A geographical study of transport in Saudi Arabia with special reference to road transport

Abdo, Ass ad Sulaiman

ABSTRACT

This thesis has a dual theme a) to make a contribution to the promotion of the geographical approach in the field of transportation and b) to make a contribution to the development of transportation in Saudi Arabia

After an examination of the historical evolution of transport in Saudi Arabia detailed analytical surveys have been undertaken on the present development of transportation with especial emphasis on road transport which forms the backbone of the transportation services in the country

Chapter One is a short introduction to get the reader acquainted with the relevant aspects of the geography of Saudi Arabia as well as with the scope approach and objectives of the study Chapter Two is a study of the history of transport in Saudi Arabia from the very early times until the first half of the present century Chapters Three Four and Five deal with the development of the modern road network and its association with socio-economic and other geographical factors Chapters Six and Seven examine the motor vehicle stock and road traffic whilst Chapter Eight is a study of air traffic In Chapter Nine three problems of under-utilization in road traffic were discussed whilst in Chapter Ten the impact of transport development on settlements and social changes were investigated and analysed Chapter Eleven ends this analytical survey with a study of the cost and pricing of road transport In Chapter Twelve the Ideal-Typical Sequence Model of transport development in underdeveloped countries was applied to Saudi Arabia the Sudan and some other Middle Eastern countries and certain modifications were suggested to make the model of more

general application   The final chapter deals with the problems and prospects of transport development in Saudi Arabia   drawing the broad lines of a general strategy for future transport development

A Geographical Study of Transport in Saudi Arabia with special reference to Road Transport

by

Ass ad Sulaiman Abdo

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CHAPTER ONE

Study Setting

Saudi Arabia occupies an area of about 830,000 square miles or more than nine times the size of Great Britain (Fig 1 1), yet the population of Saudi Arabia is as small as 3,302,330 or less than half the population of London However, there has been no published population census, and the figure mentioned above is for a census taken in 1962-63, but it has not been published because the government believes that the population is about 8,000,000 to 10,000,000

The density of population (Fig 1 2) is closely associated with the rainfall, the underground water, the economic activities and the large sand formations Consequently, the southwestern part of the country has the highest population densities (29 inhabitants per square kilometre) whilst Rub' Al Khali, An Nafud and the Dahna are unpopulated The population live in desert oases that are separated by vast unpopulated expanses In general, settlements are fairly small and the number of those with 20,000 or more inhabitants is only 11 (1962-63) The four largest cities are Riyadh (197,581) Mecca (158,938), Jedda (147,899) and Medina (72,291), which are located on an

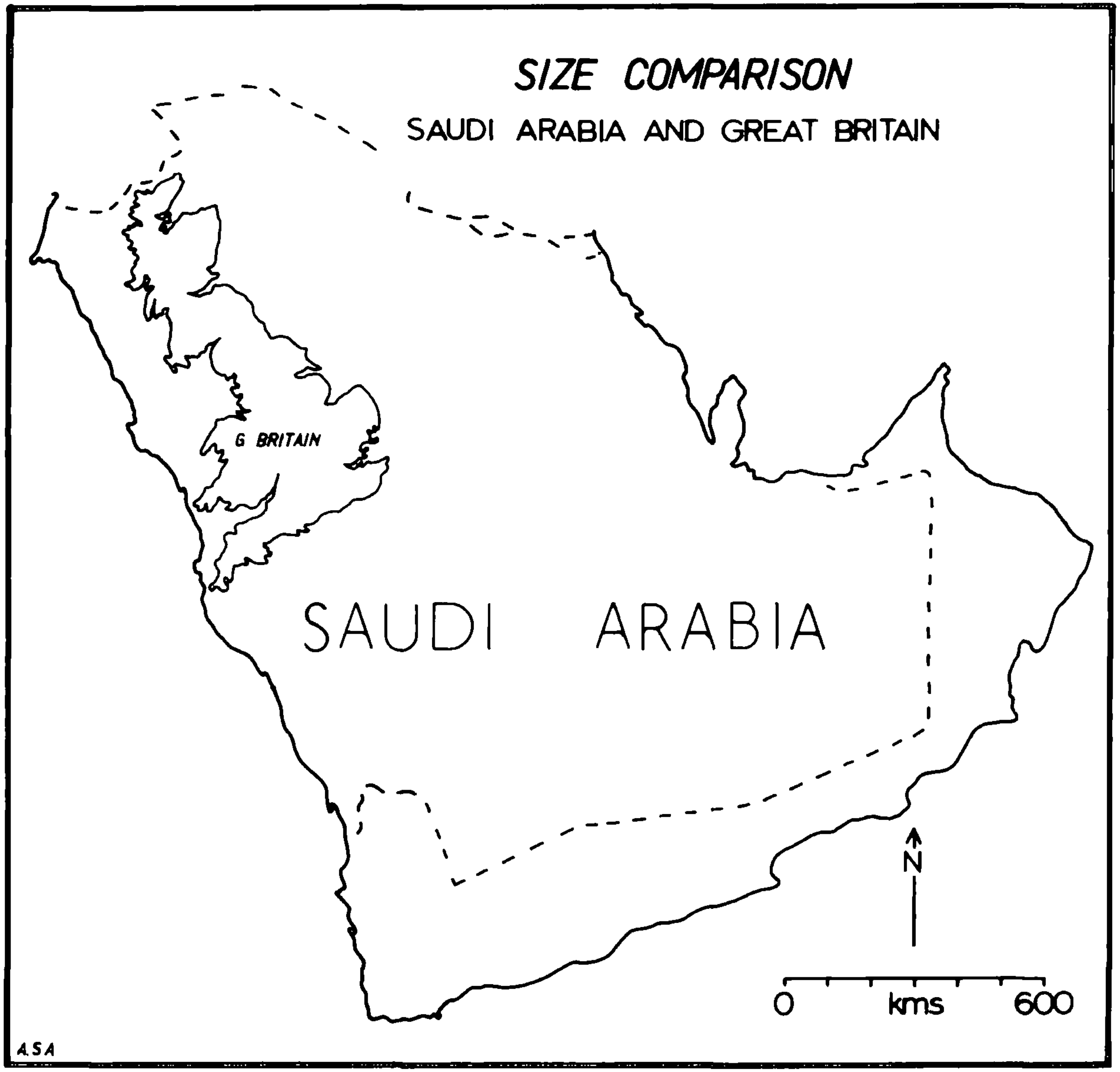

SIZE COMPARISON
SAUDI ARABIA AND GREAT BRITAIN
G BRITAIN
SAUDI ARABIA
N
0
kms
600
A.S.A

Fig I.1

east-west axis including Jedda, Mecca, Taif, Riyadh and Dammam (Fig 1 3)

The hot desert land of Saudi Arabia consists of two main geological structures a) the pre-Cambrian Surat Mountains which extends from north to south along the Red Sea coast, and b) the sedimentary strata which occupy the largest part of the country and which range from Palaeozoic in the west to Miocene and Pliocene in the east The relief is closely associated with the geological structure The Surat Mountains range from 7,000 feet in the north to about 8,000 feet in the south The plateau of Najd extends from the Gulf plain in the east to the Surat Mountains in the west ranging in elevation from 4,000 to 6,000 feet and has a number of escarpments of north south direction facing west Large parts of the country are covered by the sand formations of Rub' Al Khali which occupies an area of 250,000 square miles or about three times the size of Great Britain, An Nafud which covers an area of about 22,000 square miles, and the Dahna which extends for about 800 miles linking An Nafud in the north with Rub'Al Khali in the south The country overlooks the Red Sea to the west with a coast line of 1760 kilometres, and looks on the Arabian Gulf to the east with a coastline

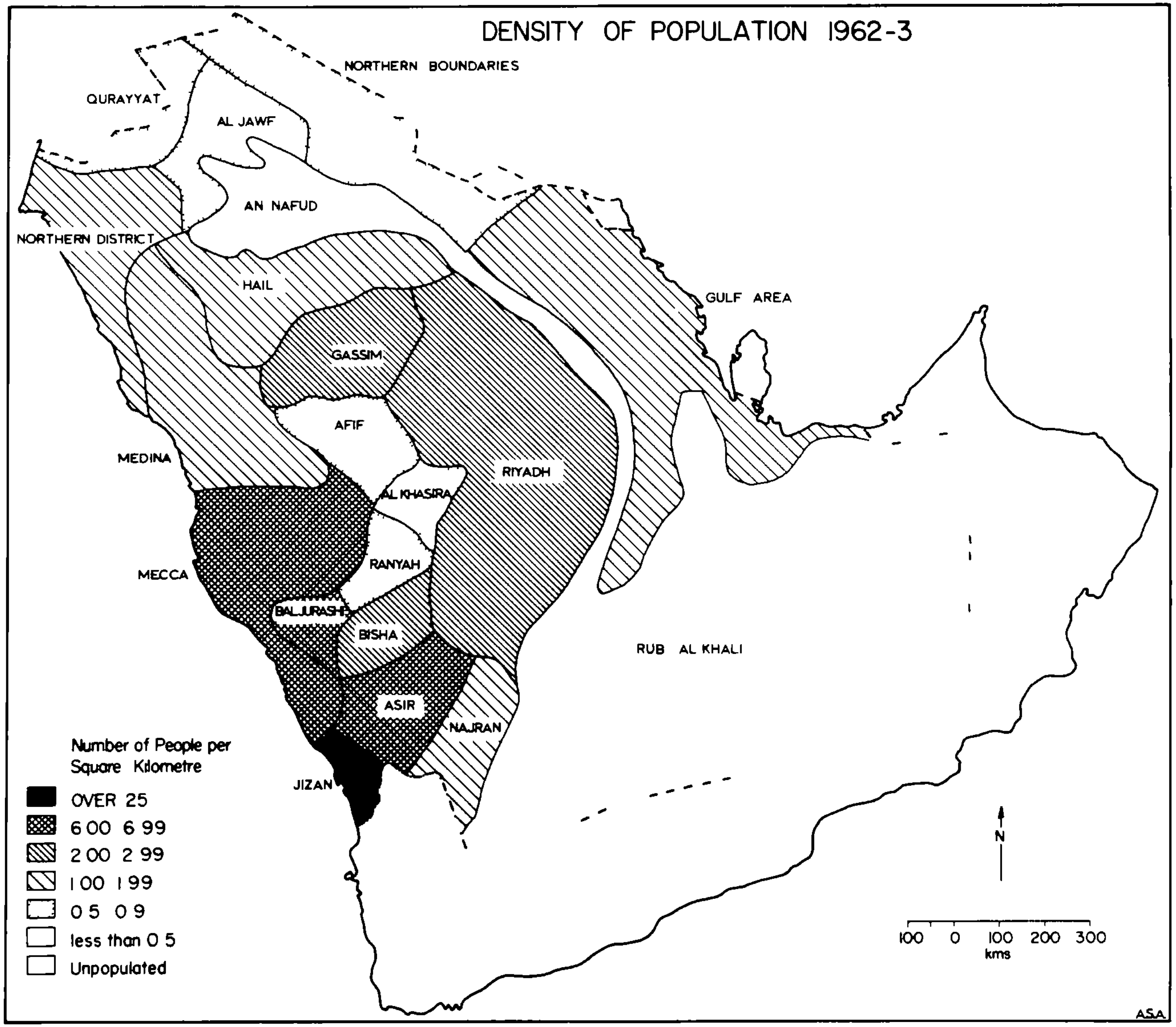
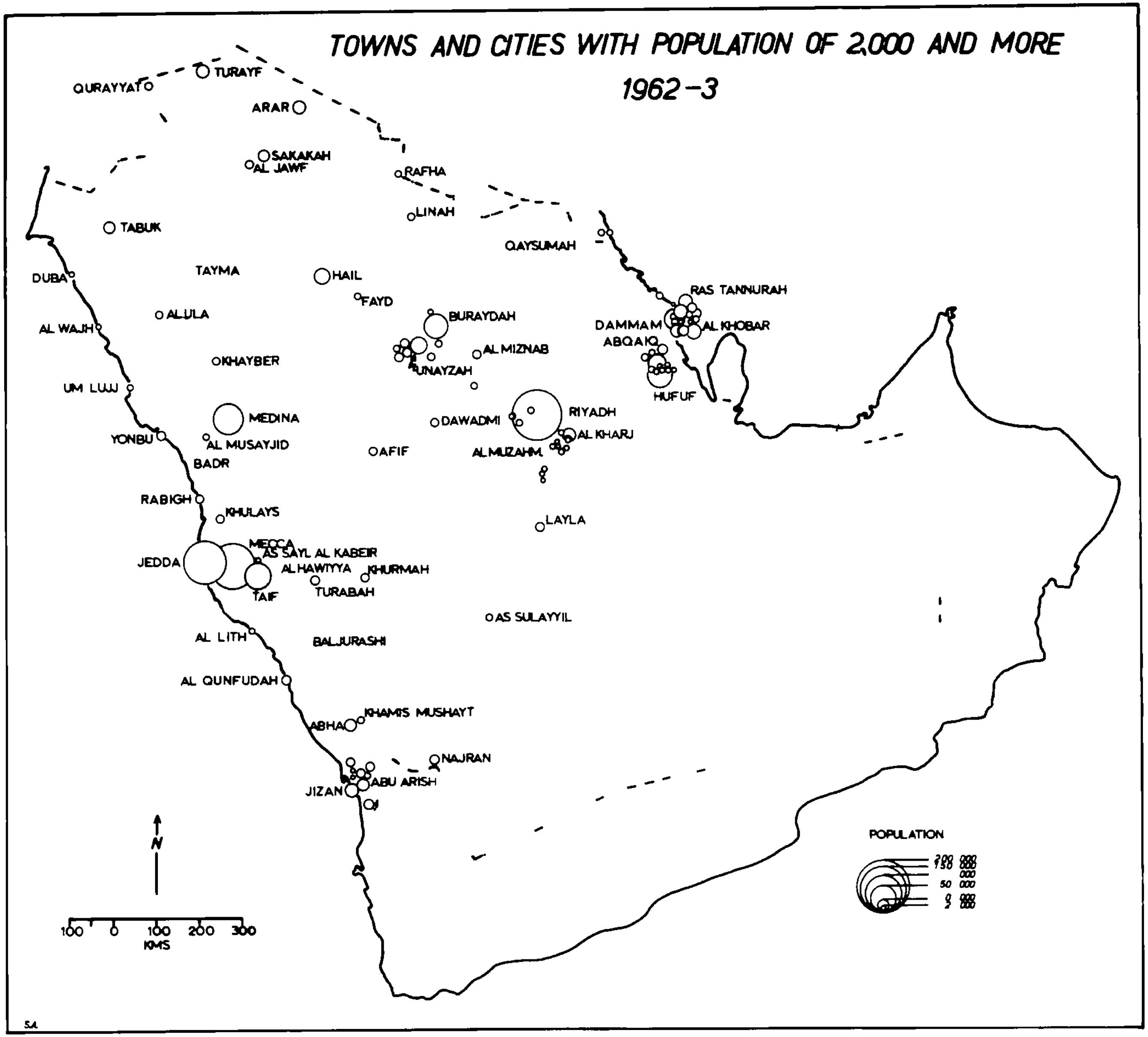

DENSITY OF POPULATION 1962-3
NORTHERN BOUNDARIES
QURAYYAT
AL JAWF
AN NAFUD
NORTHERN DISTRICT
HAIL
GULF AREA
GASSIM
AFIF
MEDINA
RIYADH
AL KHASIRA
MECCA
RANYAH
BALJURASHI
BISHA
RUB AL KHALI
ASIR
NAJRAN
JIZAN
Number of People per Square Kilometre
OVER 25
6 00 6 99
2 00 2 99
1 00 1 99
0 5 0 9
less than 0 5
Unpopulated
N
100 0 100 200 300
kms
ASA

