MODAL CHOICE IN CARGO HAULAGE FOR THE MOMBASA-NAIROBI ROUTE

By

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

Solomon Mwania Nzuki

This research paper has been submitted for examination with our approval as university supervisors.

Dr Warfa Osman

Dr Peter Coughlin

To my sons, Kimolo and Ngwele

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Abstract

This paper presents findings of a study on the determinants of choice in cargo haulage between road freighters and the railways. The study covers route between Mombasa and Nairobi for incoming dry cargo cleared from Kilindini Port. Shippers' choices of transport mode are analysed considering the characteristics of each consignment transported and the attributes of each mode.

A binary logit model is used to analyse the impact of certain variables on transport mode choice. This impact relates to the odds of one mode of transport being chosen over the other. Accordingly, freight rates, loading costs, transit time, and the availability of door to door service within the modes are the most important determinants of the probability that a shipper will choose one mode over the other. Freight rates are higher in road than in railways. However, the high speed, efficiency in cargo handling, flexibility, and availability of door-to-door service encourage truck use. A high correlation exists between road and rail haulage implying that shippers take into account the existence of the alternative mode when making their choice. The railways is disadvantaged, however, due to lack of door-to-door service where side lines do not exist.

Consignment weight is not a significant determinant of the mode chosen except for low value government imports--e.g., grains and fertilizers--which usually go by rail.

Chapter One

Introduction

Background

This chapter describes the present situation in cargo haulage between Mombasa and Nairobi, states the problem and the research's objectives, and outlines the study's significance. Cargo haulage involves the movement of goods from one place to another. Cargo transport between Mombasa and Nairobi is done by trucks and railway wagons. The study restricts itself to dry-cargo imports only. The available transport systems yield utility of time and place for people and goods because goods with little value in one place and may have much elsewhere. People move about to satisfy economic and social needs e.g., business trips, personal contacts with friends, social needs like, going to hospital, and touring.

Goods move to take raw materials to industrial bases for processing, deliver food to people, and take available produce to local and international markets. Trade, therefore, necessitates the movement of goods.

This study looks at the movement of dry cargo from Mombasa to Nairobi between two modes: railways and road freighters. It examines the determinants of modal choice and the general process of cargo handling in the two modes. In Kenya, goods markets are not always close to the sources of tradeable goods. This requires a good transport system to promote trade and enhance social and economic welfare of the population.

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To achieve this, the government has promoted transport systems including road networks, railway lines, and air lake, ocean and pipeline transport. Such an elaborate transport network requires adequate co-ordination to ensure proper use of installed capacities and allocate resources well within transport subsectors.

World trade uses these same modes of transport. Kenya is a participant in this trade and requires these transport facilities both for domestic and external trade activities. Most of Kenya's external trade is conducted through Kilindini Port in Mombasa. The port handles exports and imports from Kenya and other landlocked countries within east and central Africa. The port is served by a railway line and an international trunk road across the country to destinations in and beyond Kenya's borders. The distance considered in this study is about 500 kilometers from Mombasa to Nairobi.

Until now, transportation research in Kenya has mostly aimed at identifying bottlenecks in urban transport needs. Nairobi has been the center of these studies (Osundwa 1987:11) The studies were conducted by the Kenya Government and other organisations including the Mazingira Institute, the Belgian and the British government among others. There is no known study on the transportation of goods within this region despite increases in cargo handled at the port (Table 1).

purpose. Kenya achieved this by providing transport infrastructure and facilities. These require good co-ordination due to Kenyas position as an inlet/outlet of goods for herself and other landlocked countries. This has strained Kenyas' resource allocation in the transport sector.

This fact is aggravated because some countries served through Mombasa habour lack certain modes of transport. This biases shippers' choices to those modes available in their countries, e.g., Rwanda and Burundi have no railway; and Uganda and Zaire have railway lines and roads but most roads are dilapidated and the railway's rolling stock is inadequate. These problems have tended to bias shippers choice towards road transport because of its flexibility and speed.

To counter these problems, five countries signed the Northern Corridor Transit Agreement in 1981, (NCTA). These include Kenya, Uganda, Rwanda, Burundi and Zaire, all of which are served by this corridor through Mombasa Port via Nairobi, Nakuru, Eldoret to Malaba on the Kenya-Uganda Border. The Kenyan section has a supplementary arm through Kisumu across Lake Victoria. The agreement proposed how to speed up cargo handling along the corridor and across borders.

Although benefits emanating from the transit corridor accrue to all the countries, each country maintains transport infrastructures within its territory. Kenya has a heavy burden because failure on its part would incapacitate the whole system. There is need, therefore, to use transport facilities better while economizing on costs.

> In the Northern Corridor, railway capacity is not fully used due to the weak demand from potential customers ... and a major part of goods in transit are actually carried by road although road traffic exceeds the limited capacity of the road infrastructure in these countries (Northern Corridor Secretariat 1987: 5).

Investment in railway infrastructure depends on the country's ability to earn foreign exchange and its under-utilization is a misallocation of scarce resources. This strains the road network causing heavy road maintenance costs which could be reduced if customers' demand for railway service were increased through improved railway service. This study looks at the allocation of cargo between the road and the railway, and the determinants of the prevailing demand patterns.

Objectives of the Study

The study aims to:

- identify factors that influence modal choice in cargo haulage between Mombasa and Nairobi;
- study cargo handling time and the reasons for differences between the modes;
- measure the degree of relationship between road and railway in shippers choice using perceptive variables; and,
- draw policy implications from the above findings.

Significance of the Study

Cargo transport is important in promoting agriculture and industrial production in Kenya. By investigating what influences demand for road and railway cargo haulage, and cargo handling times between the modes, the study generates vital information about policies that could be adopted for each mode to optimize capacity utilization while minimizing capital and recurrent costs. Optimal infrastructure and facility usage in transport would save Kenya foreign exchange needed for investment elsewhere in the economy.

Transport resource allocation has not attracted adequate academic research in Kenya though 20% of the annual national budget goes to the transport sector (Kenya 1985: v). The study's results will interest those involved in planning for the provision of improved transport facilities. In the short-run where an increase in the quantity and quality of service is not possible, the available modal attributes can be manipulated to shift demand from the constrained mode to the less constrained one. In the long-run, however, investment in facilities can be made, taking into consideration shipper preferences (Osundwa 1987: 6)

The findings of this study will enable planners to promote appropriate resource allocations through better use of the available infrastructure and facilities. The methodology developed can be used to test the effects of government interventions in the market for cargo transport and to predict the repercussions of policy actions which change the attributes of either mode in cargo haulage.

Chapter Two

Literature Review

Introduction

This chapter reviews studies of transport issues in Kenya and elsewhere. The review differentiates the present study from past studies and highlights similarities.

Review of General Literature

Speed, frequency of service, freight cost, and terminal points are the attributes associated with each transport mode. These influence the mode of travel as well as shippers' modal choice in cargo haulage.

Adler (1967) studied the nature of transport systems in less developed countries (LDCs), especially their pricing systems. In Latin America, he found that the set tariffs fall short of covering the railways operating costs and road users pay for less than half of the total road costs. The study recommended that, for optimum distribution of traffic among competing modes, rates and fares should reflect the costs of the principal categories of traffic handled because subsidies lead to allocative distortions among the modes, over-investment in transport as a whole, and inefficient allocation of new industries.

Cohen, Erbaum and Hartgen (1975) used annual data collected on 31 pairs of cities to determine traffic magnitudes by mode from 1975 to 1980. The study intended to gauge traffic volume in the New York - Buffalo Corridor. Binary logit models were used to approximate city traffic volume by purpose. Analytical data on city size, employment, number of hotels and motels, annual receipts on all city business houses were collected. The logit models were approximated for each city pair to determine the degree of competition between buses railways, and automobiles. The variables of the models included: times of departure and arrival, trip fare, and frequency of service by mode. Railway share was estimated using statistics generated from the models. "The study established that rail competes differently with each mode and different modal attributes influence the level of this competition. Against air, the key variables were frequency and time; against auto, the frequency, cost, time and terminal quality were important; against bus, train service quality, frequency and time difference were important" (Cohen, Erbaum, and Hartgen 1975: 29). The resulting elasticity of demand varied greatly by mode and distance. Estimations showed that improvements in train service and terminal quality would increase train traffic by 58% to 105% in five years, 1975 to 1980.

Domenicich and Mcfadden (1975) theorised on urban transport needs. Their aim was to formulate a viable urban transport plan. Behavioural models describing commuter decisions were build to analyse commuter decisions when faced with several modes of transport. The study used rational choice behaviour theory. Travellers were assumed to be rational and were asked to rank alternative modes in order of preference given each mode's attributes. The study focused on work trips only and considered two modes of travel, namely, automobiles and trains. As revealed, socio-economic characteristics like income, sex, race, and occupation influenced travellers' modal choice.

