR	Ulu, ULU	Uplands, UPL	Visoli, VSO	Voi, VOI
Wangata, WGA	Webuye, WBY	Yala, YAL		

Source: Kenya Railways' Chargeable Kilometre Table C.M.T. Branch.

APPENDIX 4 KENYA RAILWAYS' ROLLING STOCK

LOCOMOTIVE STOCK	
Diesel Mechanical	Number
Class 32	6
Class 33	6
Diesel Hydraulic (Shunters)	
Class 35	5
Class 43	7
Class 44	3
Class 45	10
Class 46	22
Class 47	35
Class 62	56
Diesel Electric	
Class 71	10
Class 72	3
Class 87	35
Class 92	15
Class 93	26
Class 94	10
Sub-total	294
COACHING STOCK	
1st Class Passenger (FCP)	38
2nd Class Passenger (SCB)	67
3rd Class Passenger (TCBs)	146
COMBINED COACHES	
1st & 2nd	3
2nd & 3rd	1
3rd Departmental Break Boggie (BTB)	3
Buffet Boggie (BTB)	3
OTHERS	
Auxiliary Restaurant Boggie (ARB)	1
Break Caboose Boggie (BKB)	56
Break Van Boggie (BVB)	63
Caboose Break Van (BK)	49
Caboose Break van (BK)	49
Caboose Boggie (KBB)	63
Composite Buffet Boggie (CBB)	19
Departmental Coach (DC)	18
Departmental Coach Boggie (DCB)	4
Inspection Coach	90
Inspection Coach Boggie (ICB)	12
Kitchen Corridor Boggie (KCB)	1
Luggage Van Boggie (LVB)	4
Motor Caravan (MC)	2
Parcels Van Boggie (PVB)	13
Restaurant Corridor Boggie (RCB)	5
Third Buffet Boggie (TBB)	1
Sub-total	829
GOODS STOCK	
American Covered Boggie Uganda Only (ACBU)	14
American Covered Boggie Tanga Line Only (ACBt)	5
American Open Boggie (AOB)	14
Aviation Gasoline Boggie (AGB)	3
Aviation Gasoline Boggie Lined (AGBL)	1
Aviation Gasoline Wagon	5
Brime Cool Perishable Boggie (BCPB)	11
Brime Cool Perishable Wagon (BP)	5
Bulk Bitumen Boggie (BBB)	7
Bulk Bitumen Boggie Special (BBBS)	1
Bulk Bitumen Tank Wagon (BBT)	1
Cement Hopper Boggie (CHB)	30
Cement Tank Boggie (CTB)	394
Covered Ash Hopper Boggie (CSHB)	140
Covered Goods Boggie (CGB)	225
Covered Goods Boggie-Wire (CGB-W)	196
Covered Large Boggie (CLB)	1,596
Covered Goods Wagon (CG)	310
Covered Large Wagon (CG)	1,423
Covered Long Boggie Large (CLBL)	560
Covered Long Boggie Wide (CLBW)	100
Covered Small Boggie (CSB)	85
Covered Small Boggie Cement (CSBC)	68
Covered Small Boggie Pickup (CSBP)	6
Covered Small Boggie-Uganda Only (CSBU)	[illegible]
Covered Small Wagon (CS)	22
Double Decker Boggie (DDB)	10
Explosive Wagon Boggie (XVB)	5
Fuel Molasses boggie (FMB)	120
Fruit Wagon Fenced (FF)	13
High Fenced Boggie (HFB)	79
High Fenced Boggie Charcoal Traffic (HFBC)	12
High Fenced Wagon (HF)	46
High Large Boggie - B (HLBB)	46
High Large Boggie-Copper Traffic (HLBC)	[illegible]

High Long Roof Boggie (HLRB)	100
High Sided Boggie (HSB)	317
High Sided Boggie - Sugar Traffic (HSB)	9
High Sided Wagon (HS)	250
High Sliding Roof Boggie (HSBR)	35
Hydroxide Tank Boggie (HTB)	2
Iced Perishable Wagon (IP)	3
Liquid Gas Boggie (LGB)	15
Liqiud Petroleum Gas Wagon (LG)	3
Liquid Petroleum Gas Low Sided	
Low Open Boggie - Fixed Ends (LOB)	17
Low Open Wagon (LO)	602
Low Sided Boggie - Animals (LSBA)	2
Low Sided Boggie-Containers (LSBC)	11
Low Sided Boggie Large (LSBL)	118
Low Sided Long Boggie (LSLB)	440
Low Sided Wagon-Containers (LS)	8
Mechanically Refrigirated Boggie (MRB)	14
Milk Tank Wagon (MT)	23
Motor Goods (MG)	33
Motor Goods Boggie (MGB)	17
Motor Goods Boggie (MGB-R)	118
Motor Van (MV)	8
Motor Van Boggie (MVB)	7
Oil Diesel Boggie (ODB)	119
Oil Diesel Waggon (OD)	
Oil Fuel Boggie-Restricted (OFBR)	24
Oil Fuel Wagon (OF)	25
Oil Solvent Boggie - Lined (OSBL)	1
Oil Solvent Tank Wagon -Lined (OS)	2
Oil Vegetable Boggie (OVB)	4
Oil Vegetable Tank Wagon (OV)	2
Petrol Tank Boggie -Lined (PTBL)	91
Petrol Tank Wagon (PT)	97
Scrap Wagon Boggie (SWB)	4
Sugar Molasses Wagon (SM)	5
Jet Fuel Boggie - Lined (JFBL)	84
Tallow Tank Boggie (TTB)	14
Tallow Tank Boggie-Alkaline (TTBA)	1
Ventilated Wagon (VW)	27
Ventilated Wagon Boggie (VWB)	12
Well Wagon Boggie (WWB)	3
GOODS STOCK	8,398
LIVESTOCK FACILITIES	
Cattle Wagon (CW)	1
Cattle Wagon Boggie (CWB)	116
Cattle Wagon Fenced (CWF)	302
Cattle Wagon Fly Proof (CP)	1
Horse Wagon (HW)	16
Livestock Wagon (LW)	17
Pig Wagon Fenced Compartments (FF)	10
Pig Wagon Fenced Compartments (PW)	23
LIVESTOCK FACILITIES	493
DEPARTMENTAL VEHICLES	
Ballast Hopper Boggie (BHB)	28
Breakdown Covered Boggie (BOB)	65
Breakdown Covered Van (BC)	29
Breakdown Open Van (BO)	29
Covered Boggie (CZB)	18
Covered Small Boggie (CSB)	2
Covered Small Wagon (CS)	4
Crane Match Wagon (CRW)	5
Crane Match Wagon Boggies (CWRB)	5
Flat Wagon (FW)	12
Flat Wagon Boggie (FWB)	156
High Sided Boggie (HSB)	2
High Sided Wagon (HS)	5
Low Open Wagon (LO)	9
Low Sided Boggie (LSB)	31
Low Sided Wagon (LS)	4
Oil Fuel (OF)	11
Oil Fuel Boggie (OFB)	2
Oil Fuel Boggie-Restricted (OFBR)	1
Oxygen Cylinder Wagon	2
Refuse Wagon (RW)	22
Refuse Wagon Boggie (RWB)	4
Repair Van (RV)	20
Repair Van Boggie (RVB)	21
Staff Labour Van (SL)	4
Staff Labour Wagon Boggie (SLB)	
Stores Van (SV)	19
Terminal Flat Boggie (TFB)	4
Terminal Flat Wagon (TF)	2
Water Tank Boggie (WTB)	23
Water Tank Wagon (WT)	51
Sub-total	567
TOTAL RAILING STOCK	**10,536**