Fig I 2


TOWNS AND CITIES WITH POPULATION OF 2,000 AND MORE
1962-3
QURAYYAT
TURAYF
ARAR
SAKAKAH
AL JAWF
RAFHA
LINAH
QAYSUMAH
TABUK
TAYMA
DUBA
AL WAJH
ALULA
KHAYBER
UM LUJJ
YONBU
MEDINA
AL MUSAYJID
BADR
RABIGH
KHULAYS
HAIL
FAYD
BURAYDAH
UNAYZAH
AL MIZNAB
DAWADMI
AFIF
RIYADH
AL KHARJ
AL MUZAHM
LAYLA
RAS TANNURAH
DAMMAM
AL KHOBAR
ABQAIQ
HUFUF
JEDDA
MECCA
AS SAYL AL KABEIR
AL HAWIYYA
KHURMAH
TAIF
TURABAH
AS SULAYYIL
AL LITH
BALJURASHI
AL QUNFUDAH
KHAMIS MUSHAYT
ABHA
NAJRAN
ABU ARISH
JIZAN
N
100 0 100 200 300
KMS
POPULATION
200 000
150 000
100 000
50 000
10 000
5 000
2 000
S.A.

of 480 kilometres

Economically, the country depends on oil and ranks fifth among the oil producing countries (after U S A , U.S S R , Venezuela and Iran) Over 1,000,000,000 barrels were produced in 1968[1] in the Gulf area Agriculture is limited by climatic conditions and industry (apart from oil) is still in its infancy However, with the oil revenues amounting to 1,177,000,000 SR* (1968/69)[2]. various economic opportunities have been created and the Gross National Product has risen from about 4,253,000,000 SR in 1960 to about 6,543,800,000 SR in 1965 [3] (Unfortunately no later figures are available) The per capita income of about 2,000 SR ($423)[4] is much higher than in most other underdeveloped countries

Transportation Conditions

Saudi Arabia is served by five forms of transport pipelines, rail, road, air and sea transport

Pipelines are limited to the transport of oil and only exist in the eastern and northern parts of the country The main pipeline network is built in the Gulf area by the Arabian-American Oil Company (Aramco) to connect the various oil fields with the oil outlets which are Ras Tannurah, the Tapline and the pipeline to Bahrain The Tapline links the oil area of Saudi Arabia with the eastern coast of the

* £I = IO 75 Saudi Riyals(SR)

Mediterranean

Freight traffic between Saudi Arabia and the outside world depends mainly on sea transport This traffic is of two kinds the outgoing oil export traffic and the incoming import traffic The first type of traffic is handled mainly by Ras Tannurah, Al Khafi and Mena' Saud on the Gulf, with Ras Tannurah being the major oil port The second type of traffic is handled mainly by Jedda on the Red Sea and Dammam on the Gulf The port of Yonbu, on the Red Sea, also deals with import traffic but it ranks far below either Jedda or Dammam (table 1 1) All the remaining ports are little more than small fishing villages, apart from Jizan, which has new port facilities under construction

Saudi Arabia has only one railway, 565 3 Kilometres long, linking Riyadh with Dammam via Al Kharj and Hufuf The railway, which was completed in 1952 played an important role in the development of Riyadh, but in 1961-62 lost a large proportion of traffic to the newly constructed asphalt road (table 1 2) Various attempts have been taken to rescue the declining railway but, as can be seen from table 1 2, their success has been very limited

As a result of the fact that Saudi Arabia has no internal waterways, a very limited coastal transport and

Table 1 1 Freight Traffic of Saudi Ports 1957-1966

(A) Ports for Import Traffic (Goods in tons)

	Jedda	Dammam	Yonbu
1957	663,306	-	-
1958	546,068	-	-
1959	482,189	417,848	10,770
1960	454,772	399,878	17,375
1961	518,221	369,333	29,423
1962	624,220	343,485	38,141
1963	653,600	361,124	33,561
1964	766,572	477,464	-
1965	937,583	758,117	62,026
1966	1,029,322	732,583	151,891

(B) Ports for Oil Export (No of Tankers) 1961-66

	Ras Tannurah	Khafji	Mena Saud
1961	2,142	133	42
1962	2,211	161	102
1963	2,134	146	195
1964	2,154	136	217
1965	2,389	130	207
1966	2,677	261	132

Source Central Department of Statistics, Statistical Yearbook 1967, pp 191-194

Table 1 2 Volume of Traffic on The Dammam - Riyadh Railway, 1957 - 1966

	Freight (000,000 ton/km)	Passenger (000,000 passenger/km)
1957	211 3	42 8
1958	233 0	42 6
1959	202 1	44 1
1960	237 5	25 6
1961	171 6	9 8
1962	115 0	16 4
1963	77 0	24 0
1964	64 4	27 5
1965	55 8	31 9
1966	52 1	33 9

Source Central Department of Statistics, Statistical Yearbook 1967 p 212

only one declining railway, transportation services from one part of the country to another are almost totally dependent on road and air transport The latter is particularly important for passenger transport over long distances, while the former involves both freight and passenger transport

Scope, Objective and Approach

The bulk of this thesis is devoted to roads and road transport as it is the main form of transport between the various parts of the country At the time when railway traffic is declining and road traffic is increasing at a remarkable rate and new asphalt roads are penetrating to one part of the country after another, especial emphasis on roads and road transport is considered to be justifiable The roads studied are those linking the various settlements and not intra-city roads Air transport is also studied because of its importance in passenger transport, as a result of the long distances in Saudi Arabia Other forms of transport are only treated occasionally to elaborate a particular point or to support a certain idea

This study seeks to find out the present conditions of transport in Saudi Arabia, the various factors influencing transport development, and the impact of the improvement of transport on social and economic growth It is hoped that the findings of this study will be of value in transport planning in Saudi Arabia as well as in other underdeveloped countries It is also hoped that this study will contribute to the promotion of the geographical approach to the field of transportation

A geographical approach has been adopted throughout this study Transport development is surveyed and described empirically and when data allows, quantitively In the analysis, conventional as well as statistical and model techniques are employed A computer was used for the calculations of the trend-surface and regressions

Materials and Sources

The data and information on which this study has been made were mainly from four sources

(A) The largest part of the material consisted of unpublished data obtained from the Road Department, the Saudi Arabian Airlines, the Railway, the port of Jedda authority, the port of Dammam authority, Aramco and the Central Planning Organization Unpublished data were also collected from the Traffic Police, Petromin and a number of transportation firms, as well as from the Central Department of Statistics

(B) Data were also collected during two field trips to Saudi Arabia June - October, 1966 and January - May, 1968 During these two field trips it was possible to travel, mainly by road, to large parts of the country taking photographs and studying roads and road transport through personal observations Various discussions were held with those responsible for transport planning as well as with a number of people who were involved in the transportation business in one way or another

A traffic survey was undertaken on the Khurays road to count the number of cars on pleasure trips along this road

Also thirty taxi drivers were interviewed in Riyadh about the following points

1 Type of Car

2 Age of Car

3 Way of buying the car (cash or hire purchase)

4 Ownership of car (owner or employed driver)

5 Insurance (Insured or not)

6 Road Tax (paid or unpaid)

During the second field trip special interest was given to the impact of the new roads on settlements The four Tapline towns, which came to existence as a result of opening the Tapline and the Tapline road, were visited and the growth of those towns was investigated Also the three towns of As Sayl Al Kabeir, As Sayl As Sagheir and Az Zayma, which are located on the old road between Mecca and Taif and which have been declining as a result of the traffic diversion to the new road, were visited and the effect of the traffic diversion was observed and investigated

(C) A large amount of the figures used in this study was taken from the three statistical yearbooks of 1965, 1966 and 1967 These statistical books have been prepared and published by the Central Department of Statistics

(D) The largest literature available is that connected with the ancient history of transport in Arabia As for the present conditions, the literature used consisted of first, the few papers and books published on transport in underdeveloped countries, and second, the literature connected with the general principles of transport from geographic, economic, political, engineering and other points of view

Limitation of the Data

It is generally accepted that data in underdeveloped countries are rare and unreliable In view of this, it can be said that the data obtained for this study are to a large extent ample The reliability, however, cannot be guaranteed though the maximum effort has been done to collect data from the best sources and in the best possible way There are, however, two main weaknesses on the data related to transport in Saudi Arabia (a) the population data are only available for one unpublished census and must have a large marginal error, (b) most of the available data have no regional basis and the rest were collected and published according to an ununified regional classification Consequently, it has been impossible to study the social and economic variations between various parts of the country in a satisfactory way Other weaknesses in the data are mentioned in appropriate places in the text

References

1 Petroleum Press Service, No XXXVI Number 4, April, 1969, p 160

2 M E E D (Middle East Economic Digest), V XII-40, October, 1968, pp 976-977

3 Central Planning Organization, Saudi Arabia, An Economic Report, 1965, p 156

4 Ibid, p 156

CHAPTER TWO

THE HISTORY OF TRANSPORT IN ARABIA

The aim of this chapter is to draw an historical picture of inland transport in Arabia within a geographical frame So far the available literature on the history of transport in Arabia is limited to descriptive or imaginative analysis of the caravan routes before and after Islam There has been nothing written about the early modernisation of transport in Arabia especially the period of the transfer from camel to motor vehicle transport, which forms the last very important turning point in the history of transport in Arabia

In writing this chapter the available literature was used, plus the results of personal investigation carried out by the author in relation to the above mentioned missing link in the history of transport in Saudi Arabia The description of routes is only mentioned briefly and when it is necessary, the main emphasis being the relationships between the conditions and development of transport on the one hand and the historical and geographical environment on the other

The period which this chapter deals with is remarkably long, starting a considerable time before the birth of Christ It is impossible to determine an exact date for its beginning, but we assumed that the first inland transport network was started by the eighth century B C and had developed by the fourth century B C The basis from which this assumption was drawn will be mentioned later in this chapter The end of the period of this historical study will be about the middle of the present century, when motor vehicles replaced camels in transport, and therefore this chapter deals with about twenty eight centuries

This period, though very long, had a common transportation factor, the camel During all those centuries it was the only means of transport, except for the last few decades when automobiles and camels were used side by side The retirement of the camel from playing the major role in transport marked the end of the period we are dealing with

Nevertheless, in spite of this common factor the network and traffic pattern reflected historical events and thus changed from one time to another An attempt is made in this chapter to divide this long period into four phases, each with distinctive patterns of traffic pre-Islamic, Islamic, eighteenth and nineteenth centuries and, finally, the first half of the twentieth century

1 The Pre-Islamic Phase (8th Century B C to 7th Century A D)

"From very early times Arabia has formed a transit area between the Mediterranean countries and the Further East, and its history has to a large extent been determined by the vicissitudes of east-west traffic" [1]

Professor Lewis referred to the start of this phase by saying "from very early times" because no certain date could be given for the beginning of the history of transport in Arabia However, as Egypt, Mesopotamia and Syria on the boundaries of Arabia had civilizations that go back to before the thirty second century B C [2], there can be no doubt that the transit trade across Arabia was started by the eighth century B C the civilizations of the Yemen are known to have flourished[3] and by the fourth century B C the civilization of the Nabataeans in the north-west of Arabia also flourished [4]

In the fourth century B C the international trade reached a very high level [5] The Roman Empire wanted many of the products that the East could offer her silk, amber, spices, gold and especially pepper South Arabian frankincense and myrrh were in considerable demand by the Romans, Egyptians, Syrians and Mesopotamians, and were used by all these nations for embalming, on funeral pyres, as a medicine, at weddings and for religious purposes In addition to its own products South Arabia offered to the civilizations of the Nile, Euphrates and Tigris and to those of the Mediterranean the products of East Africa The geography of the southern end of the Red Sea allowed an early contact between Southwest Arabia and East Africa Moreover, the Persian Gulf and South Arabian coasts were having a fairly developed commercial sea contact with South and Southeast Asia and thus were able to offer Mediterranean people Asian spices and Indian wares and other Asian products which were in demand

The above discussion leads to the fact that the desert of Arabia was placed between regions of surplus production (India and the Far East, East Africa, South Arabia) and regions of high demand (the Mediterranean Region) With this geographical situation along with an excellent means of transport, the camel, the desert of Arabia became an important transit area for international trade

The Pattern of Pre-Islamic Caravan Routes

The pattern of any transport network is governed by its function and the geographical environment The function of the network of this phase was to carry the transit trade between Southwest Arabia, the Persian Gulf coast and the Mediterranean Region, by linking Ma'rib, Gerrha, and Petra Ma'rib was the inland store of South Arabian products, plus the products of East Africa, India and the Far East, which came by sea to the two ports of Aden and Mu'Zi' Gerrha, on the Persian Gulf Coast, was a centre for the trade that came from Persia, and South and South East Asia Petra, in the northwest was a market where goods coming from the east could be sold or exchanged and then re-distributed to different parts of the Mediterranean In view of the above mentioned functions the route network naturally consisted of three main components, Ma'rib-Petra, Ma'rib-Gerrha and Gerrha-Petra (Fig 2 1) The geographical environment was the main factor that determined the locations of these routes, as will be seen below

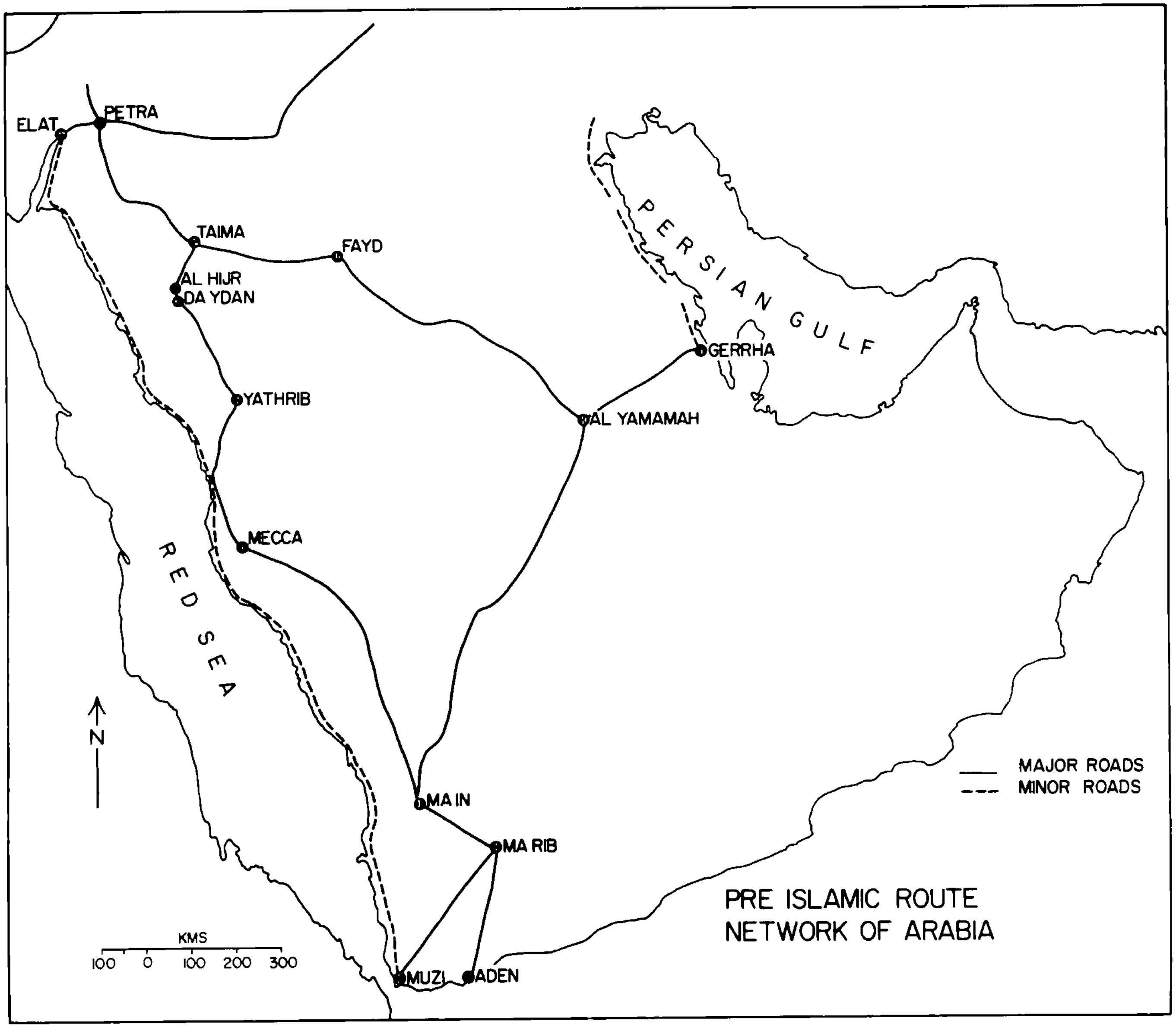

ELAT
PETRA
TAIMA
FAYD
AL HIJR
DA YDAN
YATHRIB
MECCA
AL YAMAMAH
GERRHA
PERSIAN GULF
RED SEA
MA IN
MA RIB
MUZI
ADEN
N
KMS
100 0 100 200 300
MAJOR ROADS
MINOR ROADS
PRE ISLAMIC ROUTE
NETWORK OF ARABIA