Hovel, Jones and Moran (1975) studied the factors affecting travel demand in cities and the determinants of modal choice between public transport and other competing modes. The study concluded that people's choices between modes are influenced by trip fare, and other non-monetary factors like transit time, comfort, and security.

The New Zealand, Ministry of Transport (1975) conducted a nationwide study in order to formulate a national transport policy. The study was to provide the government with well phased measures to co-ordinate the use and development of various modes of transport and improve resource allocation and use within the sector. The study estimated economic costs in relation to national resources used by various transport services. The findings of cost allocations by mode formed the basis of allocating long distance traffic to alternative modes.

Harris (1978) studied the American rail freight industry in his "Simple Analytics of Rail Costs and Disinvestment Criteria". He used "micro-economic concepts on profitability, consumer and producer surplus" in his analysis (Harris 1978: 19). Excess capacity was found in American rail freight industry although some of the techniques used were not clear economic tools of analysis. However, the paper succeeded in developing micro-economic concepts on plant indivisibilities to demonstrate the effects of operating scale when providing branch line service. Fixed and variable costs were used to show that the demand curve can be below the average cost curve making it impossible for revenue to equal cost without price discrimination. "Social welfare criteria on disinvestment theory" is developed and compared to "private profitability criteria". The paper did not estimate rail costs or demand for all rail services but used trial and error models that can be used for further "empirical investigations".

Meyer and Levin (1978) developed a system of modal choice analysis for transport. Their approach compared subjective notions about transport systems against actual observations of their attributes. The study also looked at modal choices and preferences for varying sub-groups. The traveller was seen as a rational translator of information who evaluated each mode by its observed attributes. Algebra was used to analyse evaluations by mode.

Respondents were asked to indicate their preferences for cars or buses by using subjective modal-choice conditions. The conditions involved varying: (a) the times so riders would prefer using cars, not buses; (b) costs so they would prefer buses; and (c) the number of passengers per car. All judgements had trade-offs in cost, time, and social relations. Respondents were separated using cluster analysis to yield specific classes of choice makers. Each class of choice makers had distinct preferences for car or bus and with particular perceptions about the modes. Modal choice based on work trips was determined using group preferences combined with their subjective notions. Cost, time, and transport availability constraints were considered. "Mode patronage" was measured as the proportion of work trips by bus during the month prior to the survey. The information was then used to reassign non-motor vehicle trips. Reasons for other travel needs were considered and a regression done. The resulting prediction explained 78% of the variations in the proportion of bus trips for different respondent sub-groups; The coefficient of determination (R^2) was 0.885 for all the modes.

Daniels (1979) studied transport pricing in Bangladesh. The study advocated a broad based pricing system in transport services because it was not enough to ensure that fares and tariffs meet the minimum criteria of variable costs. "The underlying framework of taxes and financial targets for government corporations should be prudent to achieve economic efficiency in traffic allocation among competing transport modes".

*Plumbe (1979) looked at what influences truck activity in Sri-Lanka. The study established that infrastructure development alone does not necessarily lead to "operations efficiency" due to institutional, economic and social factors, e.g., licensing; import policies; price controls on inputs and outputs; the nature and quality of road network; the capacities; age; the availability of associated handling equipment including transfer facilities; and national policies on the allocation of vehicles to users. The activities by trucks were influenced by: the nature of lorry ownership; the working hours of commercial establishments; the documentation requirements for transit cargo; the working hours and remuneration of drivers and their assistants; and union agreements.

*Falola and Olarewanju (1986) in a study on transport co-ordination in Nigeria found poor co-ordination and structural inadequacies. Government decrees had established a group of poorly performing and financially mismanaged transport enterprises. The authors argued that transport rates influence modal selection little. Qualitative features govern shippers' choices. These include reliability, speed, seller-customer relations, efficiency in handling and delivery of cargo, and ability to compensate for damaged transit goods.

Review of Literature Specific to Kenya

Studies carried out in Kenya aim at alerting the public about current and future transport policy. These studies were done by the former Nairobi City Council, the Mazingira Institute, the Kenya Government, Danish International Development Agency (DANIDA), Japan International Co-operation Agency (JICA), Coopers and Lybrand Associates, and K.C. Osundwa, among others.

Colin Buchman and Partners (1973) looked at the influence of socio-economic characteristics on travel habits. The study ascertained that 45% of the journeys in Nairobi are on foot and meant to fulfil necessary tasks including school and work trips. In a follow-up study in 1975, the council concluded that most transport problems emanate from the growing population in the city; the increasing vehicle concentration in the central business district; and the failure of the public transporters to increase vehicles to match demand. The later study concentrated on the safety of travellers who daily use cheap transport buses (*matatu).*

Kenya Government (1978) conducted "The Kenya Highway Transport Study" to investigate the quality and quantity of transport facilities and transport demands and needs at regional and district levels. The study covered the national railway and road network including sections traversing the Northern Corridor and assessed road classifications and railroad network conditions. As reviewed much freight could be shifted to the railways if some improvements were made in cargo handling, the telecommunications system, and widening the line. Transport co-ordination issues were also looked at. Many of the bulky products were hauled by trucks. The railways were not used fully; they carried two-thirds thirds of their potential cargo and at highly subsidized rates. The study recommended that all transport modes should operate on a "full-cost recovery basis" by shifting some costs to shippers because low rates coupled with mismanagement in railways only serve to worsen its liquidity.

The Kenya Government and DANIDA (1980) tried to quantify the damage caused to transport networks by various classes of vehicles and the proportion each class contributes to revenue to cover costs. The level of existing subsidies including intermodal subsidies were studied to establish "a system of road user taxation in order to allocate the fiscal burden between road transport and other modes equitably and to promote fair competition among them". The study also examined optimal axle load and dimensional limits and covered all the classified roads and railway networks in the country. Since road transport enjoy high, indirect subsidies, increased taxation was recommended. In railways, much stock was under or awaiting repair due to difficulties in getting spare parts.

The study indicated that railways suffered from:

- worn out sections of the track;
- an unreliable telecommunications system;
- insufficient locomotive capacity; and
- constrained capacity of the heavily used section of the line between Mombasa and Nairobi.

The total establishment, 21,000 employees, was considered too many to be used well.

According to another study, about how to streamline railway activities, Kenya Government and DANIDA (1981) found that railways is disadvantaged by its inability to offer door to door service except where side lines exist. Hence shippers incur extra movement costs in transit time, and increased insurance premiums against loss and damage. The study recommended that these shortfalls could be overcome by operating trucks from railway terminals.

Mazingira Institute (1982) examined the operations of *matatus*. The aim was to find ways to improve this mode of transport so that it can provide "safe and adequate" commuter service in Nairobi. The study concluded that commuters use *matatus* because they are flexible, fast, and available, but, their poor conditions, rough driving, and lack of comprehensive insurance cover inhibit their use.

Japan International Co-operation Agency (1984) conducted a study to formulate a national transport plan in Kenya for integrating transport modes into an optimal transport system between 1984 and year 2000. The study covered railways, road transport and their network systems, ports, marine and lake transport, air and pipeline systems. The focus was on inter city traffic both of cargo and passengers. Reportedly, in 1982, total cargo traffic was 16,503,000 tonnes; 27.1% went by rail, the rest by road. The plan's proposal maps out investment needs in all the subsectors of transport over five year periods considering population and GDP growth rates. The plan observes that it is important to promote adequate use of the existing capacity in railways as necessary improvements are undertaken.

Coopers and Lybrand Associates (1985) studied the operations of all railway departments in Kenya Railways corporation. In personnel, staff were either over- or under-qualified. This engendered job dissatisfaction because promotions and other incentives were lacking. Some sections lacked adequate staff, e.g, locomotive drivers and marine engineers. There were inconsistencies in personnel records and supportive staff were too many compared to professionals. The plan recommended reduction of staff from 22,000 to 18,000 by end of 1989. The authors noted that, though there was "need for a marketing department", non-existed due to:

- traditional management practices and procedures inhibiting individual initiative;
- total lack of marketing skills;
- lack of management information relating to customer needs and future business plans; and,
- unreliability of the services that could be marketed and hence reluctance within the railway management to promote them.

The plan recommended the development of an "integrated road-rail interchange" for final distribution and collection of goods and the installation of an aggressive marketing unit. These recommendations were to be accomplished through the "Short Term Action Programme" (STAP) of July 1985.

Transurb Consult (1986) looked at the prevailing transport needs in Nairobi. The aim was to forecast the future transport requirements in Kenyan urban centers. The study contrasted the Kenya bus service and *matatus*. It concluded that modal competition was influenced by vehicle frequency, distance to be covered, vehicle capacity, and the cost per trip.

Osundwa (1987) looked at the choice of commuting modes in Nairobi. This study considered five modes of transport, namely, Government (Nyayo) Bus Service, Kenya Bus Service, *matatu*, Railway Commuter Service, and walking. This study found that passenger safety, comfort, service availability, trip fare, and income were the most important variables in determining choice of travel modes. A multivariate logit model was used to analyse the data.

The above studies integrate both econometric and descriptive methods of data analysis as done in this study. This study is also similar to the reviewed ones because it deals with a facet of transport needs to gain insight about how to solve transport problems facing shippers along the corridor. The major difference between this study and the others is that it concentrates on cargo transport only. Though concentrating on the demand side of the problem, this study considers not only the factors that affect demand for the two modes of transport but also demonstrates empirically how each of the factors does this. The study developed a framework for analysing shippers' choices between two modes of transport along the Northern Corridor. It is the first such study in Kenya.

Chapter Three

Field Research Methodology

Introduction

The study sought information on the basis of its two major objectives:

- analysis of factors that influence modal choice in cargo haulage; and

- analysis of cargo handling times between the modes and the reasons for the existing differences.

Primary data collected through personal interviews was used. The data relates to consignments cleared and forwarded by clearing agents from Kilindini Port in Mombasa during March and April 1989. Only consignments destined for Nairobi were considered. Transit cargo was excluded.

Population-based sampling not choice based was used to ease data collection. A choice-based sample would involve interviewing shippers as they leave the port and at the railway stations. This would have yielded many incomplete interviews because the shippers are in a hurry there.

Consignment Sampling

The population of consignments cleared from the port for up-country shipment was identified from the landing and despatch registers maintained by the Commissioner of Customs at the port. In total, there were 1,636 consignments destined for Nairobi only. Of these, a random sample of 121 consignments was drawn.

Each consignment was measured in metric tonnes. The sample was for dry-cargo consignments only. A unique serial number was assigned to each consignment in the sampling frame. Random number tables were then used to select the sample. To balance between loose cargo and containerised cargo, the percentage of each category in the population calculated. Thirty-six percent of the population was in containers; the rest was loose cargo. The population was then stratified according to these percentages. Four digit numbers were assigned to each consignment in each strata. Stratified sampling was used to draw the sample.

Identification of Clearing Agents

After the sample was drawn, landing and dispatch notes for each sample consignment were pulled from the files maintained by the Commissioner of Customs and the KPA Operations Department in order to identify the agent who cleared each consignment. In total, 33 clearing agents;--25 in Mombasa and 8 in Nairobi--handled all the 121 consignments. I visited the firms in Mombasa and Nairobi to distribute questionnaires and alert the management about the research aim.

Interviews

Structured questionnaires were used to gather information about consignments handled by each agent. Data collection took seven weeks during April and May 1989. The respondents were requested to study the questionnaire's contents and pull relevant information from their files. New appointment dates were fixed for the author to come and fill the questionnaire under a manager's guidance. This was done to avoid errors and inconsistencies in the information.

All respondents interviewed were co-operative and talked enthusiastically about the problems they face with the two modes. They were, however, reluctant to reveal personal details, even their names, in case they are quoted. They also insisted that individual firm data should not be published separately because many had not been authorised by their boards of directors to give the information.

Data Type

The questionnaires required primary data on the following variables:

- personal back ground of the interviewee;
- company activities;
- port clearing procedures;
- factors that influence transport mode choice;
- cargo handling procedures in each mode;
- consignment characteristics and modal choice; and
- mode ranking using perceptive variables (Appendix 4).

Research Sites

The research sites for the study were the Kenya Ports Authority (KPA) offices in Mombasa; Commissioner of Customs office in Kilindini Port, Mombasa; railway stations in Mombasa and Nairobi; and the inland container depots in Embakasi-Nairobi. The KPA offices and the Commissioner of Customs' office were I obtained primary information on consignments and the agents who cleared them. I visited the Inland Container Depot since it is the terminal point for containers hauled by railways from Mombasa, while all the identified agent's offices were located in Mombasa and Nairobi.

Verification of Cargo Handling Times

To determine the time taken to load and off-load cargo by the modes, direct observations were made at the KPA's loading bays (sheds) and the container terminal at the port for consignments similar to those in the sample. Available freighters at the port were asked about the observed times to confirm whether the observations were normal for all periods. I also visited railway stations and perused documents to confirm whether the times observed times tallied with past experiences. The container terminal in Mombasa and the inland container depot (Embakasi) were visited to verify container handling procedures and the times taken by KPA and railway staff in loading and off-loading containers.

Observations were made in railway depots in Mombasa and Nairobi to discern whether goods take longer to be loaded and off-loaded in railways as compared to truckers. Observed times were checked against existing records in railway offices.

To identify causes of observed bottlenecks within railways, the railway line capacity was assessed through reviewing literature in railway records and interviews with the management. Working time and remuneration structure of the cargo-handling staff, and the administrative process in cargo handling were studied to find out whether paperwork delays cargo handling.

Chapter Four

Descriptive Data Analysis

Introduction

This chapter examines consignment distribution between the modes, the characteristics of the agents interviewed, duration of cargo clearing within the port, aggregate population of consignments handled by the agent firms, anticipated changes in modal choice in case of a 100% increase in import cargo, consignment characteristics and modal choice, ranking of the two modes using perceptive variables, sample of consignment distribution by class of cargo and mode, and average handling time by mode and class of cargo.

Consignment Distribution by Mode and Cargo Class

Aggregate-consignment distribution refers to all consignments cleared from the port by the agent firms interviewed. The consignments included those that formed the basis of the interviews and those outside the sampling frame. The 33 agencies firms interviewed handled 368 (23%) of the 1,636 consignments in our sampling frame. This was an indication of the stiff the competition existing among the 287 licensed clearing and forwarding firms in the country. Among these, 102 have head offices in Mombasa, and 185 are in other major towns in Kenya including Nairobi.

The sample of agents, therefore, comprises of 12% of the total clearing agents operating in Kenya and 32% of all the agencies located in Mombasa. The total weight of consignments handled by the 33 agents was 4,243 metric tonnes of dry cargo, with an average of 11.53 tonnes per consignment. Of the 368 consignments, 201 (55%) were transported by road and 167 (45%) by railway (Table 2).

Table 2: Modal split in aggregate cargo haulage by consignment and weight

pper er	Consign-ments handled per shipper	Total tonnage	Road Haulage Consignments	Road Haulage Tonnes	Railway Haulage Consignments	Railway Haulage Tonnes
	4	26	4	26	0	0
	3	56	2	6	1	50
	15	150	12	120	3	30
	5	45	0	0	5	45
	3	18	2	15	1	3
	15	43	12	25	3	18
	9	125	7	63	2	62
	7	140	7	140	0	0
	2	75	2	75	0	0
0	3	15	2	8	1	7
1	12	190	10	126	2	64
2	5	50	4	45	1	5
3	3	70	2	30	1	40
4	25	600	25	600	0	0
5	105	1050	0	0	105	1050
6	8	250	8	250	0	0
7	2	21	2	21	0	0
8	14	54	14	54	0	0
9	6	48	2	15	4	33
0	10	74	7	51	3	23
1	40	350	30	185	10	165
2	10	100	8	80	2	20
3	5	75	4	40	1	35
4	15	135	6	54	9	81
5	3	38	2	18	1	20
6	7	65	5	29	2	36
7	9	160	5	85	4	75
8	4	4	4	4	0	0
9	6	48	5	30	1	18
0	2	70	0	0	2	70
1	5	33	4	23	1	10
2	3	35	3	35	0	0
3	3	30	1	11	2	19
Total	368	4243	201	2264	167	1979
rcent	100	100	55	53	45	47

The consignments were classified as containers or loose cargo. A sample of 121 consignments was drawn: 44 containers and 77 loose cargo consignments. The 44 container consignments weighed on, average, 17.25 metric tonnes. The 77 loose cargo consignments weighed on average, 28.65 metric tonnes. Containers, therefore, constituted 26% of the total sample weight of 2,965 metric tonnes; loose cargo constituted 74%. Total sample consignment weight represented 70% of the aggregate consignment weight of 4,243 metric tonnes handled by the 33 agent firms during the March and April 1989.

Among the 77 loose cargo consignments, 27 were transported by rail and 50 by road. The railway handled 35% of the loose cargo consignments; trucks, 65%. Thirteen container consignments went by rail and 31 by road. The 121 sample consignments represent 33% of the 368 consignments handled by the interviewed agents (Table 3).