Fig 2 T

Ma'rib-Petra Route

The centres which were developed along this route indicate its location, its importance in comparison to the other two trans-Arabian routes, and the impact of its traffic on the life and development of the people of the western part of Arabia

From Ma'rib, which was connected by over~~land~~ caravan routes with the two ports of Aden and Mu'zi', the route struck to the north Both the long, north-south wadis and the narrow coastal plain were the natural ways in this difficult mountainous area The coastal plain was used only by a minor route because of its high temperature, humidity and saline underground water The main route followed the wadis as they not only provided suitable relief features but also formed the places with most underground water supplies and the best agricultural lands Consequentely, the main route was along the eastern edge of the Surat Mountains passing Mecca, Yathrib (Medina) Mada'in-Salih to Petra

The main effect of this route on the population of western Arabia seems to have been at its northern end southern ends and the mid-point At the southern end Ma'rib flourished and developed as a capital of the famous Sabaean state by the eighth century Petra, at the northern end, facing the door to North Africa and

Egypt, became a focal point for the routes coming from the West, North and South Consequently, it became a big market for the trade coming from the East and the West and in the fourth century B C it became known as the capital of the Nabataeans, who had a very famous civilization [6] Halfway between Petra and Ma'rib, some cities such as Mada'in-Salih, Mecca and Yathrib (Medina) flourished and developed along this route

The ancient history of the above mentioned points were not matched by any station on the other two trans-Arabian caravan routes This indicates that the Ma'rib-Petra route was the main link in the network of this period

Ma'rib - Gerrha Route

The location of this route, which ran from Southwest Arabia to the coast of the Persian Gulf, was determined mainly by the huge sands area of Rub' Al Khali and the escarpment of Jabal Tuwayq Soon after leaving Ma'rib the route had to traverse the escarpment of Jabal Tuwayq which forms a sharp cliff about 800 feet high Wisely, the route overcame this physical obstacle by using the As Sulayyil gap cut by Wadi ad Dawasir Confronted by Rub' Al Khali the route bent to the north - northeast striking on a narrow consequent plain between Rub' Al Khali in the east and Jabal Tuwayq in the west At the southern end of Wadi Hanifa in the centre of Arabia the route turned to the east, crossing the Aramah escarpment through a natural gap then crossing the Dahana sand dune before striking the coastal plain to Gerrha

This route contributed to the development of Gerrha, Al Yamamah and other oases in central Arabia Gerrha was described by Strabo as follows

> "From their trafficking both the Sabaeans and Gerrhaeans have become richest of all, and they have a vast equipment of both gold and silver articles, such as couches, tripods and bowls, together with drinking-vessels and very costly houses, for doors and walls and ceilings are variagated with ivory and gold and silver set with precious stones "[7]

Apart from Gerrha the most important developed city on this route was Al Yammamah, almost the halfway station between Gerrha and Ma'rib Having that strategic commercial position and being located in an area famous for its richness in water and agricultural lands, Al Yamamah was a very important oasis Unfortunately, archaeological discoveries in Saudi Arabia have not yet seriously started, and thus very little can be written about Al Yamamah during this phase of history

This shortcoming applies also to the many other oases in the Aflaj plain where future archaeological studies will certainly show that many of these oases had a golden era and a great development during this phase of history due to their location on one of the main caravan transit routes The part of this route south of Al Yamamah upto Wadi ad Dawasir is full of ancient ruins awaiting studies Amir believed that some of the articles found by Philby on this caravan route are of Persian origin and he came to the conclusion that the Persians must have used this route in the sixth and seventh centuries A D in supplying military support to their vassal state of the Yemen [8].

It is interesting to find history repeating itself in the same geographical context in the second half of the 20th Century Just after the Yemen revolution in 1962 Persia supplied the Yemen royalists with military assistance carried by sea from Persia to Dammam and then by lorries along the same ancient route to the Yemen

Gerrha - Petra Route

At Al Yamamah in central Arabia, the Gerrha - Ma'rib and Gerrha - Petra routes divided to the south and north From Al Yamamah the Gerrha - Petra route struck to the northwest along Wadi Hanifa, crossed Al Mahmal, Sudayr and then followed Wadi al Rumah to Al Gasim and then to Ha'il From Ha'il the route went round the huge sand body of An Nafud to Tayma From Tayma one route followed Wadi Al Galiba and Wadi Dubi' to Petra, and another which seems to have been even more important went round An Nafud to Al Jawf and Sakaka and then through Wadi as Sirhan to Syria

The role played by these routes was similar to that of the Gerrha - Ma'rib route The Gerrha - Petra route was used to carry the international trade which came by sea to Gerrha from Persia, India and the Far East to Petra where it could be distributed to Egypt and the Mediterranean Region As incense and myrrh were among the most valuable commodities carried by the Ma'rib - Petra route, Persian Gulf pearls were probably the most valuable commodity carried on the Gerrha - Petra route

Again, unfortunately, it is impossible to find any well founded information about the wealth that was gained from the caravan transit trade by the oases of central Arabia that provided stations along this route

Arab Traders and Cultural Contact

As the topographical factor to a large extent determined the location of the caravan transit routes the climatic and vegetation conditions meant that no means of transport but the camel, and no traders but the Arabs, could carry this trade across the desert of Arabia By being hostile and unbearable to strangers the climatic and vegetational conditions ensured that only the Arabs of Arabia could do the work The Nomadic Arabs of the Peninsula had excellent knowledge of the country, large parts of which no one visited until recently They were familiar with the camel and knew how to treat it They were also familiar with the people among whom they travelled Above all they had a good knowledge of the location of wells and water supplies which were of vital importance to a traveller in a hot waterless desert like that of Arabia Thus, the nature of Arabia made it impossible for the Romans, Syrians, Babylonians or any outsider to work in the transit trade across the desert of Arabia without the mediation of the Arabs as caravaners and as traders

Through the trade the Arabs had the opportunity to contact people of different civilizations and thoughts in the Mediterranean Region and in Asia It was due to this cultural contact which took place as a result of the transit traffic that the Arabs were able to develop their culture and thoughts and make Mecca a religious centre for the Arabs long before Islam It should be mentioned here that the prophet Muhammad himself descended from a famous trading family (Abdul Muttalib) of a famous trading tribe (Quraysh) Furthermore, Muhammad benefited from two trading missions which he made to Syria, in the first one he was a member of a caravan led by his uncle and in the other he was the leader of the trade caravan belonging to Khadija who later became his wife This contact was no doubt among the very important factors which developed the thoughts of Muhammad who became a prophet in his forties

Pattern and Trend of Traffic

The caravan transport across Arabia without doubt consisted mainly of freight Passenger transport was very limited if not completely absent

However, it has always been thought that the trade between east and west was not balanced [9] While the

Mediterranean region was mainly the market, South Arabia, South and South East Asia were the points of supply Accordingly, the transit traffic going to Petra was greater than the traffic coming from it, as far as the caravan traffic across Arabia is concerned, and it is likely that some of the camels had to return unloaded on their journey from Petra to both Ma'rib and Gerrha This must have affected the rates of transport

However, the volume of traffic on each of the three main routes of the network seems to have been unequal too Both geographical and historical factors tend to indicate that the traffic on the Ma'rib - Petra route was greater than on either the Ma'rib - Gerrha or the Gerrha - Petra route This conclusion was mainly drawn from the high level of development reached by Ma'rib, Petra and other centres along the Ma'rib - Petra Route No such clear evidence has been found to indicate which of the other two roads had the greater traffic

Internal domestic traffic between different parts of Arabia, is not known during this phase of history Nevertheless, domestic trade and traffic must have flourished due to the development of the oases and cities on the major routes Exchanges between nomads and the agricultural peoples of the oases must have been stimulated

It is needless to conclude that consumption of imported goods and wares was stimulated by the great wealth that was gained by the Arab traders and caravaners and by dwellers of the stations who offered their services to the caravan transit trade

In general, the transit traffic should have reflected the changeable political situation during this phase During peace time between the big powers (the Romans and the Persians) and inside Arabia, traffic across Arabia would have been encouraged, while during wars, international disputes or internal disturbances the transit traffic would have declined Consequently, the fourth century B C must have had the highest traffic peak of this phase

The third century A D saw the start of the end of the transit trade, largely because of the unfavourable conditions which prevailed after the appearance of the Sassanid Empire in Persia in 224 A D and its confrontation with the Roman Empire [10] This confrontation not only turned the Syrian desert into a battle-ground but also caused a decline in the trade across the desert of Arabia as both the Sassanids and the Romans were engaged in incessant wars and paid less attention to commerce This trend of decline continued and cities and civilizations which were developed along the caravan routes started to decline too By the sixth century A D the Yemen fell under foreign rule, Petra and other places lost their glory The result was a return to nomadism and migration to the Fertile Crescent

This deterioration brought the first phase of the history of transport in Arabia to a close In the seventh century this phase was completely brought to its end by the appearance of Islam from Mecca and Medina and the collapse of the big powers of the Romans and the Persians

2 <u>The Islamic Phase (7th to 17th Century)</u>

Never in the history of transport in Arabia has there been a factor more important than Islam In its early days Islam changed the pattern of traffic completely from what it used to be in Pre-Islamic times Since those days Islam has remained a significant factor influencing transport

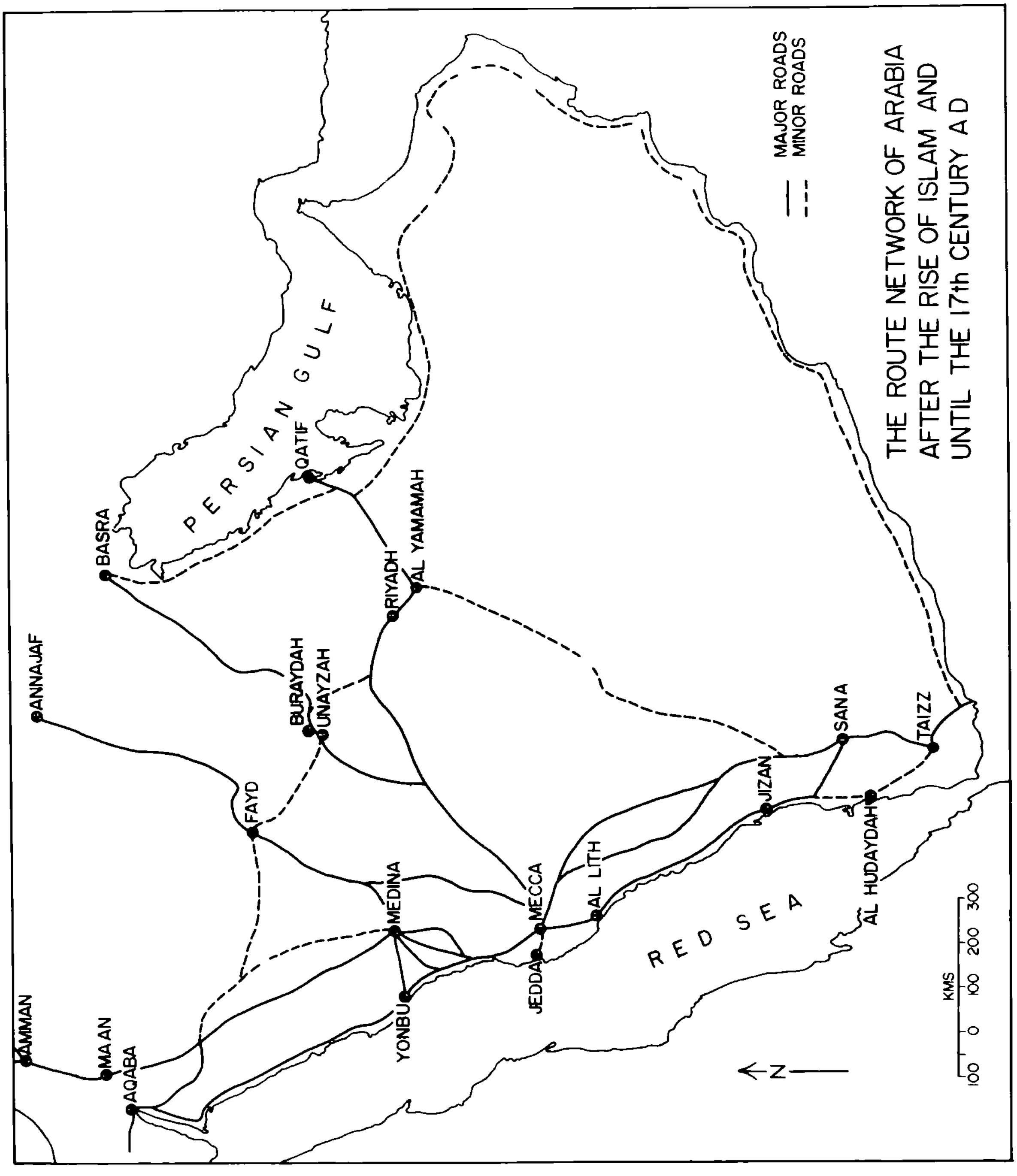
The rise of Islam meant the closure of Arabia to the international transit trade for Arabia acquired a new, strong and ambitious religion, which spread very fast to most of the civilized world But by making the pilgrimage to Mecca, one of the five pillars required of every Muslim, the rise of Islam created a new pattern of traffic and a new route of network That is the Hajj traffic and the