Table 3: Consignment distribution by cargo class and mode

Cargo class	Consignments by mode		Total
	Rail	Road	
Loose cargo	27 (35%)	50 (65%)	77
Containers	13 (30%)	31 (70%)	44
Total	40 (33%)	81 (67%)	121

Among the 44 containers, 30% were transported by railway, 70% by road. Total container weight was 759 tonnes. Railways transported 23% of that weight and road trucks, 77%. Average container weight by rail was 13.46 tonnes and by road was 18.84 tonnes (Table 4). The total weight of the 27 loose-cargo consignments hauled by rail is 922 tonnes and the 50 consignments trucked by road is 1284 tonnes. Total loose cargo weighed 2,206 tonnes representing 74% of the 2,965 tonnes of total consignment weight in the sample (Table 5).

Table 4: Container distribution by consignment and weight

	Containers	%	Tonnage	%	Average weight in tonnes
Rail	13	30	175	23	13.46
Road	31	70	584	77	18.84
Total	44	100	759	100	17.25

Table 5: Loose cargo distribution by consignment and weight

Mode	Consignments	%	Tonnage	%
Rail	27	35	922	42
Road	50	65	1284	58
Total	77	100	2206	100

Thirty-three agent firms with varied characteristics were interviewed; 15 were clearing and forwarding firms, and 18 did other activities (Table 6). Some operated their own trucks to ferry goods to Nairobi, and others were known to KPA personnel; others were bound by prior contracts to offer transport business to specific carries only. Ten firms (30%)

specialized in clearing certain types of cargo consignments; the rest handled all sorts of cargo (Table 7). Eight of the 10 specialized firms preferred dealing with containers because cargo in containers is more secure in transit. Two firms preferred small parcels and have vans for them. Parcel delivery was reportedly more lucrative than delivery of heavy consignments though two firms handled both parcels and containers and claimed that handling containers is easy (Table 8).

Table 6: Agent activities

Nature of activity	Firms	%
Clearing only	15	45
Clearing and other activities	18	55
Total	33	100

Table 7: Agent preferences

Preference	Firms	%
Specialized	10	30
None Specialized	23	70
Total	33	100

Table 8: Cargo preferred by specialised firms

Category	Firms	%
Container	8	80
Parcels	2	20
Total	10	100

The non-specialized firms had many activities (Table 9). Warehousing and road transport were the most popular activities. Eight firms (24%) had private contracts with road freighters, five (15%) with railways, and 20 firms (61%) had no contracts with either mode (Table 10). Twenty two firms owned trucks for ferrying goods to Nairobi; the other 11 firms subcontract for trucking services (Table 11). Of all 33 agents, 79% operated door-to-door service or subcontracted other firms to do it for them (Table 12).

Table 9: Distribution of firms among other activities

Activity	Firms	%
Warehousing	6	26.1
Ocean freight	2	8.7
Real estate	1	4.4
Shops	2	8.7
Import/export	2	8.7
Couriers	1	4.3
Marketing	1	4.4
Air freight	1	3.3
Road transport	7	30.4
TOTAL	23	100.0

Table 10: Transport contracts with road and railway carriers

Contracts	Firms	%
Road	8	24
Rail	5	15
Not contracted	20	61%
Total	33	100

Table 11: Proportion of firms owning trucks to those without trucks

Category	Firms	%
With trucks	22	67
Without trucks	11	33
Total	33	100

Table 12: Availability of door-to-door service

Service	Responses	%
Door-to-door	26	79
No Door-to-door	7	21
Total	33	100

Two agents reported clearing consignments from the port in 2 to 3 days; 17 agents within 4 to 8 days; and 7, within 9 to 10 days. The remaining seven agents indicated that their average duration of clearing from the port was 12 to 15 days. A weighted average showed that it took 8 days to clear goods. Twenty-two shippers had private contacts with Port's and Customs personnel. Among these shippers, 12 cleared goods in 3 to 8 days; 6 did so in 9 to 10 days. For those without contacts, 7 cleared their goods in 2 to 8 days; 4 did so in 9 to 15 days.

Seventeen shippers considered the duration taken to clear consignments from the port as acceptable; 16 felt that it is too long. In all, 20 agents cleared consignments in 2 to 8 days. Fifteen (75%) of these felt that the duration was adequate; the rest said it is too long. Most of the 13 agents who cleared their goods in 9 to 15 days said the duration was too long; only two (15%) said it was adequate (Table 13).

Table 13: Average cargo clearing period in days within port and private shipper contacts

Clearing days	Response	Agent known	Agent not known	Comment	
				Adequate	Too Long
1-2	1	0	1	1	0
3-4	4	4	0	4	0
5-6	7	3	4	6	1
7-8	7	5	2	4	3
9-10	7	6	1	1	6
11-12	1	1	0	0	1
13-14	5	3	2	1	4
15-16	1	0	1	0	1
Total	33	22	11	17	16
Per cent	100	67	33	52	48

Anticipated Effects of Cargo Increase on Mode choice

Thirty three percent of all the consignments were transported by rail. Shippers were asked to indicate how these proportions would be affected by a 100% increase in cargo consignments cleared from the port. Thirteen shippers said they would not change their cargo allocation percentages between the modes. However, 20 agents (61%) anticipated changing their cargo allocations: 9 agents (45%) would contract the railways for more cargo haulage capacity, 11 agents (55%) felt the road freighters could handle more cargo and, hence, preferred road transport (Table 14).

Table 14: Anticipated mode choice due to 100% increase in cargo consignments

Cargo allocation	Responses	In favour of	
		Rail	Road
Keep same proportions	13 (39%)	4 (31%)	9 (69%)
Alter the proportions	20 (61%)	9 (45%)	11 (55%)
TOTAL	33 (100%)	13 (39%)	20 (61%)

Among the 13 agents who anticipated allocating their cargo in the prevailing proportions, 4 (31%) preferred rail, 9 (61%) preferred road. Overall anticipated changes due to this cargo increase would increase the relative demand for railway haulage from 33% to 39% and decrease demand for road transport from 67% to 61% of the total consignment haulage. The agents said that these changes are likely to be minimal in relation to the overall cargo increase due to the road haulers' aggressiveness and versatility and the overall development in road infrastructure and facilities.

Shipper's Preferences Based on Consignment Characteristics

All consignments were classified into seven groups based on the observed characteristics of consignments sampled. These groups are: fragile (delicate) consignments, bulky but light, bulky and heavy, small and heavy, containerised, non-containerised (loose cargo), and high value consignments. Agents were asked to indicate the preferred mode for each category. For delicate consignments, 13 shippers (39%) preferred rail transport, 20 shippers (61%) preferred road transport. For bulky, light consignments, 64% (21 shippers) preferred road transport, 36% (12 shippers) preferred the railway. However, 86% of the shippers preferred railway haulage for bulky and heavy consignments due to the low value of these consignments e.g., imports of food and fertilizer by the government. Two respondents were indifferent between road and rail haulage for bulky low-value cargo.

Twenty-seven percent of the respondents preferred railway haulage for small and heavy consignments, the rest preferred road (Table 15). Nineteen shippers of containerised cargo preferred railways; 21 favoured road freighters; and seven were indifferent in their modal choices. Out of a total of 240 responses made on modal choice based on consignment characteristics, railways had 94 (39%) and road 146 (61%) of this total (Table 15).

Table 15: Consignment characteristics and shipper preferences in modal choice.

Characteristic	Mode chosen		Total
	Rail	Road	
Frangile (delicate)	13 (39%)	20 (61%)	33
Bulky and light	12 (36%)	21 (64%)	33
Bulky and heavy	30 (86%)	5 (14%)	35*
Small and heavy	9 (27%)	24 (73%)	33
Containerised	19 (47%)	21 (53%)	40*
Non-containerised	3 (9%)	30 (91%)	33
High-value	8 (24%)	25 (76%)	33
Total	94 (39%)	146 (61%)	240(100%)

* Two respondents were indifferent in modal choice if cargo consignments were bulky and heavy; seven were indifferent about containers.

Mean Handling and Delivery Times

Different observations on the loading process showed that the actual loading for containers takes only 15 to 20 minutes for both lorries and wagons. The time to load loose cargo varied between 45 to 120 minutes in each mode. However, adequate direct observations could not be generated due to the frequency of interruptions in the process. Respondents were, therefore, asked to indicate the length of time it took to have specific wagons or lorries loaded once they became made available for loading. I observed that it took 3 hours to have containers loaded into a wagon and 7.5 hours for lorries. Loose cargo took up to 9 hours to be loaded in wagons and 12 hours into lorries.

The loading times differ because all loading at the port is done by KPA personnel. Wagons are given preference since cargo going by railway is not charged storage expenses. Hence KPA earns more through this policy. Loading cranes are tied to wagons; and only short intervals are allowed for lorry loading especially during the day. Lorries usually pick consignments from different sheds. This causes queues and delays. Lorries are, however, allowed to hire labourers to hasten loose cargo loading (Table 16). The transit times were on average 6.92 days for rail and 4.19 days for road (Table 17).

Table 16: Average loading time by class of cargo and mode

Cargo class	Mode		Mean loading time by class of cargo (hours)
	Rail hours	Road hours	
Containers	3.08	8.97	6.02
Loose cargo	8.78	15.82	12.30
Mean loading time by mode	5.93	12.39	-

Table 17: Mean transit time by mode after loading

Mode	Mombasa-Nairobi Days	Nairobi-Customer Days	Total Days
Rail	4.05	2.87	6.92
Road	2.48	1.71	4.19

Mode Ranking Using Perceptive Variables

To determine the shippers' perceptions about the two modes, perceptive variables were used to rank each mode. Each variable was ranked as very good, good, fair, poor, or very poor. To ease comparison between the two modes, each rank had a score:

Rank	Score
very good	1
good	2
fair	3
poor	4
very poor	5

The lower the total score for a perceptive variable the better the mode.

The applied perceptive variables are:

- *Efficiency in time keeping* - the ability of the mode to observe agreed times of delivery as per contract.
- *Efficiency in cargo handling* - the degree of care exercised in loading and off-loading cargo to avoid damages.
- *Trustworthness* - the likelihood of the mode employees to interfere with transit consignments and give other reasons e.g. theft.

- *Customer relations* - the degree of public relations within the mode and its perceived impact in general business matters.
- *Reliability* - the likelihood of the modes employees to induce others to tamper with goods while on transit and yet claim innocence.
- *Rate setting* - the predictiveness of prevailing freight rates within the modes.
- *Capacity availability* - ability to offer space without causing unnecessary delays.

The rank responses by mode are shown in Table 18.

Table 18: Road freighter and railway rank responses by perceptive variables

	Rank responses											
	V.good		Good		Fair		Poor		V. poor		Total	
	f	rw	f	rw	f	rw	f	rw	f	rw	f	rw
Efficiency in time keeping	21	4	12	15	0	11	0	3	0	0	33	33
Efficiency in cargo handling	11	13	22	11	1	7	0	1	0	1	33	33
Trustworthiness	6	15	24	12	2	3	1	3	0	0	33	33
Customer relations	30	0	3	5	0	10	0	13	0	5	33	33
Reliability	15	3	15	14	3	9	0	7	0	0	33	33
Rate setting	2	8	6	22	11	2	12	1	2	0	33	33
Capacity availability	11	0	20	13	2	11	0	8	1	1	33	33
Total	96	43	101	92	19	53	13	36	2	7	231	231
Percent	41	19	44	40	8	23	6	15	1	15	100	100

Note: f, indicates road; rw, railways.

Road transporters are perceived as better performers in all the perceptive variables except in trustworthiness and rate setting where railways was perceived as doing better. Most respondents (85%) ranked truck transport as good or very good except in rate setting where road performance was perceived as generally poor. Railway haulage attained 59% of all the responses in these two ranks but performed very well in rate setting where 91% (30 responses) of the respondents ranked it as good or very good. This reflects the government's control of railway tariffs. The rank responses are translated into scores by perceptive variables (Appendix 1).

Chapter Five

Theoretical Framework and Data Analysis

The study assumes that shippers have perceptions about the characteristics of the two modes before making their choice. The characteristic of each consignment and the time of its use in the final destination are believed to influence a shipper's choice of the railway or road freighters. A shipper's choice is, therefore, dichotomous. Several factors influence the probability of either mode being chosen. This probability can be determined by a discrete choice model. As the study also compares handling and delivery periods of cargo between the two modes, the application of a discrete choice model is supplemented with descriptive statistical analysis.

Discrete Choice Models

Since the choice between road freighters and railway cargo haulage is dichotomous, a qualitative choice model is needed. The qualitative choice models are: the linear probability, probit, and logit models. Each has shortcomings.

(i) *Linear Probability Model*

The regression form of the linear probability model is:

$$Y_i = \alpha + BX_i + E_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where:

X_i = the value of an attribute for the ith variable

$$Y_i = \begin{cases} 1 \text{ if the first option is chosen} \\ 0 \text{ if the second option is chosen} \end{cases}$$

E_i = an independently distributed random variable with zero mean.

This is written formally as:

$$P_i = \begin{cases} \alpha + BX_i \text{ when } 0 < \alpha + BX_i < 1 \text{ ....(2)} \\ 1 \text{ when } \alpha + BX_i \geq 1 \\ 0 \text{ when } \alpha + BX_i \leq 0 \end{cases}$$

This model has analytical limitations because the independent variables and their unknown parameters do not necessarily lie between 0 and 1, as required of any probability. The limitation is corrected by constraining the functions of independent variables. This method results in unrealistic kinks as the limits 0 and 1 are approached (Wonnacott and Wonnacott 1978: 195). Since the error terms also remains heteroscedastic, efficiency is lost (Pindyck 1976: 96).

(ii) *Probit Model*

The shortcomings of the linear probability model led to the development of the probit model using the cummulative probability function,

$$P_i = f(\alpha + X_i) \int_{-\infty}^{Y_i} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}U^2} du \quad \text{....(3)}$$

where $Y_i = \alpha + BX_i + E_i$

The resulting distribution is symmetric around 0 and bounded between 0 and 1 with a variance of unity. Though quite efficient, this model involves non-linear estimation methods.

(iii) *The Logit Model*

The logit model improves the first two models and is used in part of the present analysis to identify factors influencing modal choice in cargo haulage. The model uses the cummulative logistic probability function whereby:

$$Z_i = \alpha + BX_i + E_i$$

$$P_i = f(z_i) = \frac{1}{1-e^{-z_i}} = \frac{1}{1-e^{-(\alpha + BX_i)}} \quad \ldots\ldots\ldots\ldots\ldots \quad (5)$$

where:

P_i = The probability that an individual will make a certain choice given knowledge of x_i

Z_i = Measures the characteristics of all independent variables against the available choices

X_i = A vector of independent variables

B = A vector of unknown parameters

$Z_i = \alpha + BX_i$

E_i = an independently distributed random variable with zero mean

The B parameters in the model are estimated using maximum likelihood procedures. The resulting probability function of the logistic distribution is symmetric around 0 and bounded between 0 and 1 with a variance of π squared divided by three. The probit and logit models yield nearly identical results except where data is densely distributed in the tails (Amemiya 1981: 1483-1507)

Estimation Purpose

The purpose of our logit estimation is to identify the factors that influence transport modal choice in cargo haulage between Mombasa and Nairobi. Once these are identified, the differences between them are tested to check for significant differences between the modes.

Logit Estimation Method

A binary logit model is constructed to analyse shipper's choices of the transport mode. This model helps predict the probability that an individual shipper chooses one of the two modes considering the characteristics of each mode and consignment. The model's variables and measurements are shown in Table 19.

Table 19: Variable definitions and measures

Variable	Symbol	Measure
Consignment weight	WT	Metric tonnes
Cost of loading	CL	Kenya shillings
Loading time per tonne	LT	Hours
Road freight charge per tonne	RF	Kenya shillings
Rail freight charge per tonne	RC	Kenya shillings
Relative freight Cost	RFC	RF/RC
Road shipping time to Nairobi	RN	Days
Rail shipping time to Nairobi	RY	Days
Relative shipping time	RST	RN/RY
Nairobi customer delivery time by road	RD	Days
Nairobi customer delivery time by rail	RT	Days
Relative delivery time (Nbi-customer)	RDT	RD/RT
Total transit time by road	RN + RD = TRD	Days
Total transit time by rail	RY + RT = TRY	Days
Relative total transit time	RTT	TRD/TRY
Consignment characteristic	CC	$\begin{cases}1 \text{ if container}\\0 \text{ if Loose cargo}\end{cases}$
Customer relations in road freighters	RS_d	Perceptive score 1 to 5
Customer relations in railways	RS_y	Perceptive score 1 to 5
Relative customers relations	RSS	RS_d/RS_y
Constant term	C	-
Error term	E	-
Mode used	MU	$\begin{cases}1 \text{ if road}\\0 \text{ if rail}\end{cases}$
Probability of road being used	P_{ir}	0 to 1
Probability of rail being used	P_{iy}	0 to 1

One hundred and twenty-one observations are used to estimate the logit equation:

$$\text{Ln } \{Pir/Piy\} = C + C_1 \text{lnWT} + C_2 \text{lnLT} + C_3 \text{lnRFC} + C_4 \text{lnRDT} + C_5 \text{lnRT} + C_6 \text{lnCL} + C_7 CC + C_8 SC + E$$

Except for dummy variables, all the other variables are log linearized. Since relative-shipping-time (RST) and relative-total-transit time (RTT), were highly correlated, they were used alternately for estimations.