Hajj network

The Hajj route network

The route network of this phase may logically be called the Hajj route network since seven of its eight routes were created by pilgrim traffic The only exception was the Aflaj route which had no importance at all to the pilgrim Pilgrims, of course, used the ancient routes for their journey to Mecca wherever this was possible (Fig 2 2) Thus four of the seven Hajj routes were pre-Islamic caravan transit routes, these were the Syrian-Egyptian Hajj route, the Egyptian-Syrian Hajj route, the Inland Yemeni Hajj route and the Coastal Yemeni Hajj route, all of which were exactly located on the inland and coastal routes between Ma'rib and Petra in the pre-Islamic phase The other three Hajj routes were entirely created by the pilgrim traffic, these were An Najaf - Mecca Hajj route, the Basra - Mecca Hajj route and the Omani Hajj route

The route network of this phase was different from that of pre-Islamic times Now all the routes led to Mecca Mecca and Medina which were little more than two halfway stations on the ancient Ma'rib-Petra route now formed the main focal points of the Hajj network, Mecca was far more important than Medina since the function



THE ROUTE NETWORK OF ARABIA AFTER THE RISE OF ISLAM AND UNTIL THE 17th CENTURY A D of the routes was to link Mecca with the rest of the Muslim world (Fig 2 2)

The Egyptian - Syrian Hajj Route (Tareeq Al Hajj Al Masri-ashShami)

This route was used by pilgrims coming from or via Cairo and also from Syria The pilgrims from Cairo came to Al Gulzam (Suez) to Elat at the northern end of the Red Sea where they met pilgrims from Syria They then took the route which ran along the narrow coastal plain between the Red Sea and the Surat Mountains Among the most important stations along the route were Duba and Al Wajh [11]

The Syrian-Egyptian Hajj Route (Tareeq Al Hajj ash Shami - Al Masri)

This route was mainly used by pilgrims from Syria and those who came from other countries and gathered at Damascus for their trip to Mecca as well as by pilgrims from Egypt and North Africa [12] It ran along on the northern half of the ancient Ma'rib - Gerrha route, a line which was used at the beginning of the present century by the Hijaz railway Among the main stations on this route were Ma'an, Tabuk, and Al Ula

The an Najaf - Mecca Route (Darb Zobayda Route) [13]

This route is famous by the name of Darb Zobyada, for

Zobayda, the wife of the Abbasiyan Khalifa Harun Al Rashid (786-809), improved it in 800 A D by means of a number of stonelined wells and water reservoirs along the route [14] Thus it became the first route in Arabia to have a major improvement by a central government, some of these wells and reservoirs are still in existence now

From an Najaf, Darb Zobayda went southward over the Higra Plateau for about two hundred miles before entering the huge sand dunes of An Nafud The route crossed An Nafud at its eastern end where it was relatively narrow and not continuous but divided into many 'Irqs separated by sandless areas (the 'Irq according to Arabian terminology which is different from North African terminology is a long linear sand ridge) After crossing An Nafud the route went to Fayd, east of Jabal Salma, and the continued southwards to Nugrah At Nugrah a route went westward to Medina while the main route ran southward to Mecca

The Basra - Mecca Route (Tareeq Basra - Mecca)[15]

This route ran from Basra through the great Wadi of Al Batin and then across the Dahana sand belt to the oases of Al Gassim From Al Gassim the route followed Wadi Al Rumah for some distance before turning to the southwest

The route passed via Afif and Al Dafina and then went to Mecca

The Bahrain Hajj Route (Tareeq Al Hajj Al Omani)[16]

From the Persian Gulf Coast there was a Hajj route striking westward, crossing the Dahna sand belt to Al Yamamah From Al Yamamah the route continued west to Mecca [17]

The Inland Yemeni Hajj Route (Tareeq Al Hajj Al Yemeni)[17]

This route ran exactly on the southern half of the Ma'rib - Gerrha route Among the important stations along this route were Sa'dah, Bishah and Turabah All the way the route ran through long north-south wadis in the eastern edge of the Surat Mountains

The Coastal Yemeni Hajj Route (Tareeq Al Hajj Al Yemeni)[18]

The route left San'a to the west and then started along the coastal plain known as Tihamat Ash Sham to the north via Jizan, Al Gunfidhah and Al Lith and then to Mecca

Non-Pilgrimage Route (The Aflaj Route)[19]

The only trans-Arabian route in this phase which had no pilgrim traffic was the Aflaj route which ran from the Yemen in the southwest corner to Wadi ad Dawasir crossing the Tuwayq escarpment and striking along the Aflaj subsequent plain to Al Yamamah This, as was mentioned above, was a part of the ancient Ma'rib - Gerrha route

In addition to the above eight main routes there was a route from Oman which ran northwest to join the Bahrain Hajj route and a route from this point struck north to Basra [20] There was also another route from Oman which ran along the coast of South Arabia and then joined the Yemeni Hajj route [21] The only other route which is worth mentioning here is the route which ran from Al Yamamah[22] north towards Basra and joined the Basra - Mecca route, which was described above

The above description of routes was mainly based on the work of Arab Geographers of the Middle Ages But, while our description is meant to be very brief and only to draw the general pattern of the route network of this phase, the Arab Geographers' work was based on personal travel and included lists with all the stations on the routes and in most cases the distances between them The works of some Arab geographers are given for each route in the reference list, as well as some general works that included most of the routes [23]

The Pattern of Hajj Traffic

The effect of the rise of Islam on the pattern of traffic was by no means less significant than that on the network In all respects the pattern of the Hajj traffic was different from that of the pre-Islamic traffic

In the previous phase trade across Arabia consisted of goods and materials Now the traffic was of pilgrims who came from all over the Muslim World to Mecca and then returned to their countries when the Hajj was over

Apart from changing the nature of traffic, Islam increased the volume of traffic, increased the number of routes across Arabia and the number and size of the settlements along the Hajj routes

It is impossible to estimate the volume of traffic on each pilgrimage route, but a look at the countries feeding each route may give a clue as to the more important routes The Egyptian, Syrian and Darb Zobayda routes would therefore probably have had more traffic than other routes The Egyptian route was used by pilgrims from North Africa and Egypt, the Syrian route by pilgrims from Syria and Turkey and the Darb Zobayda route by pilgrims from Iraq, Persia and Central Asia The Yemeni Hajj route would come next if not equal in the volume of traffic as it was fed by pilgrims from the Yemen, South Arabia and East Africa The route with the least traffic was the Omani Hajj route which was used by pilgrims from Oman, and the Persian Gulf area

Because of the hostile nature of the desert and the distances involved, camel caravan traffic was the only type of traffic on the Hajj routes, except on the Yemeni Inland Hajj route, where the climate, vegetation conditions and the density and distribution of population in the area between the Yemen and Mecca allowed a number of pilgrims mostly Africans, to make their trip travelling on foot This type of traffic lasted until only a few years ago

One of the most significant impacts of the new pattern of traffic was the development of the camel transport itself Now that the main function of transport was no longer freight but passenger traffic, the caravaners wanted to carry as many passengers on as few camels as possible Consequently they invented a cabinet, known as "shugdof" which they put on the back of the camel Among other advantages of using the "shugdof", it protected passengers from the hot sun and wind and kept the women pilgrims secluded

The Hajj traffic, however, though very heavy, took place only during a certain time of the year, which might be very hot, very cold or moderate Consequently, the Hajj traffic should have been less in those years in which the Hajj took place during a hot summer and vice-versa Further, it is a one-way traffic at any one time, before the

Hajj all the pilgrims travel to Mecca, while afterwards all pilgrims travel from Mecca to their countries

Since the rise of Islam the Hajj traffic has been reflecting the historical events which occurred in the Muslim World in general and inside Arabia in particular General decline in the overall traffic took place at times of wars and disputes while general increase occurred in times of peace and strong central government A general decline must have occurred at the end of the ninth century at the time of the breakdown of the Muslim empire Later from the eleventh until the thirteenth century there was the struggle against Crusaders occupation of the Levant and Jerusalem This was followed by another struggle against a barbarian incursion into Persia (1220-1227) and Iraq (1258) by the Mongols [24] Syria a century later was also devastated by the Mongols This series of wars must have led to a radical decline in the number of pilgrims coming from Persia, Iraq, Turkey and Syria

Following the breakdown of the Muslim empire the interior of Arabia returned to tribal unrest Nomadic attacks on pilgrim caravans prevailed especially when there was a weak central government in Damascus or Baghdad This disunity and insecurity was greatest in the sixteenth century when Al Hijaz and Al Hasa were incorporated into the Ottoman empire, while central Arabia was left to local leaders, and in the eighteenth and nineteenth centuries when there were wars between The house of Saud, leading the Wahhabis and other leaders in and around Arabia [25] However, what may be bad for pilgrim traffic on a certain route may be good for the pilgrim traffic on other routes Syrian and Egyptian Hajj routes and to a certain extent the Yemeni Hajj routes no doubt benefited from the annexation of Al Hijaz with the Ottoman empire as pilgrims using these routes became encouraged by the fact that they now made all their trips inside Ottoman territory The case is different from any of the other Hajj routes

Very little can be said about the domestic traffic during this phase, although there is no doubt that for the first time in the history of Arabia there was heavy regional traffic between the two holy cities in the Hijaz region Domestic freight traffic was also no doubt stimulated by the economic activities and prosperity which Islam had brought to the holy cities, the Hijaz region and Arabia in general

<u>The Hajj Traffic Impact on the Growth of Desert Oases</u>

The change from freight to passenger traffic must have had a great impact on the oases of central Arabia Stations along the routes were now needed at shorter distances than those on the route network of the previous phase Passengers needed rest houses providing, food and water and other needs while travelling in an unfamiliar hostile desert Hence, the number and size of stations along routes was greater during this phase than during the previous phase

Obviously, certain stations tended to be more important for the Hajj traffic than other stations Keeping in mind the factors that may lead to the growth of a desert oasis, observation of the location of stations along the routes of this phase and the previous one leads to the conclusion that halfway stations tend to be more important for the traffic across the desert and thus grow faster than other stations

Putting the strong example of Palmyr in the Syrian desert aside, and looking only at the routes across Arabia we find that Mecca was a halfway station on Ma'rib - Petra route, the most important route of the pre-Islamic phase Mecca was developed to be a major trading market and a religious centre and then the source of a new religion that changed the face of the world It is rather difficult to identify a halfway station on the other two pre-Islamic routes though Al Yamamah may be considered the halfway station of both, and was no doubt the largest oasis in central Arabia

Coming to the Hajj network, we find Fayd on Darb Zobayda route, and again Al Yamamah on the Omani Hajj route, both of which had more importance than any other station on those two routes

For the Yemeni Hajj routes, particularly on the inland route, the halfway station theory does not apply but this is because of the different geographical conditions The area between the Yemen and Mecca has a moderate climate and vegetation conditions with high density of population and a large number of settlements, none of which were as important for pilgrims travelling along this route as were Fayd or Al Yamamah for pilgrims travelling along the Darb Zobada route or the Omani Hajj route

So, the situation was different with stations such as Fayd and Al Yamamah on routes that ran across vast hot desert with long distances between each settlement For caravaners coming from An Najaf, Fayd was the station that came after crossing An Nafud which formed the most difficult physical problem in the route network of this phase For pilgrims coming from Mecca, Fayd came just before crossing An Nafud In both directions travellers needed a lot of rest and a plentiful supply of food and water The same applies to Al Yamamah which came after crossing the Dahana for pilgrims going to Mecca and before crossing the Dahana for pilgrims coming from Mecca

However, a comparison between Al Yamamah and Fayd shows that the latter was more important for the travellers on the Darb Zobayda route than the former for the travellers on the Omani Hajj route A comparison between An Nafud and the Dahana as two physical obstacles will justify this, needless to mention the traffic and the distance on the first route were more than those on the second one

The development of sea transport, which had been marked by the discovery of the Cape of Good Hope in the fifteenth century and the cutting of the Suez Canal in the nineteenth century together with the great technical development in shipping industry, led to a major decline in the trans-Arabian Hajj transport The Red Sea now changed from a land locked sea to the most important and busiest waterway in international trade Hence, pilgrim traffic to Arabian ports on the Red Sea was encouraged Most pilgrims now found it safer, and probably less expensive, to come by sea to Jedda or Yonbu, or any other port, and then travel a short distance to Mecca and Medina, rather than travel across Arabia

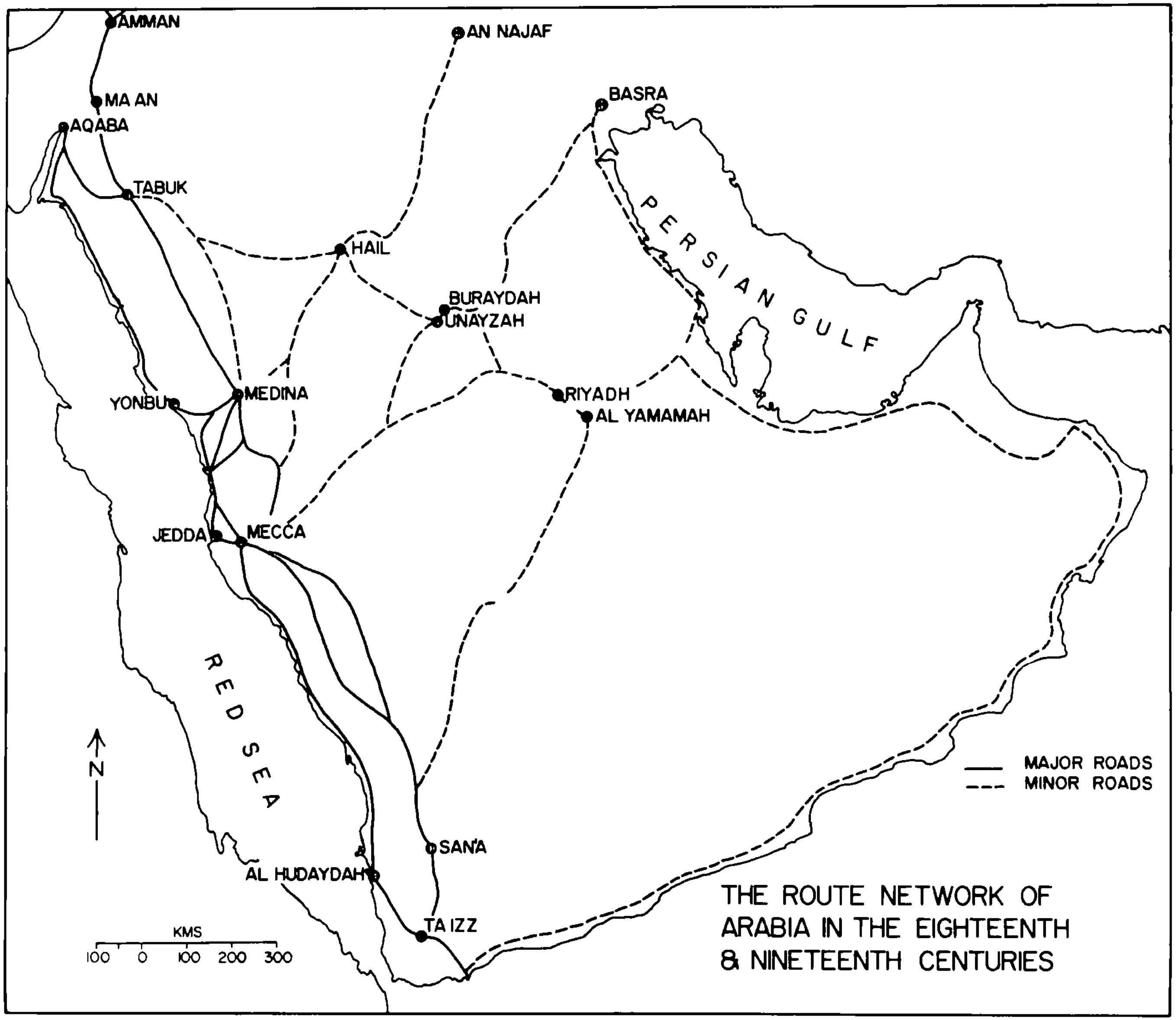
The development of sea transport together with the insecurity in the interior of Arabia changed the patterns of traffic and network of the eighteenth and nineteenth centuries