Logit Estimation Results and Interpretation

Several logit equations were estimated, but insignificant variables and those with wrong signs were dropped using a stepwise approach. The initial equation included all independent variables defined in Table 19, but weight (WT), loading time (LT), relative total transit time (RTT), and relative customer relations (RSS) were insignificant (Table 20: equation {a}). Other variables such as loading cost (CL) and relative total transit time (RTT) had wrong signs. In equation (b), relative transit time (RST) was introduced after dropping RTT and other insignificant variables in equation (a), but RST was insignificant. WT replaced RST in equation (c), but weight (WT) remained insignificant. Indeed, the average weights by mode were not statistically different i.e., 11.79 tonnes by rail and 13.27 tonnes by road.

Table 20: Logit estimation results

Independent variable	Coefficient	Std Error	T-stat	2-tail significance
Equation (a)				
C	1.2466774	1.8163831	0.686	0.494
WT	0.0081585	0.0081462	1.002	0.319
LT	-0.4022257	0.2886982	-1.393	0.167
CL	0.0528946	0.0124191	4.259	0.000
RFC	-1.6226429	0.8571602	-1.893	0.061
RDT	-1.4976547	0.5492477	-2.727	0.008
CC	1.0683215	0.5434856	1.966	0.052
RTT	0.7440112	0.6209046	1.198	0.234
RSS	0.2234920	0.1750581	1.276	0.205
Equation (b)				
C	3.0097884	1.6153106	1.8633	0.065
CL	0.0399506	0.0106813	3.7403	0.000
RFC	-1.5031146	0.7971349	-1.8856	0.062
RDT	-0.9084231	0.3732868	-2.4336	0.017
RST	0.4377384	0.4478621	0.9774	0.331
RSS	0.2128371	0.1880186	1.1320	0.260
Equation (c)				
C	2.9840952	1.5382405	1.9399	0.055
CL	0.0434122	0.0109451	3.9664	0.000
RFC	-1.4366103	0.7611295	-1.8875	0.062
RDT	-1.0177205	0.3802484	-2.6765	0.009
WT	0.0078917	0.0070376	1.1214	0.265
Equation (d)				
C	3.3022223	1.5686951	2.1051	0.038
CL	0.0406853	0.0105886	3.8424	0.000
RFC	-1.4943833	0.7863705	-1.9004	0.060
RDT	-0.9351914	0.3688395	-2.5354	0.013

Note: Dependent variable is MU. Sample range was 1-121. There were 81 cases with MU=1 and 40 cases with MU=0. Convergence was achieved after 3 iterations.

The best results included relative freight cost (RFC), relative delivery times (RDT) after cargo arrives in Nairobi, and loading cost LC (Table 20: equation (d)). Other equations were estimated but rejected due to insignificant variables or wrong signs of variable coefficients (Appendix 2).

Although loading cost (LC) was one of the variables included in the best equation, it was a tiny fraction of the total transport cost. Despite this cost being high in road freighters, many shippers chose road haulage. Hence, the choice of mode determined the level of loading costs to be incurred. From the logit results, the cause of choice is in the wrong direction because increasing this cost in one mode would imply that more cargo would go by the mode where the cost has increased. It was expected that lowering this cost in one mode would lower the probability of choosing the alternative mode.

Relative freight cost significantly influenced choice. Reduction in freight cost in one mode dampens the demand for the other mode. Relative customer delivery time is significant at 99% confidence implying that shippers are conscious about the availability of door-to-door service. Its availability in one mode dampens demand for the other mode. Since shippers are conscious about the availability of door-to-door service, it is important, therefore, to determine how improvement in this variable will alter the probability of choosing either mode.

To determine how improvement in shippers perceptions about railway delivery time would affect the demand for its service, probabilities were calculated using descriptive statistics (Table 21). The resulting probabilities were to indicate how changes in RDT due to an improvement in shippers' perception about railway delivery times would alter the demand for its services. The regression results in table 20 (d) and variable means in Table 21 were used to find the impact of changes in RDT. From the logit model (Pindyck 1976: 249):

Table 21: Descriptive statistics of significant variables in equation d, Table 20.

Variable	Mean	Std Error	Maximum	Minimum
CL	40.00	56.00	300.00	0.00
RFC	1.98	0.30	3.44	1.25
RDT	0.70	0.58	5.00	0.20

$$Z_i = \text{Ln}\ \frac{P_i}{1 - P_i} = \alpha + BX_I$$

$$\Rightarrow Z_i = 3.302 + (0.041)(40) - (1.494)(1.98) - (0.935)(0.705)$$

$$= 1.325$$

$$\text{Ln}\ 1.325 = 3.762 = \frac{P_i}{1 - P_i}$$

$$\Rightarrow P_i = 3.762(1 - P_i)$$

$$P_i = 0.79$$

A shipper with average perceptions about the two modes had a probability of 0.79 of choosing road freighters. If railways improved shippers perceptions about the delivery time differential by promoting door-to-door service, the probability of choosing road transport would decline. One way of reducing delivery time in railways is to reduce transit time from the main yard to the sheds in Kaloleni by 50% or more i.e., from two days to one day. Off-loading on public lines could also be encouraged for shippers with own transport (Table 22).

Table 22: Impact of changes on railway delivery times

Percentage reduction in RT	P_i	Change in P_i
RT constant	0.79	
		-0.03
20%	0.76	
		-0.13
50%	0.66	
		-0.45
75%	0.34	

Note: The above changes are possible if railways could install same day delivery services in Nairobi by operating trucks over short distances. This would require 24 hour operations at cargo loading and off-loading sheds unlike the present situation where wagons are moved to sheds at night only.

In railways, installation of door-to-door service would increase demand for railway haulage, hence, promote their profitability and save foreign exchange. There is adequate capacity in railways to take more cargo above the present levels (Kenya 1986: 164). A foreign exchange component included in the cost of cargo transportation. Some of these costs are for fuel consumed and the wear and tear of vehicles, roads and railway lines. Accurate estimation of the foreign exchange used to maintain these facilities is difficult. However, considering variables like fuel consumption, necessary spares after a trip for trucks, grease, tyres, interviews with road freighters revealed that it costs about KSh 130 in foreign exchange to transport a tonne of goods for 500 kilometers by truck (Appendix 4). Published data on railway operations was apportioned between cargo haulage and passenger service based on traffic tonne kilometers done in 1988. To haul a tonne of cargo by railway over 500 kilometers costs KSh 74 in foreign exchange (Appendix 3). There is a saving of KSh 56 in foreign exchange on every tonne transported by railway. Improving railway delivery times by 50% would incease the probability of its being chosen by 0.13. Such change would increase demand for railway cargo haulage from Mombasa and Nairobi by 60% from its present level.

Using these estimates and the figures on cargo transported by railway from Mombasa to Nairobi in 1986, we can estimate the amount of increase in revenue and possible foreign exchange savings at various levels of improvement in railway service. In 1986, the railways transported 1,584,000 metric tonnes from Mombasa to Nairobi (Kenya Railways 1986: 17). If the railway improved its delivery times by 50% the following year, the probability of choosing road freighters would have declined by 16.45% and demand for railway cargo haulage would have increased by 60%. This would have increased cargo hauled by 950,400 tonnes earning the railways an extra K£ 13,210,560 and saving K£ 2,661,120 in foreign exchange. Each tonne hauled by railways earned KSh 0.556, per kilometer or KSh 278 for 500 km.

Though the above argument is based on estimates, it stresses the need to promote railway haulage where possible to save foreign exchange now spent on road haulage. As long as railway capacity is not fully used, there is a misallocation of resources costing much foreign exchange.

Analysis of Relative Variables in Cargo Haulage between the Modes

This section compares some variables between the two modes to ascertain the existence of significant differences in these variables. The variables examined in this analysis include comparison of mean:

- loading cost by rail and road (LC)
- loading time by rail and road (LT)
- road and rail shipping times between Mombasa and Nairobi (RN and RY)
- road and rail freight charges per ton (RF and RC)
- road and rail customer delivery periods after arrival in Nairobi (RD and RT)
- total transit time by road and rail (TRD and TRY)

Eighty-one consignments went by road; fourty, by rail. These sample sizes are large enough to the apply the Z-statistic for this analysis.

Table 23: Sample parameters used in the analysis of relative variables

Variable	Mean	Standard Deviation (SD)	Variance (SD2)
Road sample size--81 consignments			
LT	1.31	2.10	4.41
CL	52.10	60.96	3716.00
RF	610.46	112.12	12571.00
RN	2.65	1.67	2.79
RD	1.38	0.80	0.64
TRD	4.04	1.92	3.69
Rail sample size--40 consignments			
LT	0.80	1.24	1.54
CL	14.60	32.57	1061.00
RC	350.00	143.01	20452.00
RY	3.93	2.34	5.48
RT	3.23	1.31	1.72
TRY	7.15	2.86	8.18

Tests of Hypotheses

In this section, six hypotheses were tested to determine whether there was a significant difference between the population parameters of road and rail haulers. One tail tests were applied for the sample means (X) of variable pairs for the two modes. The null hypothesis supposes that there is no difference between the population parameters of the modes; whereas, the alternative hypothesis supposes that the mean parameters of road freighters are greater than those for railways in loading time, cost of loading, and freight charges. The alternative hypothesis for the remaining three variables--shipping time (RN and RY), customer delivery time (RD and RT), and total transit time (TRD and TRY)-- states that the means of these variables for truck transport are less than for railways.

The first set of test hypotheses are:

Null hypothesis H_o: $U_1 = U_2$

Alternative Hypothesis H_1: $U_1 > U_2$

where U_1 is the population mean of each road variable, and U_2 is the population mean of each railway variable for the first three variables (LC, LT, RF and RC).

The second set of test hypotheses are:

Null hypothesis $Ho: U_1 = U_2$

Alternative hypothesis $H_1: U_1 < U_2$

The Z critical values set at 90%, 95% and 99% levels of confidence, and the Z computed statistics appear in Table 24.

Table 24: Tests of hypotheses on relative variables

Variable	Z-computed	Z - Critical Values at Different Levels of Confidence 90%	95%	99%
LT	1.68			
CL	4.41			
RF, RC	10.09			
		1.65	1.96	2.58
RN, RY	-3.09			
RD, RT	-8.20			
TRD, TRY	-6.22			

The following formula is used to compute Z values:

$$Z = \frac{X_i - Y_i}{\frac{var(X_i)}{n_1} + \frac{Var(Y_i)}{n_2}}$$

Where X_i and Y_i are the sample means in road and railway haulage and n_1 and n_2 are their respective sample sizes.

The Z-computed values on loading time, loading cost, and freight charges are different from the critical value of Z at 90% level of confidence (Table 23). I, therefore, reject the null hypotheses that there is no significant difference between the modes and accept the alternative hypotheses that there is a significant difference in these parameters between the modes. For delivery, shipping, and total transit times, the Z critical values are higher than the computed ones. I also reject the null hypotheses and state that, at 90% level of confidence, there is a significant difference in these variables between road and railway: road has lower times than rail in all the three variables.

The Level of Interdependence between the Modes

Any modal choice is governed by the shipper's perception about the alternative mode. The dependency between road and rail haulage is observable, but the distribution of this dependency is unknown. Hence, the normal methods of finding the correlation coefficient (r^2) can not be applied (Yamane Taro 1973: 498).

The rank correlation coefficient developed by Spearman in 1904 which measures the degree of association between such variables is used. The statistic uses the ranks or order of observations and does not depend on a specific distribution of the variable. It is a non-parametric or distribution free statistic.

The Spearman's rank correlation coefficient is defined as

$$r_s = 1 - \frac{6 \sum d^2}{n(n^2 - 1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

where d is the difference between the ranks of X and Y observations. This coefficient is used to test the hypothesis that the population proportion, P_s, equals zero against the alternative hypothesis that $P_s = 0$. The ranks are between road and rail haulage, and their total scores use perceptive variables (Table 25).

Table 25: Analysis of road and railway scores by perceptive variables

	Mode-score		Mode-Ranks			
	Road	Rail	Road	Rail		
	X	Y	X	Y	d = X-Y	d^2
Efficiency in time keeping	45	79	2	4	-2	4
Efficiency in cargo handling	58	65	5	3	2	4
Trustworthiness	64	60	6	1	5	25
Customer relations	36	117	1	7	-6	36
Reliability	54	86	3	5	-2	4
Rate setting	105	62	7	2	5	25
Capacity availability	57	96	4	6	-2	4
Total	n.a	n.a	n.a	n.a	n.a	102

There were 33 responses on each perceptive variable. Accordingly, the rank correlation coefficient was:

$$1-\frac{6(102)}{33(33^2-1)} = 1 - \frac{612}{35904}$$

$$r_s = \underline{0.983}$$

The variance, r_s, is:

$$\text{Var}\ (r_s) = \frac{1}{n-1} = \frac{1}{32} = 0.03125$$

$$Z = \frac{r_s}{\sqrt{\text{Var}(r_s)}} = \frac{0.983}{0.177} = 5.55$$

Since r_s is 5.5 standard deviations from 0 in the sampling distribution, it differs significantly from 0. So, I reject the null hypothesis that $P_s = 0$, and accept the alternative hypothesis that the observations are not independent. This implies that the shippers' perceptions about road and rail haulage are interdependent.

Chapter Six

Conclusions and Recommendations

Two modes of transport were studied, namely, road and railway haulage. Primary data collected through personal interviews using structured questionnaires was used for analysis. The research sites were Kenya Ports Authority (Mombasa), Kenya Railway Stations in Mombasa and Nairobi, the Inland Container Depot (ICD) Nairobi, Mombasa Town and Nairobi City, and the Customs office in Mombasa (KPA). A random sample of 121 consignments was selected using random number tables.

The study examined the determinants that affect the relative odds of choosing one mode of transport over the other. Several, binary-logit equations were estimated to examine the effect of certain variables on the probability of choosing one mode over the other. The purpose was to find which variables significantly influenced shippers' choices.

The logit results revealed that some of the variables studied are quite important in shipper choices. The best equation results results indicate that relative freight charges (RFC) and relative delivery times (RDT) after cargo arrives in Nairobi are the most important variables in determining modal choice in cargo haulage.

The data collected through interviews indicated that most shippers use road transport even when rail service is available although road haulage is more expensive. Speed, flexibility and lack of excessive bureaucracy in road haulage, and the availability of door-to-door service favoured the use of road haulage. Consignment weight was not a significant factor in modal choice although bulky low-value cargo went mostly by rail.

There were big differences in the loading time, loading cost and freight charges between the two modes. The road freighters were more expensive. Road freighters, however, have shorter transit time and also offer door-to-door service not available from the railway. This encouraged shippers to prefer road haulage despite higher costs.

The choices were dependent on the characteristics of each mode and the consignment. Therefore, decisions affecting either mode depended on the existing perceptions about the other mode. No policy variable could be manipulated to eradicate the use of either mode in cargo haulage, but changes in the significant variables would greatly affect the demand for the alternative mode.

Changes in freight charges could shift demand from one mode to another but to be effective, other non-monetary improvements are required e.g., reducing the transit times by mode and having strong marketing and public relations units. Decreasing the loading time in one mode would increase the demand for its services; and improvement in delivery times in one mode would increase the probability of its being chosen. Variations in the variables examined would alter the demand patterns between the two modes though each mode would have some share in cargo haulage since the constant term in the logit equation was positive. Loading time was not significantly different between the modes at 95% confidence.

Loading cost and freight charges were significantly higher for trucks than for the railways. The higher costs did not deter shippers from using the expensive mode because the transit time for trucks between Mombasa and Nairobi was short and they offered door-to-door service. If the railways want to compete well with road freighters, it should streamline cargo handling procedures to ensure that cargo leaves Mombasa the day it is loaded. Road and rail were highly interdependent though shippers choices were biased against rail haulage due to delays. These delays are caused by the low speed of the trains due to the narrow gauge track and the lack of door-to-door service.

The paper verified that installation of door-to-door service in railways would increase demand for railway cargo haulage by 60% thus raising revenues and saving foreign exchange. A combination of several improvements would result in very high levels in cargo hauled.

These findings are consistent with those of Cohen, Erbaum and Hartgen (1975: 29) who estimated that improving rail service by 40% in the USA would increase demand for rail services by between 58% and 105% over five years.

The study's limitations

The consignments handled within the two selected months may not be representative of what happens throughout the year. Moreover, the study considered only dry cargo. Including other types of cargo may have yielded different conclusions. Transit cargo and the distance of haul were not studied since the route and distance were fixed: Mombasa to Nairobi.

Recommendations

Since shippers consider door-to-door service as a priority when making their choices, the railways should establish this service for short distances up to 50 kilometers from its terminals. The railways' cargo handling staff should get bonuses after attaining a certain level of output. This would improve cargo-handling procedures and reduce total handling times at railway terminals. The possibility of inaugurating an express-goods service should also be explored.