3 <u>The Eighteenth and Nineteenth Century Phase</u>

The pattern of traffic in this phase was a result of the fear of brigandage which led to the diversion of pilgrims from Darb Zobayda and Basra - Mecca Hajj routes to the Syrian and Egyptian Hajj routes Pilgrims from Oman and the Persian Gulf preferred to go around North Arabia to Damascus and then take the Syrian Hajj Route, or go around South Arabia to San'a and then take the Yemeni Hajj routes [26]

Further, all routes seem to have lost traffic to sea transport Some of the pilgrims from East Africa, South and Southeast Asia preferred to come by sea to one of the ports near the holy places The same was true of some of the pilgrims from North Africa, Egypt and the Mediterranean Region

Fortunately, some figures showing this swing from trans-Arabia Hajj transport to sea transport are available The number of pilgrims arriving by sea at Jedda was



THE ROUTE NETWORK OF ARABIA IN THE EIGHTEENTH & NINETEENTH CENTURIES

Fig 23

62,000 in 1896 The total number arriving in Mecca is not known for that year but in 1885 it was 80,000 [27] This indicates the great change especially if we take into account that apart from Jedda some pilgrims came via Yonbu, Al Lith and Al Gunfidhah [28]

Although the swing from overland to sea Hajj transport caused a considerable decline in trans-Arabian traffic it created heavy regional traffic in Al Hajiz The traffic over the short distances between Jedda and Mecca, Yonbu and Medina, and Medina and Mecca increased remarkably

Obviously, the change in the pattern of traffic changed the shape of the route network (Fig 2 3) The long trans-Arabian routes, though still existing, became minor routes during this phase This applies more particularly to the routes that run across central Arabia the Omani Hajj route, the Basra-Mecca Hajj route and to a certain extent the Darb Zobayda route

4 The Beginning of Modernization (the First Half of the Twentieth Century)

For better understanding of the modernization of transport in Arabia, and as a base for the study made in a later chapter on the ~~Taaffe model~~ Ideal Typical Sequence Model on transport network development in underdeveloped countries, we start this section by a brief survey of transport development in the Arab Middle Eastern countries

As in all underdeveloped countries, modernization of transport in the Arab Middle Eastern Countries was carried out or greatly influenced by one or another strong foreign power The date and the locations of first railway lines in the Middle East can only be understood within this context

The geographical situation, again, proved to be the most significant factor in this period of transfer to modern means of transport Being on the way to India and the Far East the western powers carried out the construction of railways in the Middle East only a short time after the construction of the first railway line in Great Britain In 1837 by improving the road between Cairo and Suez the British found that the journey from London to Bombay which took four months by sailing ships around the Cape of Good Hope was reduced to only forty days by the road through Egypt [29] It was the significance of the geographical situation which partly decided the date and location of the first roads and railroads constructed in the Middle East in the nineteenth century Space does not allow any further emphasis of this very important factor which should be kept in mind while reading the following pages.

Until the end of the eighteenth century, however, transport in all the Arab Middle Eastern countries was primitive, animals, mainly camels, being the best means of transport The situation at this time was described by Lewis as follows

> "In 1800 there was hardly a road or a wheeled vehicle in the Arab Orient, transport being mainly by pack and riding animals or by inland waterways "[30]

This situation started to change at the middle of the same century The real modernization of transport in the Middle East was started in 1851 - 1856 by the construction of the first railroad in the area from Alexandria to Cairo, and then was taken further after the first world war when the use of motor vehicles began The improvement of roads in some countries which came before the era of railway construction did not modernize transport but improved it

The date of the construction of the first railway line in the Middle East can be better appreciated when compared with the history of railway construction in Europe The Stockton - Darlington line was opened only 31 years earlier However, if, as Savage[31] suggested, the construction of the Liverpool - Manchester line which was built in 1830 was considered the start of the railway era, then the railway construction in the Middle East comes only 26 years later

Early Railway Construction in the Arab Middle East

The construction of the Cairo - Alexandria line was begun in 1851, the section from Cairo to Kafr Azzayyat was opened in 1853, and the whole line was opened in 1856 Only two years later (1858) another railway line was built from Cairo to Suez The construction of these two lines was to link the Red Sea and the Mediterranean by a modern means of transport to facilitate the communications between Great Britain and India However, railway construction continued in Egypt and by 1870 the length of the railway network reached 1880 Kilometres [32]

Between 1875 - 1897 the first railway in the Sudan was constructed This was built along the Nile between Wadi Halfa and Kerma Another line was built across the Nuba desert to Atbara in 1897 - 1898 and was extended in 1899 to Hafaya on the opposite side of Khartoum [33]

Greater Syria (Syria, Lebanon, Jordan and Palestine) was the third country to have railways At the end of the nineteenth century (1889) a railway was built between

Jaffa and Jerusalem to serve Christian and Jewish pilgrims and tourists In 1891 - 1895 the railway between Beirut and Damascus was built The extention of railways to Hama took place in 1901 - 1902, and the penetration to Aleppo came shortly afterwards in 1906 [34]

The beginning of the twentieth century saw the construction of the Hijaz Railway between 1900 - 1908 and the first section of Berlin - Baghdad Railway which was built between Baghdad and Samarra' and opened in 1914

The first world war had both positive and negative effects on railway penetration in the Arab Middle East Among the positive results were the construction of the Alexandretta - Aleppo line and the linkage of the Syrian and Egyptian railway networks, both built during the war for military purposes The negative result of the war was the destruction of the Hijaz Railway by the Arabs who were revolting against the Turks

Early use of Motor Vehicles in the Arab Middle East

Unlike the history of early railway construction information on early use of motor vehicles and road construction is very limited Nevertheless, the little information available is very valuable to this study as it throws a light on the second major step in the modernization of transport in the Middle East

The use of motor vehicles came half a century after railway development, and in another half a century it became more important than railway transport The use of motor vehicles and the construction of roads suitable to handle motor traffic came almost at the same time The spread in the use of motor vehicles made the construction of more roads a necessity

The date of the first use of automobiles in the Middle East can be more meaningful when compared with the general history of motor vehicle development in the more developed countries The first internal combustion engine was invented in 1860 by Jean Lenoir of Paris After being improved it came into fairly common use in small manufacturing establishments by the 1870's and 1880's [35] By about 1900 the experiments in motor vehicle construction had reached a high level, which allowed the spread of motor vehicle use and highway construction at a very fast rate The total number of motor vehicles in use in Great Britain and the United States were as follows

Table No 2 1 Early Spread of Motor Vehicle Use in Great Britain & U S.A

Year	Great Britain	Year	United States
1904	17,810	1900	13,824
1910	107,635	1910	468,497
1914	265,182	1915	2,445,666

~~Source.~~ Savage, C I ; The Economic History of Transport, 1966 p 93

Like railways, motor vehicles seem to have been used in Egypt before any other part of the Middle East There is no clear proof of this, but the establishment of a road department in 1913 to "improve the roads to suit motor vehicle transport"[36] and the establishment of the Ministry of Transport in 1919 would confirm the statement There is no doubt however that motor vehicles were used in Egypt by the first world war [37] By 1949 the number of motor vehicles in Egypt reached 66,500, and motor cycles 6230

Table No 2 2 Motor Vehicle Stock in Egypt 1949

Private Cars	42,747
Taxis	8,880
Lorries	11,757
Buses	3,124
Total	66,508
Motor Cycles	6,230
G Total	72,738

Source Assayyad, M M : Transport in the Arab Countries 1956 p 52

Iraq had less than a dozen motor vehicles in 1914 [38] This number was increased during and after the first World War, though it was said that most of the vehicles used in the inter-war period were military cars

In Greater Syria the first motor car in the interior reached Aleppo from Alexandretta in 1909 [39] The real advance in the use of motor vehicles came in the 1920's when motor traffic absorbed most of the transport activities

By 1939 the number of buses, cars and lorries reached 20,000

Table No 2 3 Motor Vehicle Stock in Greater Syria, 1939

(Buses, Cars and Lorries)

Palestine	9,000
Lebanon	6,300
Syria	4,100
Transjordan	600
Total	20,000

Source Issawi, C , The Economic History of the Middle East 1800-1914 1966, p 275

Although road construction came shortly after the use of motor vehicles, road improvements came some time before that to facilitate wheeled traffic of carriages We here mention the situation of roads in Egypt and Syria in the 19th Century as a proof of this statement During Muhammad Ali's reign the roads in Egypt were secured against brigandage, the road between Cairo and Suez was levelled to suit wheeled traffic, stations were built at 10 mile intervals along it, and horse drawn carriages were used The improvement of this road was aimed at easing and encouraging the traffic between Europe and India and the Far East It was stated that the improvement of this route raised the transit traffic of passengers from 275 in 1840 to 2300 in 1845 to over 3,000 in 1846 The Cairo - Suez road was paved with stones between 1849 and 1854 The results of the improvement of the Cairo - Suez road brought the improvement of the complementary road from Cairo to Alexandria in 1854 - 1863 In 1879 - 1892 a decree was issued by Tawfiq for the construction of country roads to facilitate movement between towns and villages [40]

In Syria the road between Jaffa and Jerusalem was built in 1869 In the early 1900's there were many improved roads in Greater Syria, though neglect meant wheeled traffic was able to pass on very few of them The best arteries were the Aleppo - Alexandretta road and the Tripoli - Homs road [41]

As on the early use of motor vehicles, the information on the early regular automobile services in the Middle East is unsatisfactory

However, the available literature indicates that just after the first war a service was started between Haifa and Beirut by Nairn, a man with great transport enterprise [42] In 1923 a regular weekly service was started by Nairn Transport Company between Baghdad and Damascus following a request from the Iraq Post Office [43] The service was scheduled to connect with the weekly Anglo-Indian mail to and from London An irregular extra trip a week was provided for passengers when necessary During its first year the Nairn Transport Company carried 1476 passengers and 35,000 lbs between Damascus and Baghdad Baghdad became within nine days from London and two days from Port Said [44]

Another company under the name of Eastern Transport Company started two services a week between Beirut, Baghdad and Tehran via Palmyra, but due to financial difficulties it was taken over by the Nairn Transport Company in 1926 [45] The service across the Syrian desert has been very successful and improved by using more modern automobiles [46]

The Beginning of Transport Modernisation in Saudi Arabia

Modernisation of transport in Saudi Arabia came fifty years after Egypt, forty five years after Syria but about six years before Iraq In Arabia modernization started by the construction of the Hijaz Railway in

1900 - 1908

The idea of constructing a railway in Arabia was declared by Sultan Abdul Hamid, on May 2nd, 1900 when he ordered the construction of a railway between Damascus and the holy cities in Al Hijaz In autumn of the same year the work started by a unit comprising of two battalions [47] Finance came from Turkey as well as from individual Muslims in all Muslim countries

The inauguration of the section from Damascus to Ma'an took place on September 1st, 1964, the sedtion from Damascus to Al Ula was opened on September 1st, 1907, and the whole line from Damascus to Medina was inaugurated on September 1st, 1908 In 1911 engineers were carrying out surveys in order to extend the Hijaz railway to Mecca [47] But, unfortunately, the holy 1,465 Km railway was destroyed at many points during the first world war by the Arabs under the command of T E Lawrence in revolt against Turkey The Arabian part of the line was completely out of use by 1920, but the Syrian part is still operating today

From Camel to Motor Transport

The early use of automobiles in Egypt, Syria and Iraq took place in the 1900's and the 1910's In all these countries, except probably in the case of Iraq, the use of motor vehicles came as a second step in the modernisation of transport This was not exactly the case in Arabia, although it is rather similar, the railway which penetrated Arabia did not live long and modernisation of inland transport was developed through the use of motor vehicles

The first use of motor vehicles in what is now Saudi Arabia occurred about the time of the first world war The Turkish military ruler of Medina, Fakhri Basha, had a private car in the 1910-16 Also the Sharif Hussain, ruler of Al Hijaz who was living in Mecca had a car at the time of the first world war The Sharif used his car in his travel between Jedda and Mecca [48]

Thus, the Hijaz, being a part of the Turkish Empire and the region that contains the two holy cities of Mecca and Medina, had first a railway then motor vehicles before any other part of what is now Saudi Arabia Information on the first use of automobiles in other regions is lacking, but it seems that the first use of automobiles in the Gulf area was in 1933 In September of that year the oil geologists of Aramco who went from Bahrain to Al Jubayl used two government cars and a truck which was brought from Jedda Motor vehicles were also used in Riyadh, in the centre of Arabia in the early 1930's or late in the 1920's as it was the capital of Ibn Saud The south of Saudi Arabia was the last part of the country to know the use of motor vehicles

The regional spread of the use of motor vehicles from Al Hijaz Region in 1910-16 to the Gulf area and Central Arabia in the 1930^{s}-40^{s} and to the other parts later was affected by religious, political and social, and economic factors Until the later 1920's and early 1930's all of Arabia was nothing more than a vast desert with a few scattered, insignificant oases The Hijaz was the only exception as it had the holy places and the pilgrim traffic as well as the largest cities and highest economic standard So, it was in this region that vehicles were used about twenty years before any other regions Late in the 1920's and at the beginning of the 1930's the growing power of Ibn Saud in the centre of Arabia and the search with great certainty of oil discovery in the Gulf area gave central and eastern Arabia new importance which brought with it the modernisation of transport for the first time The mountainous nature and the lack of an important factor such as the religion, oil or political power made the southern region the last to use motor vehicles

Traffic across the desert of Arabia has always been a major aspect in the traffic pattern In the pre-Islamic phase it was an international transit traffic, and in the following phase it became a Hajj traffic Motor traffic across the desert started in 1934[49] or about 11 years after the start of regular motor services across the Syrian desert This was not a transit traffic as it was in Syria but a Hajj traffic During the Hajj of this year automobiles were used on the road from the Persian Gulf and Oman via Al Hassa It was almost at the same time that automobiles ran on the Darb Zobayda road The Nairn Transport Company started a Hajj service from Baghdad to Mecca via Ha'il and Medina in 1934-35 [50] The date of the first motor services on the Syrian and Egyptian Hajj roads is not known but there should be no doubt that motor vehicles travelled along these roads during the Hajj by 1934 since they are among the most important Hajj roads

The import of vehicles is a sign of development in transportation and a factor that encouraged and led to the spread of motor traffic 1926 (1345 A H)[51] was the year when motor cars were first officially imported to Arabia, via the port of Jedda It is interesting to mention that the importers were J Philby and a native citizen called Ali Al Ammari, and that the year 1926 was the year of the conquest of the city of Jedda by Ibn Saud Information on the number of vehicles imported this year and whether they were second-hand or new is not available Neither is it known if they were imported for private, commercial or government use