Appendix 1

Modal scores using perceptive variables

	Scores by rank										Total	
	1		2		3		4		5			
	f	rw	f	rw	f	rw	f	rw	f	rw	f	rw
Efficiency in time keeping	21	4	24	30	0	33	0	12	0	0	45	79
Efficiency in cargo handling	11	13	44	22	3	21	0	4	0	5	58	65
Trustworthiness	6	15	48	24	6	9	4	12	0	0	64	60
Customer Relations	30	0	6	10	0	30	0	52	0	25	36	117
Reliability	15	3	30	28	9	27	0	28	0	0	54	86
Rate setting	2	8	12	44	33	6	48	4	10	0	105	62
Capacity Availability	11	0	40	26	6	33	0	32	0	5	57	96
Total	96	43	204	184	57	159	52	144	10	35	419	565

Appendix 2

Other estimated equations of the logit model.

Independent variable	Coefficient	Std-error	T-stat	2 tail significance
Equation (i)				
C	1.0831522	1.8981498	0.571	0.570
WT	0.0077511	0.0082896	0.935	0.352
CL	0.0534829	0.0126076	4.242	0.000
LT	-0.5241939	0.2943273	-1.781	0.078
RFC	-1.6799339	0.8999126	-1.867	0.065
RST	0.7078714	0.4984216	1.420	0.159
RDT	-0.9790316	0.3965907	-2.469	0.015
CC	1.1163465	0.5485495	2.035	0.045
RSS	0.2467303	0.1968932	1.253	0.213
Equation (ii)				
C	1.8643555	1.8088690	1.031	0.305
LT	-0.5050333	0.2729635	-1.850	0.067
CL	0.0502267	0.0121202	4.144	0.000
RFC	-1.6170530	0.8661878	-1.867	0.065
RDT	-0.9838240	0.3844428	-2.559	0.012
CC	0.7740257	0.5028031	1.539	0.127
RSS	0.7205563	0.4896051	1.472	0.144
Equation (iii)				
C	1.7815798	1.7591921	1.013	0.314
LT	-0.5802245	0.2735782	-2.121	0.036
CL	0.0495890	0.0121455	4.083	0.000
RFC	-1.4230714	0.8312281	-1.712	0.090
RDT	-1.0256755	0.3854996	-2.661	0.009
RST	0.4862928	0.4687929	1.037	0.302
RSS	0.2125788	0.1737503	1.223	0.224
Equation (iv)				
C	3.7524582	1.6498795	2.274	0.025
LT	-0.4298664	0.2776545	-1.548	0.125
CL	0.0498293	0.0120546	4.134	0.000
RFC	-1.7802856	0.8464579	-2.103	0.038
RDT	-0.8930277	0.3725261	-2.397	0.018
CC	0.5800618	0.4820430	1.205	0.231

Note:- Dependent variable is MU
- Sample range 1-121
- Convergence achieved after 3 iterations
- Cases with MU = 1 81
- Cases with MU = 0 40

Appendix 3

Maintenance cost allocation in railways

	K£ '000
Fuel consumed	7857
Railway truck	1312
Rolling stock	2431
Other maintenance expenses	1929
Total	13529

kilometers done

Passenger train kilometers	1,478,000
Freight ton kilometers	1,831,000,000
Total	1,832,478,000

Cost allocation between freight and passengers

$$\frac{13{,}529{,}000 * 1{,}831{,}000}{1{,}832{,}478{,}000} = \text{K£}13{,}518{,}000$$

Cost of hauling one tonne over 500 Km in KSh

$$\frac{13{,}518{,}000 * 20 * 500}{1{,}831{,}000} = \text{KSh } 73.82$$

Revenue generated per tonne kilometer

Tonnes hauled ----------------3,352,000
Revenue--------------------K£ 50,928,000
Revenue per tonne------------ K£15.193
Average tonne Km--------------------546
Average revenue per tonne Km KSh 0.556.

* Source: Kenya (1987b: pp 172-173), Kenya Railways (1986: pp 17, 22-23).

Appendix 4

Foreign-exchange costs incurred by selected road transporters for 500 Km-for 30 tonne lorry (KSh equivalent).

Cost variable	Respondent			Mean	Foreign exchange content
	First	Second	Third		
Fuel	1300	1350	950	1200	960
Spares	1800	2400	2100	2100	1680
Grease	250	330	320	300	240
Tyres	800	1200	1000	1000	1000
Total	4150	5280	4370	4600*	3880

* Mean cost per tonne was KSh 3880/3 = KSh 130

The data related to 30 tonne lorries travelling between Mombasa and Nairobi when loaded.

Appendix 5

This questionnaire requires information concerning the shippers general characteristics and factors that influence transport mode choice in cargo haulage between Mombasa and Nairobi.

1. PERSONAL BACKGROUND:

1.1. Name of interviewee

1.2. Employer --

1.3. Postal Address -----------------------------------

1.4. Telephone ---------------------------------------

1.5. Location of the Company's head office ------------

1.6. Employers position in the Company ---------------

----

2. COMPANY ACTIVITIES

2.1. Does your company engage in other activities apart from clearing and forwarding of cargo? YES/NO

2.2. If Yes, please specify ----------------------------

2.3. Do you specialize in the clearing and forwarding of certain consignments only? YES/NO

2.4. Please give reasons for your answer in (2.3) above.

2.5. Are you obliged in any any way to offer business to a specific carrier, i.e. railways or any road transport company? YES/NO

2.6. If Yes, please specify ---------------------------

2.7. Does your company run its own trucks to transport cargo between Mombasa and Nairobi? YES/NO

3. <u>PORT CLEARING AND MODE CHOICE</u>

3.1. On average, how many days does it take to go through all the Port procedures before a consignment can be loaded for up-country journey?

3.2. Do you consider the duration taken to clear a consignment as adequate or too long?

3.3. If too long, explain why?

3.4. Are you known to people at the Port who assist you in your business? YES/NO

3.5. If Yes, please explain the assistance given--------

3.6. Briefly explain the problems you encounter at the Port --

----

3.7. Which of the problems above do you think influences your choice of transport mode most? --------------

----

Why? --

3.8. How can the above problems be solved?

----

4. TRANSPORT MODE CHOICE

4.1. Name the various categories of consignments you have cleared from the Port within the last two months.

4.2. What was the total weight of imported consignments cleared in the last two months. ------------------

-------------------------------------- Metric tonnes

4.3. What was the number of consignments cleared?

4.4. Among these, how many consignments went by railway ---------------------------- and what is their estimated weight ------------------------------------ metric tonnes.

4.5. If the number of imported consignments you clear from the port doubles would you allocate cargo to the two modes in the same proportions? YES/NO

Why? ---

----

5. CARGO HANDLING

5.1. Once cargo is cleared from the port, how long does it take to ship it to Nairobi? --------------days.

5.2. How long does it take to clear it from the warehouse in Nairobi to your consignees' premises --------------------------------- days.

5.3. Do you operate door-to-door service for imported cargo in Nairobi? YES/NO -----------------------
----
Why? --
----

6. CONSIGNMENT CHARACTERISTICS

6.1. In the table below, tick the mode you would choose if consignments destined for Nairobi had the listed characteristics:

Characteristic	Railway	Road
Fragile (Delicate		
Bulky but light		
Bulky but heavy		
Small and heavy		
Containerized		
Non containerized		
High value		

6.2. Within the last two months, your company cleared the consignments shown below for up country shipment. Please fill in the required information against each consignment in the table below:

Consignment Name	Tonnage	Mode Used hours	Loading time in	Cost of loading	Consignment characteristic (Those shown in 6.1. above)	Road Freight Cost KShs.	Rail freight cost KShs.	Time taken to ship to Nairobi (days)

Time taken to deliver to customer in Nairobi	Handling time if alternative mode was used

6.3. Which mode do you think offers compensation fast in case of damage while goods are on transit? railway/ road freighters.

6.4. In the table below, list some of the main problems you encounter with each mode, e.g. capacity availability, damage rates, theft etc.

Railways	Road Freighters
(a) --------------------	----------------
(b) --------------------	----------------
(c) --------------------	----------------
(d) --------------------	----------------

6.5. How can these problems be alleviated? -----------

6.6. Please rank the two modes as either very good, good, fair, poor and very poor on the basis of the variables given below:-

Variable	Road Freighters	Railway
-Efficient in time keeping		
-Efficient in Cargo handling		
-Trustworthiness		
-Customer Relations		
-Reliability		
-Rate setting		
-capacity availability		

6.7. Give general comments on any other factors you consider important in choosing your mode of cargo transport.

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