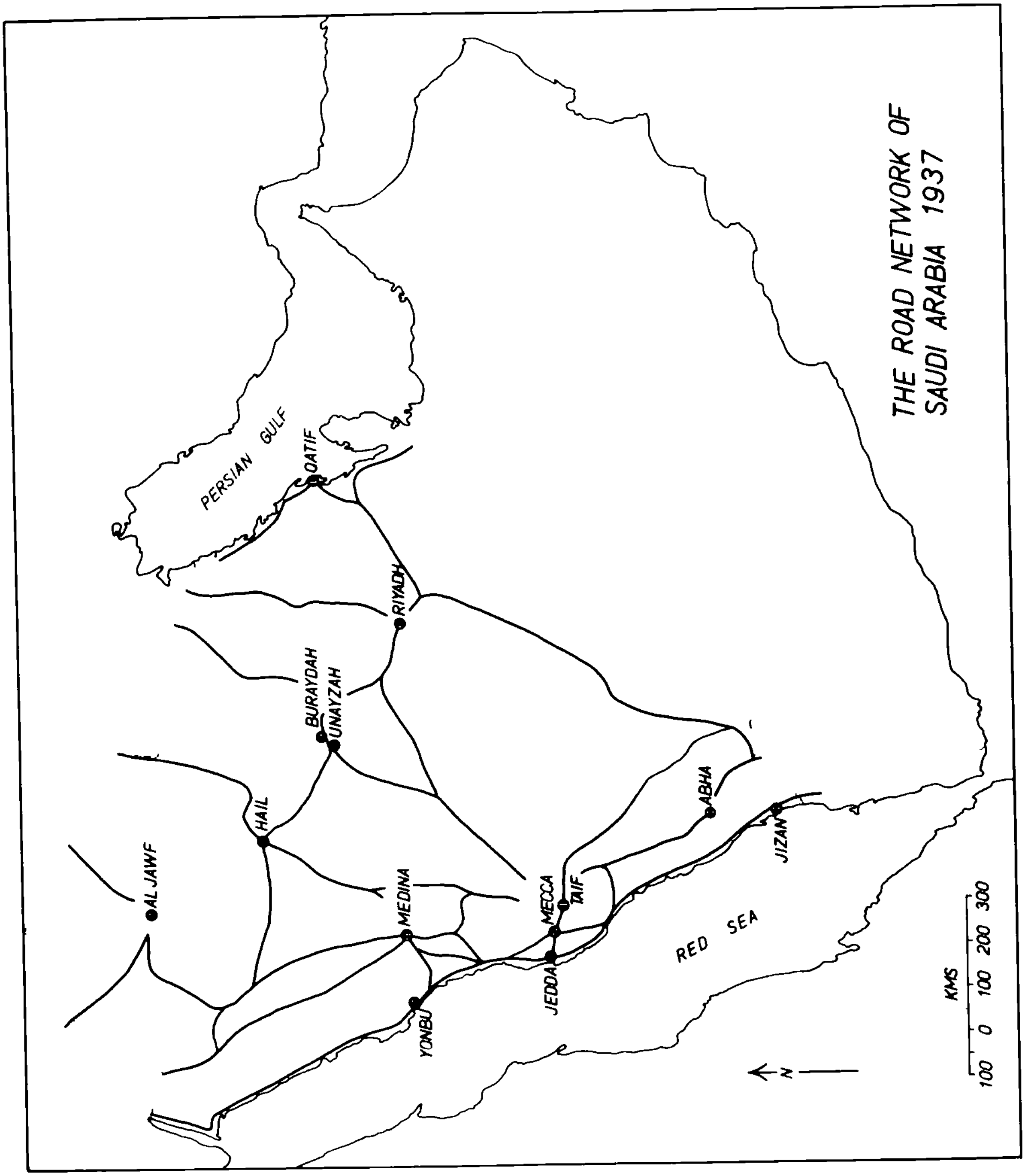
Obviously, at the beginning of the era of transport modernisation, camels and motor vehicles were used side by side The advance of time meant a change in the proportions of the traffic carried by primitive and the modern means of transport In the beginning the contribution of automobiles was much smaller than that of the camels, but gradually motor vehicles carried the larger proportion In 1947 the Naval Intelligence Division wrote "Land-routes have become increasingly important since the automobile began to replace the camel as means of transport, though the camel has by no means yet been entirely supplanted" [52]

The heavy Hajj traffic between Mecca, Jedda and Medina led to the formation of transport companies shortly after 1926 A large number of small companies were formed by individual citizens By 1935 the number of these companies reached 30 These companies provided Hajj services for pilgrims in their trips between Jedda, Mecca and Medina and between Mecca and Arafat The total number of motor vehicles operated by the Hajj companies amounted to 89 cars and 448 lorries and converted lorries in 1935 (1354)[53]

For a number of reasons that will be discussed later (see Chapter Nine) the small Hajj transport companies were united by a royal decree into one big firm under the name of Ash Sharika Al Arabia Li As Sayyarat (The Arabian Automobile Company) Only this new big company was given the right of carrying the pilgrims The small companies which did not wish to be amalgamated in the new company lost this right which they enjoyed before The formation of Ash Shavika Al Arabia Li As Sayyarat also marked the end of the camel Hajj transport between the holy cities and the ports of Jedda and Yonbu

The Impact of the Formation of Saudi Arabia on the Road Network

The disturbance of the Hajj and trade traffic across Arabia which was greatest from the eighteenth century was mainly caused by the wars made by the House of Saud against other rulers of Arabia to spread Wahhabism During the eighteenth and nineteenth centuries the tide was sometimes with the Saudis and sometimes against them But in 1926 the local wars and the insecurity of travelling across Arabia was brought to an end by Abdul Aziz Ibn Saud who



THE ROAD NETWORK OF SAUDI ARABIA 1937

Fig 2.1

successfully united most of Arabia under his rule and provided law and order for his country In 1932 this new country was officially named The Kingdom of Saudi Arabia

Obviously the new favourable conditions encouraged the Hajj and trade traffic across Arabia, though this traffic was never as it used to be before the eighteenth century for now most of the traffic came by sea either to Jedda and Yonbu on the Red Sea or via Kuwait on the Persian Gulf coast

However, the formation of Saudi Arabia gave Riyadh, in the centre of the desert, a new role to play Riyadh now became the capital of a new strong king and his state As a result of its political weight, Riyadh, developed as an important focus in the route network Riyadh became for the first time in the history of transport the main focus although Mecca and Medina remained two important focal points (Fig 2 4)

<u>Summary and Conclusions</u>

It was possible to identify four different networks in the history of transport of Arabia (a) The Caravan Transit Network which consisted of three main trans-Arabian routes linking the Mediterranean with South and Southeast Asia, with three focal points all on the margins of Arabia (b) The Caravan Hajj Network which consisted of eight main trans-Arabian routes All the routes of this phase led to Mecca, though Medina was the second important focal point (c) The Eighteenth and Nineteenth Centuries Network, when trans-Arabian routes became minor routes in comparison with the short important routes which appeared between Mecca, Jedda, Medina and Yonbu (d) The Network in the 1940's of which Riyadh became a main focus for the first time

The division into four networks should not, however, conceal the similarity in the shape of the networks of Arabia in all periods of history This similarity which can be seen in Fig 2 5 is a result of the physical geography of Arabia No route could have ever run across the middle of the two huge sand bodies of Rub' Al Khali or An Nafud In the west, routes of all times have to run either on the eastern edge of the Surat Mountains or on the narrow coastal plain between the Surat Mountains and the coast of the Red Sea In central Arabia the Tuwayq escarpment and the Dahna sand belt are only traversable at certain points These physical factors played a major role in shaping the route network in each period of history

Nevertheless, the division into four different networks is fully justified and clear The shape of the

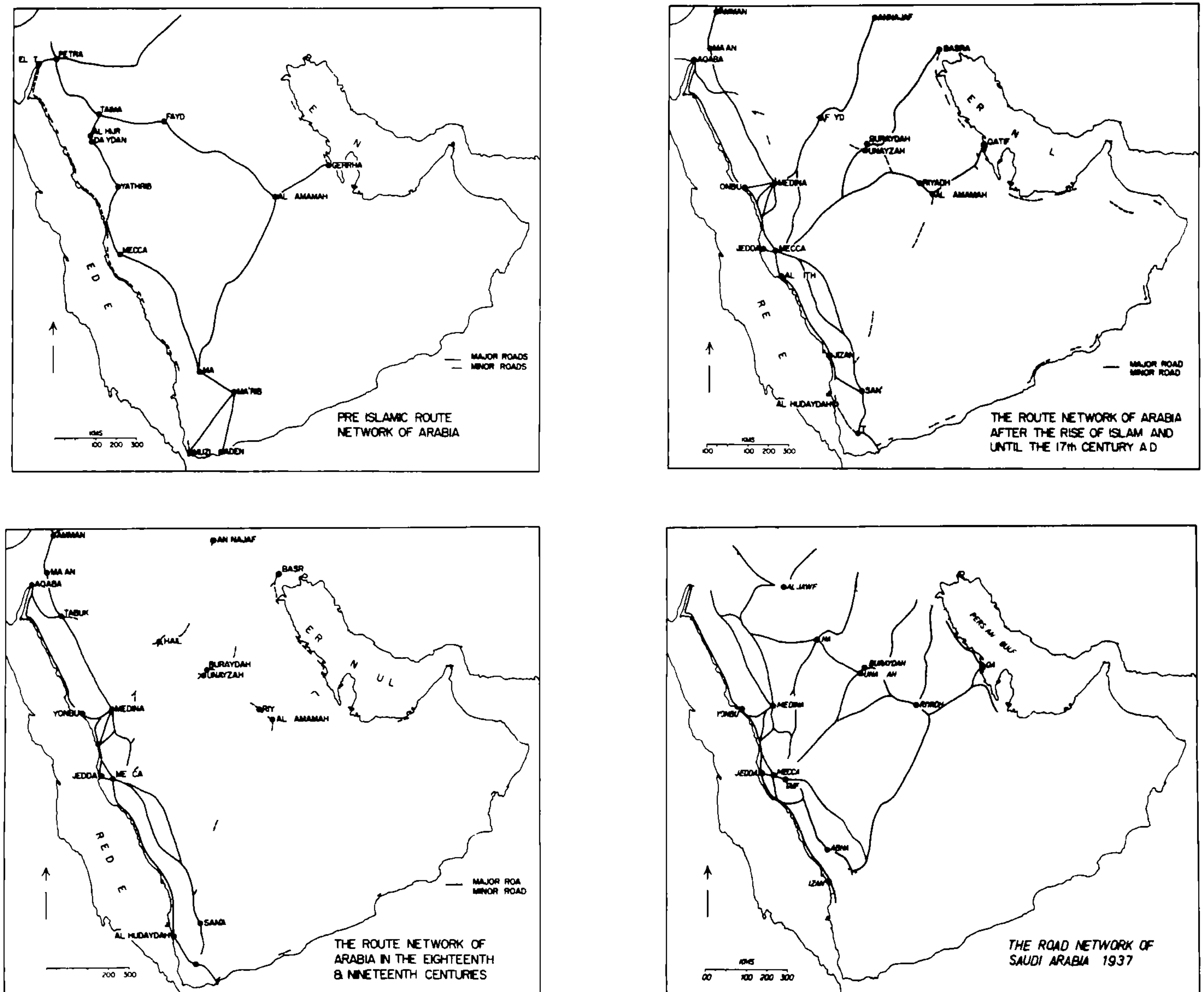


Fig. 2.5 Route Network Development from Pre-Islamic Times until the First Half of the Twentieth Century

route network of each period of history is different from that of the others as can be seen from Fig 2 5

Three types of change in the pattern of traffic in the period studied were possible to define (a) The remarkable change from freight traffic in the pre-Islam time to passenger traffic in the Islamic time, (b) the change from trans-Arabian to regional traffic in the eighteenth and nineteenth centuries when the main traffic became that on the routes between Mecca, Jedda, Medina and Yonbu, and (c) The use of the motor vehicle and the increase of the traffic to and from Riyadh which took place with the formation of the Kingdom of Saudi Arabia

Being a hostile desert, Arabia, logically should have been avoided by international traffic For the same reason domestic traffic could not be expected to be of any significance This is contradictory to the long history of transport which Arabia actually had If we leave the discovery of oil and the modern evolution of transport in Arabia aside, as we have done, five remarkable factors should be considered behind the shaping of the networks and traffic we have just defined (a) Possessing the camel was a significant factor, for without it Arabia would have remained uncrossable until the twentieth century

(b) The Geographical Situation was the factor that produced the transit traffic and network which in turn allowed the cultural impact which introduced the Islam religion Had it not been on the way of the trade between east and west, Arabia would have remained a negative area in transport (c) The rise of Islam, which came about as a result of the cultural contact with the east and the west, was a factor that produced the Hajj traffic and network (d) The development of sea transport was the main factor behind the change from trans-Arabian to regional traffic which took place in the eighteenth century (e) The use of the motor vehicle and the modernisation of transport which started in the beginning of the present century

Finally it may be agreed that the history of transport in Arabia owes more to historical and technological factors than to physical environment Physical factors have changed little but historical and technological conditions have changed considerably It was due to the changing strategic, cultural, technological and political factors that Arabia witnessed various patterns of traffic and different networks during the period studied in this chapter

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CHAPTER THREE

THE EVOLUTION OF MODERN ROADS

In this chapter the evolution of modern roads in Saudi Arabia is surveyed and the influences upon their development are examined Throughout this study roads are treated as a product of human activities built to serve certain requirements of life, and the hypothesis that roads come into existence only where and when they are needed and can be afforded is tested This chapter, therefore, starts with a pattern for social and economic development, then examines the evolution of modern roads in relation to regional and national growth and ends with an analysis of the present areal distribution of road mileage

The Pattern of Socio-Economic Development

Socio-economic development in its wider sense did not start in Saudi Arabia until the late 1940's and early 1950's Previously development was impossible because of the second world war and the civil wars inside Arabia which led to the formation of the Kingdom of Saudi Arabia in 1932 (see Chapter Two) Until this date, the Hijaz was the only developed part of Arabia, and the socio-economic life of its main cities was far ahead of any other part of Arabia The economic superiority of the Hijaz, which was based on the Hajj, was, however, challenged in the 1940's and the 1950's by the Gulf area as a result of the discovery of oil, and by Riyadh, which was chosen to be the capital of Ibn Saud's Kingdom Consequently, by about 1955, Saudi Arabia had three relatively developed regions located on an east-west axis with the holy cities at its western end, the oil centres at its eastern end and Riyadh at its centre It is important to state that the development of the three regions results from unexpected factors the rise of Islam, the discovery of oil and the formation of Saudi Arabia No such miracles occurred in any other regions, and thus socio-economic development in the rest of the country awaited planned development, which was unknown in Saudi Arabia until only few years ago Consequently, it was only in the present decade that development started to reach the areas which are not located on the east-west axis

The Pattern of Expansion of the Modern Road Network

Being one part of modern development, the expansion of modern roads has coincided to a remarkable extent with the pattern of socio-economic development, which was summarised above Modern roads were first built in the Hijaz, then in the Gulf area, then in the Riyadh region

This was followed by the linkage of the three axis regions and only recently, modern roads penetrated into the regions located far away from the east-west axis

The first modern road was built in the Hijaz in 1938, (Fig 3 1 A) this was only a 73 kms road built by Egypt with money from the Waqfs of the Holy Mosques'[1] The financing of this road by an outsider reflects the poor financial situation of the Ibn Saud government in those years The Hijaz attracted modern roads before any other parts of the Kingdom for three obvious reasons (a) It contains the two holy cities of Mecca and Medina which are visited annually by a large number of pilgrims Development of transportation was an obvious requirement to facilitate the movement of pilgrims between Mecca, Medina and the port of Jedda, especially since the Hijaz railway was destroyed in the first world war (b) As a result of the Hajj, the Hijaz in general and its main cities of Mecca, Medina and Jedda in particular achieved a relatively high level of economic and social progress The rest of Arabia was little more than a vast desert with a few scattered oases in which camel transport was sufficient to meet all the requirements of its economic and social life (c) The bad financial situation of the

THE EXPANSION OF THE MODERN ROAD NETWORK IN SAUDI ARABIA 1938-65

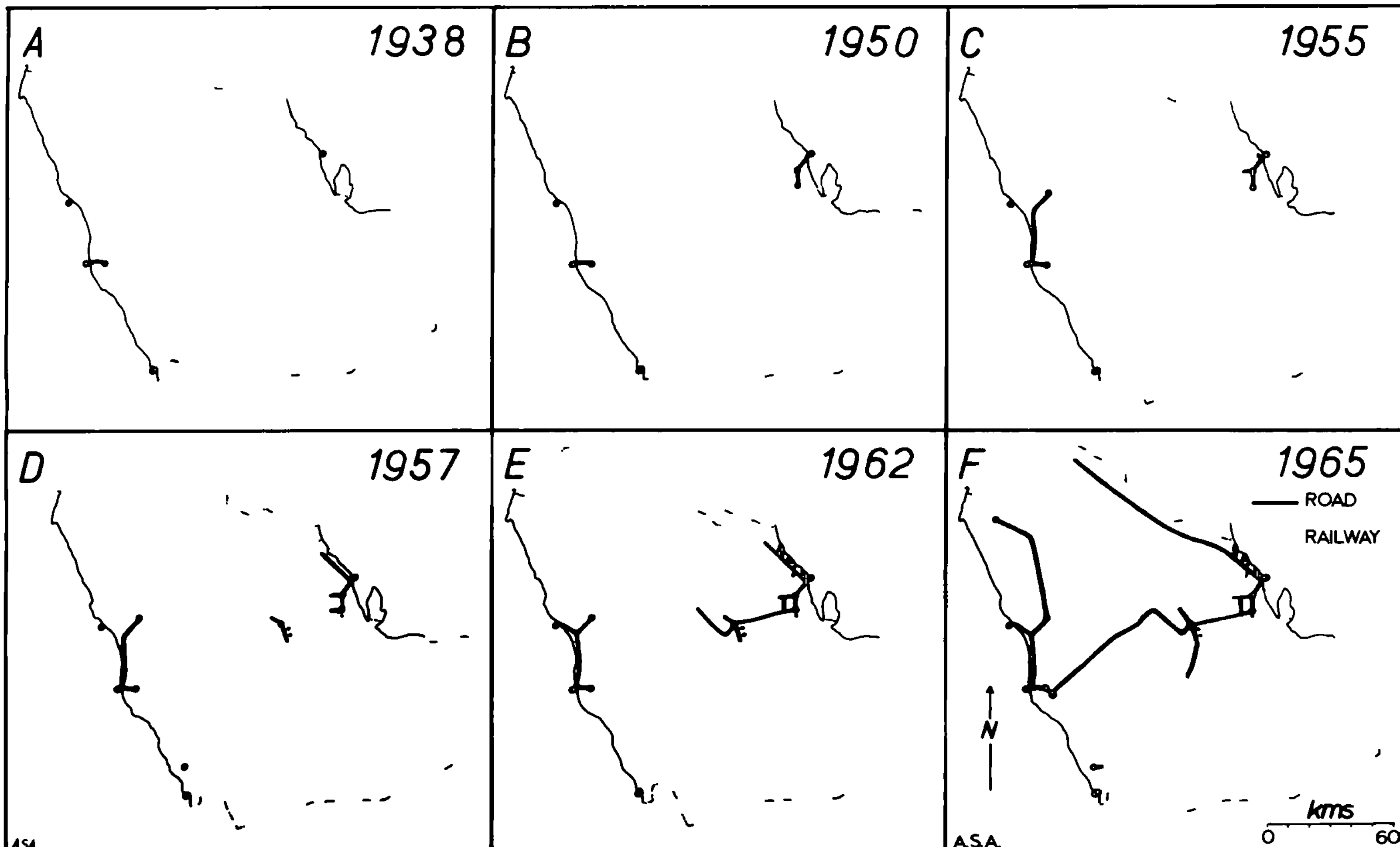


Fig 3 I

government did not allow any development, and as we have seen the road which was built in the Hijaz was financed by an outsider, as all Muslim governments felt responsible for the holy cities and the development of the Hajj facilities

It was only in 1950 that the construction of modern roads in Saudi Arabia began In 1950 the Arabian - American Oil Company (Aramco) built a few asphalt roads in the Gulf area, where oil was discovered in 1936 and produced in 1938 During 1950 a 55 km long road was built from the Dammam Junction to Ras Tannurah Road and another short road of 11 km was built to Ras Tannurah Terminal A 45 km road was also built in the same year between Abqaiq and Ayn Dar (Fig 3 1 B) An analysis of the date of early road construction in the Gulf area is necessary here, since it is difficult to understand why the construction of modern roads was begun as late as 1950 A large pipeline network and even an oil refinery were built in the area before any asphalt road Does this contradict the theory that road development in Saudi Arabia accompanied the general socio-economic development? If not, why did modern road construction not start in the Gulf area before 1950? Many factors seem to have influenced the date of the start of modern roads in this area (a) The activities of the Arabian American Oil Company in Saudi Arabia were limited and orientated by the outbreak of the second world war and its strategy [2] (b) The topography of the oil area, being a smooth wide plain, allowed motor vehicles to travel with a reasonable speed and safety on slightly improved roads (c) The nature of oil as a liquid commodity necessitates the construction of pipelines rather than any other media of transport These three factors worked together and caused the delay of the construction of modern roads in this area which came in 1950 as a kind of luxury rather than a necessity However, road construction by Aramco continued to show the expected progress in the 1950's

The road which was built from Jedda to Mecca in 1938 was, of course, not by any means sufficient for modernizing pilgrim transport A road that linked Jedda with Medina, and thus Medina with Mecca via Jedda, was badly needed But the distance involved was much greater than that between Jedda and Mecca and thus a much greater sum of money was necessary to build this road, especially as it would need to traverse the Surat Mountains The government of Saudi Arabia was busy with many problems that were more urgent than the construction of this road, and did not have enough money for such an expensive project The first time the government of Saudi Arabia spent money on roads was in 1951 There is no written evidence, but there is no doubt that the 0 8 million SR [3] which were spent in that year went for the improvement of the Jedda - Medina road In the following year (1952) the government started the construction of the Jedda - Medina road (Fig 3 1 C) The first section (100 km from Jedda) was finished in 1953 and the whole road was completed in 1955 The construction of the 424 km road from Jedda to Medina was among the biggest projects of the early 1950's, causing a rise in the government's popularity among the people of the Hijaz as well as among Muslims in all countries Pilgrims now, for the first time in history, were able to use motor transport for their whole journey between Jedda, Mecca and Medina with safety and comfort The trip from Jedda to Medina was shortened from an average of two days to an average of 6 - 8 hours, and the possibility of unlimited delay was ended All these benefits, of course, encouraged the government in the construction of more modern roads

In 1954 there were two separate modern road networks (a) the Hijaz road network in the west, which consisted of the two holy roads between Jedda, Mecca and Medina and the 30 Km road between Ta'if and the King's Palaces at

Al Hawiyah, a total of about 527 kms, and (b) the Gulf area road network in the east which consisted of 400 kms of modern roads connecting the oilfields with the main ports and administrative points The two small networks were separated by a distance of about 1500 kms of desert which had no modern roads (Fig 3 1 C)

The isolation of central Arabia from the outside world, even from the more developed parts of Arabia in the Hijaz or the Gulf area, was a logical result of the vast distances and the physical barriers The Dahna sand belt in the east, the escarpment of Tuwayq in the west, the huge sand bodies of An Nafud in the north and Rub' Al Khali in the south were among the most important physical barriers that isolated central Arabia This situation was changed by the formation of the Kingdom of Saudi Arabia and the choice of Riyadh as its capital Riyadh, the small, isolated town in the centre of Arabia, was to be changed to the main centre of the country and gradually the centre of the road network, especially as the financial status of the government was improving remarkably from increasing oil revenues The decision to transfer all important government offices from Mecca to Riyadh which appeared very clear in the latest years of King Ibn Saud's life, and which was carried out in the early years of the reign of his elder son, King Saud, meant that Riyadh would be developed as a modern city This in turn meant the construction of government buildings, streets, houses, shops, and that a large quantity of different types of goods were needed to supply the growing capital To achieve this, Riyadh had to be linked by a modern road or a railway with a modern port on the Gulf Dammam was chosen to be the port and was linked with Riyadh by a railway This twin project which was completed in 1952 (Fig 3 1 D) was the most important factor in the development of Riyadh (see Chapter Ten) Most of the required building materials and goods which were badly needed for the development of Riyadh came via the new port of Dammam and were carried to Riyadh by the modern railway In 1955 a short asphalt road of 11 kms linked Riyadh with Ad Diriyah and in 1956 another road of 85 kms was built to Al Kharj These two short roads linked Riyadh with the two main agricultural areas around it and created a third separate road network in the middle of the east - west axis (Fig 3 1 D)

Each of the three small, separate road network of the east - west axis was expanding The road network of the Gulf area reached Khurays in 1958 as a result of the discovery of oil in that area, which is only 150 kms east of Riyadh The construction of the Riyadh - Khurays road started in 1958, and in 1961 the linkage between the two road networks of the Riyadh and the Gulf area was achieved (Fig 3 1 E) Since then the expansion of the Riyadh road network was orientated towards the west to achieve a linkage with the Hijaz road network In 1961 a road of 170 kms was constructed from Riyadh to Marat, in 1962-3 another 170 kms were constructed from Marat to Ad Dawadmi, in 1962-63 a 66 km road was constructed from Ad Dawadmi to Ber Sagra and in 1964-65 the construction of the 473 km road from Ber Sagra to Taif linked the road network of the Hijaz with that of Riyadh and consequently with the Gulf area road network (Fig 3 1 F) This created a road network which extended from the Gulf to the Red Sea via Riyadh

Modern roads penetrated from the centres of the east - west axis both northwards and southwards The Tapline road which was improved in 1947 at the time of laying the Trans - Arabia oil pipeline, was constructed as an asphalt road in 1965-68, (the 296 kms from Al Qaysumah to Rafha were constructed in 1965, the 522 kms from Rafha to Turayf in 1967 and the 251 kms from Al Qaysumah to An Nu'ayriyah in 1968) From Medina, the east - west axis road network expanded to the north reaching Tabuk in 1964 From Riyadh

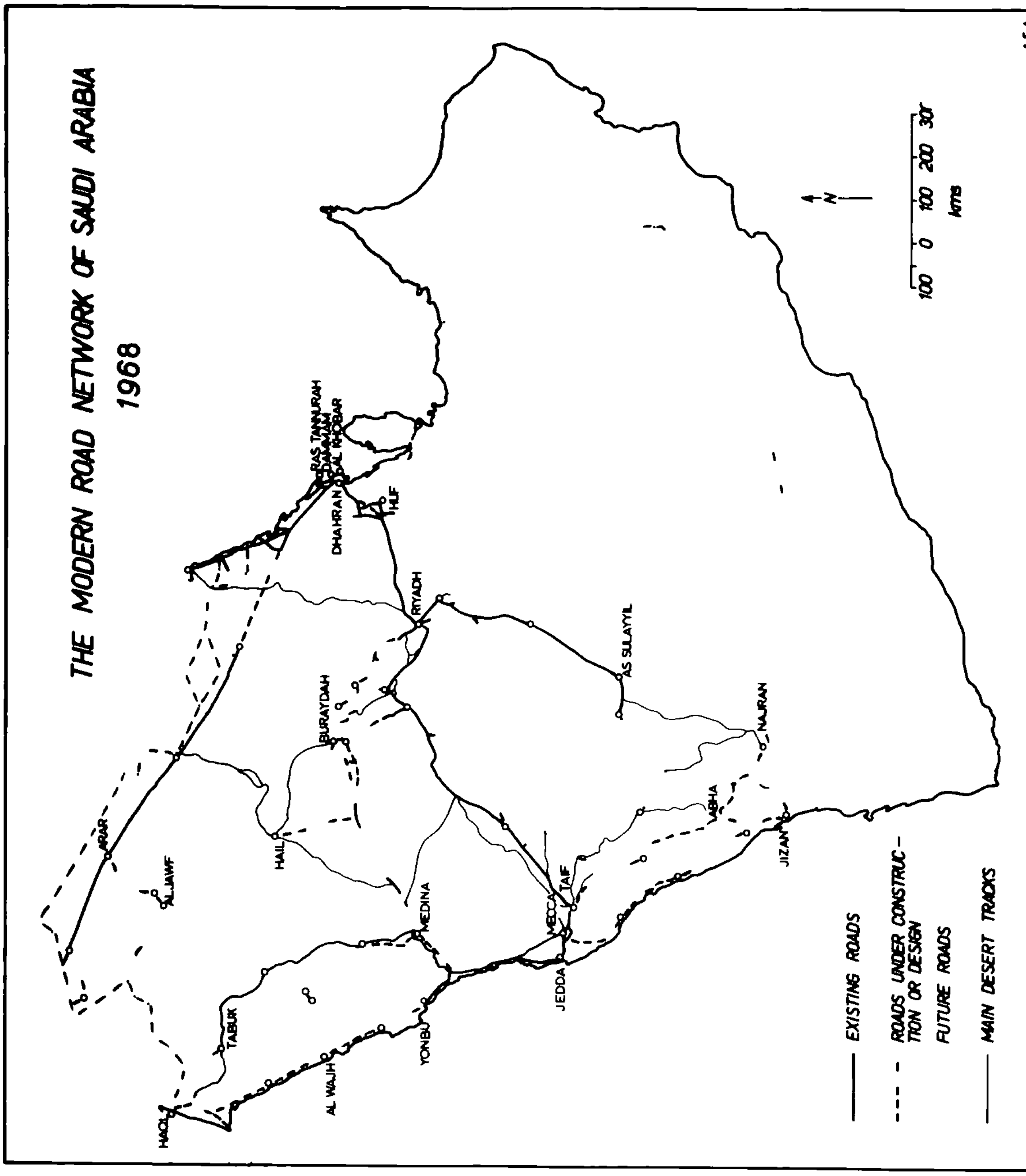

THE MODERN ROAD NETWORK OF SAUDI ARABIA
1968
RAS TANNURAH
DAMMAM
AL KHOBAR
DHAHRAN
HUF
RIYADH
AS SULAYYIL
NAJRAN
ABHA
JIZAN
BURAYDAH
HAIL
ARAR
AL JAWF
MEDINA
MECCA
TAIF
JEDDA
TABUK
YONBU
AL WAJH
HAQL
N
100 0 100 200 300
kms
EXISTING ROADS
ROADS UNDER CONSTRUCTION OR DESIGN
FUTURE ROADS
MAIN DESERT TRACKS
A.S.A

Table 3 1 Increase in the length of Asphalt Roads, 1950-1965 (kms)

Year	ARAMCO Total	ARAMCO Increase	TAP LINE Total	TAP LINE Increase	GOVERNMENT Total	GOVERNMENT Increase	Grand Total	Incr-ease	Three Years Running Means
1950	111	111	-	-	-	-	111	111	-
1951	191	80	-	-	-	-	191	80	160
1952	315	124	-	-	165	165	480	289	151
1953	401	86	-	-	165	-	566	86	218
1954	456	55	-	-	389	224	845	279	170
1955	459	3	-	-	530	141	989	144	176
1956	478	19	-	-	615	85	1093	104	96
1957	478	-	-	-	655	40	1133	40	161
1958	728	250	-	-	745	90	1473	340	189
1959	797	69	-	-	863	118	1660	187	192
1960	797	-	-	-	911	48	1708	48	194
1961	797	-	-	-	1257	346	2054	346	190
1962	797	-	-	-	1432	175	2229	175	174
1963	797	-	-	-	1432	-	2229	-	525
1964	797	-	300	300	2532	1100	3629	1400	796
1965	797	-	676	376	3143	611	4616	987	

Sources 1 Statistical Yearbook, 1967 Central Department of Statistics, Saudi Arabia, pp 1845

2 Engineering Department, Aramco, Dhahran

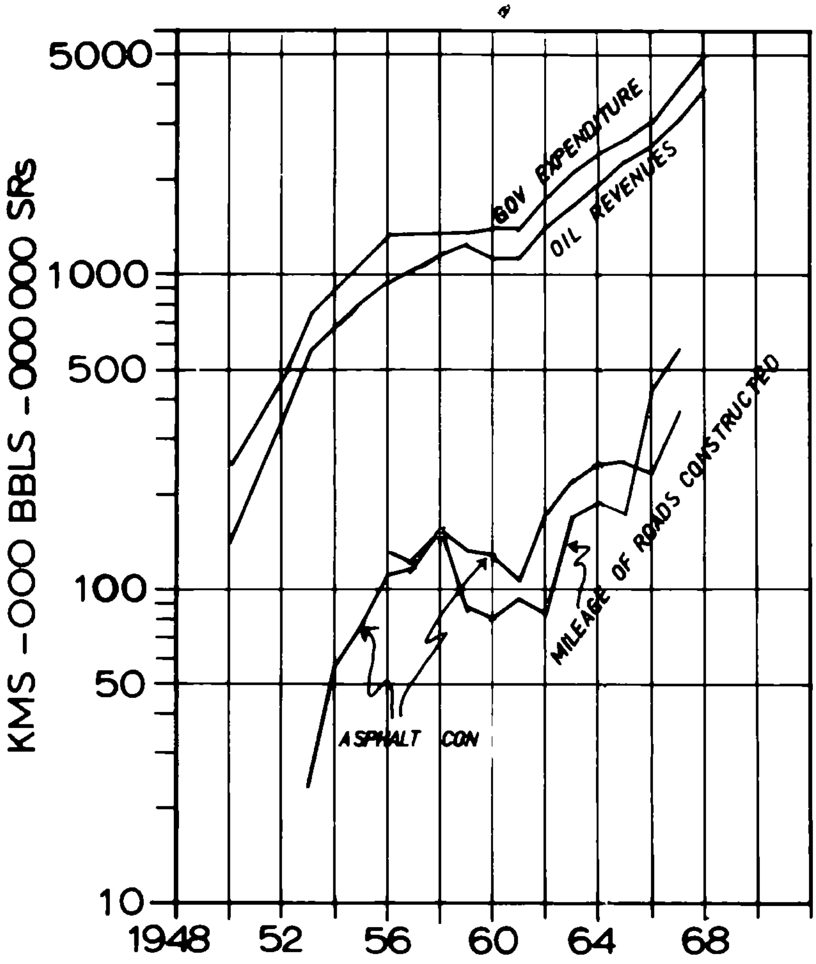
a modern road of 541 kms was constructed in 1968 to Wadi Ad Dawasir along the Aflaj region At the time of writing the expansion of modern roads is advancing at a very fast rate (Fig 3 2) Consideration was also given recently to the improvement of rural roads By 1967, about 1,850 kms of rural roads were improved in the regions of Jedda, Riyadh, Al Baha, Abha, Gassim, Dammam and Hail

The above survey is aimed to show the close association between the expansion of the modern road network and the pattern of socio-economic development Both socio-economic and road development were not, however, associated with the pattern of the density of population As can be seen by comparing Figs 3 1 and 1 2, districts with high population densities (e g the southwest) did not attract modern roads before the three east - west axis regions which have the primate cities (Fig 1 3)

<u>Bodies Responsible for the Evolution of Modern Roads</u>

If we set aside the Egyptian government, which built the Jedda - Mecca road in 1938, three bodies are responsible for the construction of the present road network of Saudi Arabia The Arabian - American Oil Company (Aramco), The Trans - Arabian Oil Pipeline Company (Tapline), and the government (table 3 1) Aramco improved a road network in

ANNUAL ROAD MILEAGE CONSTRUCTED BY THE GOVERNMENT AND ASPHALT CONSUMPTION IN RELATION TO ECONOMIC GROWTH



ASA

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the Gulf area during the period 1950 - 59 to support the oil industry, and during this period it built an average of 84 kms per annum The Tapline improved the Tapline road in 1947 and paved it in 1965-8 as was explained above The government of Saudi Arabia did not construct any modern road until 1952, but since then it has been building new roads at a reasonable rate as can be seen from table 3 1 The length of roads built by the government each years is closely related to the government income which was highly dependent on oil, as can be seen from Fig 3 3, the period 1956-60 which was characterised by an interruption in the economic growth was also a slump period for road development However, since 1960 the length of roads constructed by the government each year has been increasing at a higher rate than that of the oil revenues or the government budget

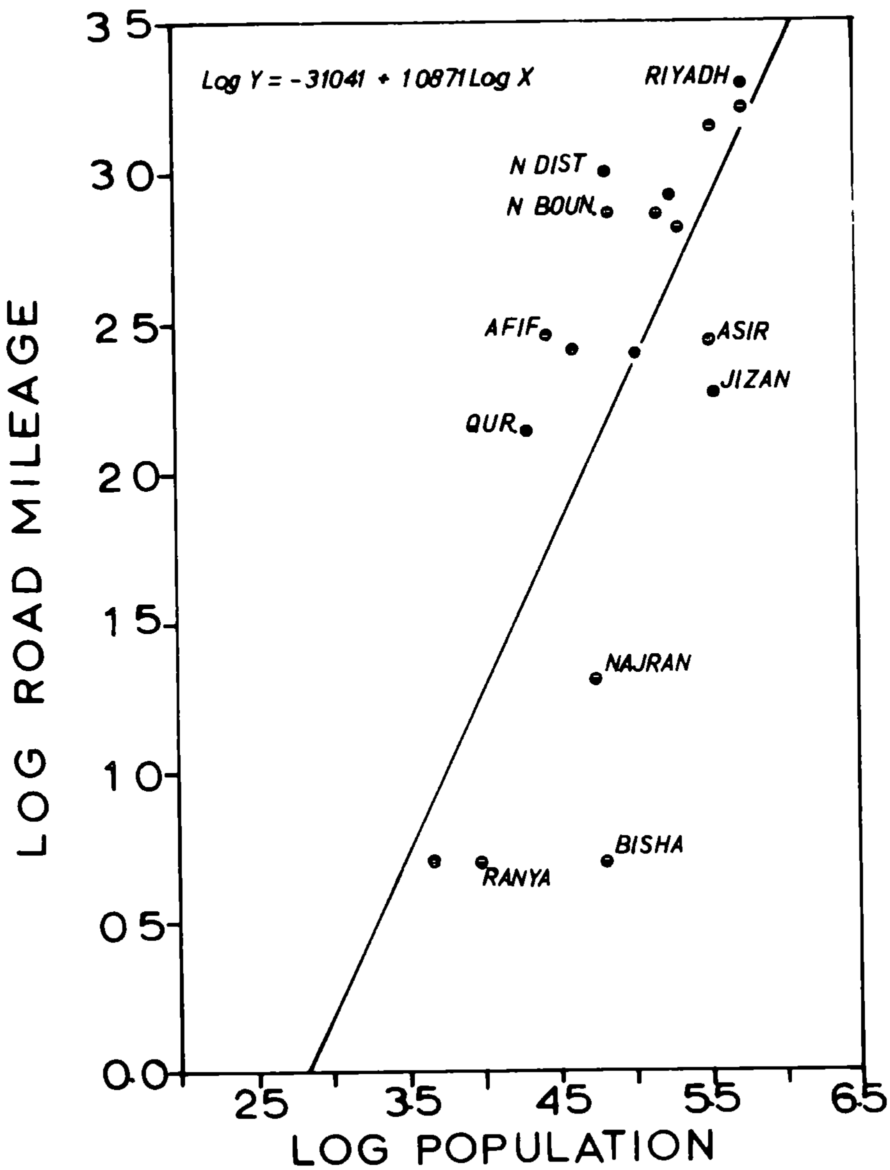
Relationship Between Road Mileage and the Main Influencing Phenomena

It has been seen that most of the roads which were built during the last decade were orientated mainly towards the regions with high population densities, as such regions were neglected in the early stages of road development The aim of this section is to investigate the relationship between the present distribution of asphalt roads (existing roads as well as roads at present under construction, but not rural or intra-city roads) and the population as well as the other relevant factors involved To do this, the length of roads in each of the 18 population census districts was compared with the population and the area of each district A correlation analysis between road mileage and population in the 18 districts showed a high association between these two variables with r = 0 74 at the 99 9 confidence level (data were normalized by log transformation) The regression of road mileage on population is shown in Fig 3 4

The value of the above comparative analysis between road mileage and population is, however, hindered by the fact that the districts are of unequal size, and that the road mileage in each district is affected not only by the size of the population but also by the size of the area on which they live In fact when the road mileage was compared with the area factor the result of a correlation coefficient analysis was as high as r = 71 at (nearly) the 99% confidence level Consequently, it was found that road mileage should be compared with both the population and areas as one independent factor

Conventionally to combine the two factors of population and area in one, the population density is used Such a method, however, may give misleading results The following

THE REGRESSION OF ROAD MILEAGE ON POPULATION



A.S.A

Fig. 3.4

hypothetical example is especially designed to show the weaknesses of the density method and to prove that the best way of combining the population and area factors is by multiplying the square root of the population by the square root of the area

A Hypothetical Example

	Section 1			Section 2		
	District	Pop	Area	District	Pop	Area
Density	I	10	÷ 5 = 2	I	5 ÷	10 = 0 5
Method	II	20	÷ 5 = 4	II	5 ÷	20 = 0 25
Multiplication	I	10	x 5 = 50	I	5 x	10 = 50
Method	II	20	x 5 = 100	II	5 x	20 = 100

The above hypothetical example is based on the assumption that road mileage is proportional to the population and area factors and that the populations of the two districts are similarly distributed As can be seen from the first section of the example, where the area factor is equal and the population factor varies, the ratio of district I to district II was similar in both methods (1 2) meaning that either methods can be used The second section of the example is, however, more important to notice In this section the population factor is equal whilst the area factor varies As can be seen, the ratio of district I to district II is 2 1 in the density method and 1 2 in the multiplication method At this stage we should reject the density method as it means that district II should have less road mileage than district I, although the former has an equal population and twice as much area than the latter On the other hand, we should accept the multiplication method which indicates that district II should have more road mileage

It must be admitted, however, that the multiplication method need some modifications since the 5 people who live in 20 km^2 do not, in reality, need twice as much roads as the 5 people who live in 10 Km^2 This shortcoming can, however, be overcome by the use of the square root instead of actual data [4] With the use of square root we get a ratio of 7 10 instead of 1 2

It should, however, be noticed that both the multiplication and density methods fail to take into account the way in which the population is distributed (concentrated or scattered) which is an important factor, as shall be seen later It follows, that the value of such comparative analysis is reduced with the use of un-unified large districts and increased with the use of small unified cells

It was of some interest to find that the results of a simple correlation analysis, using the square root of

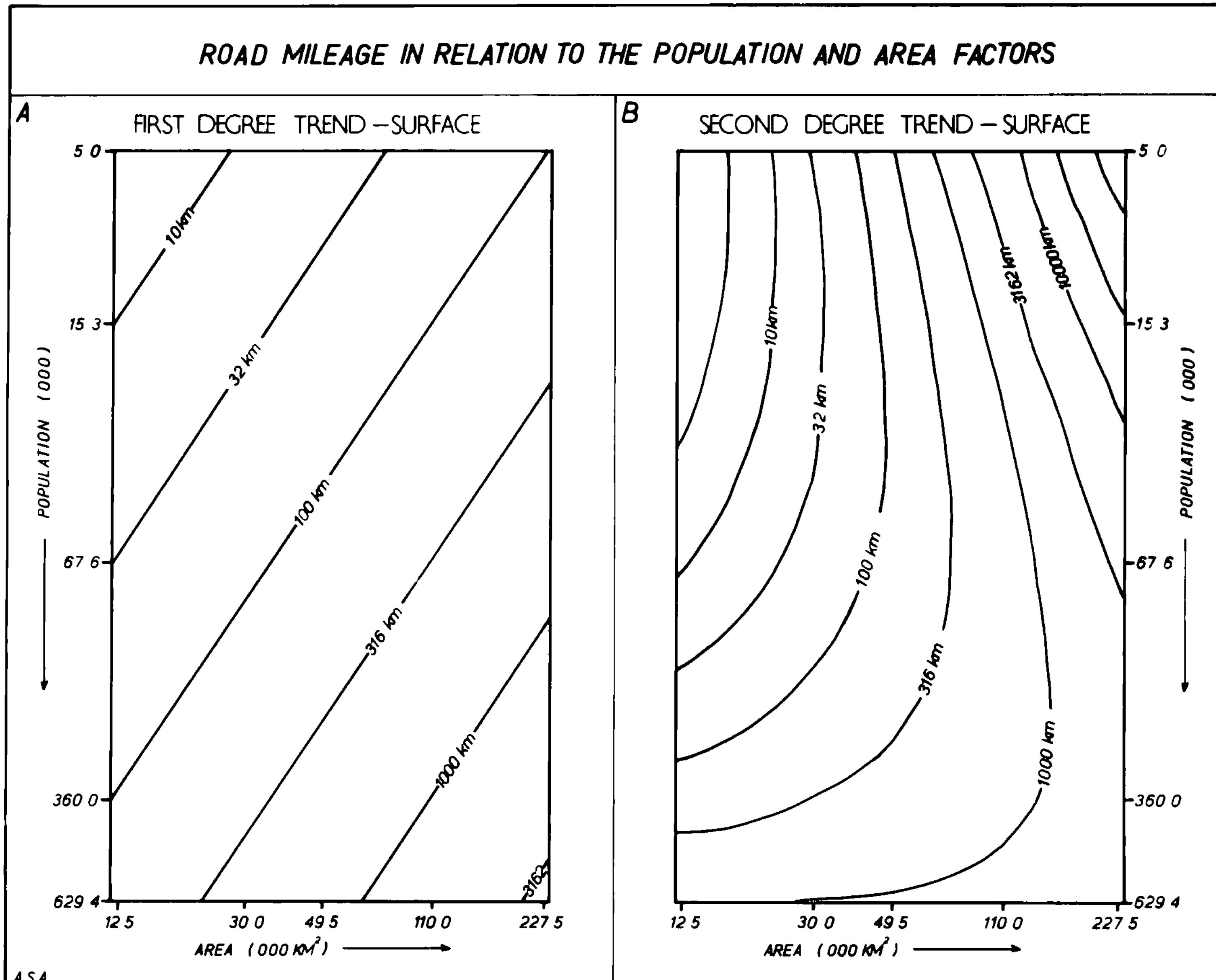
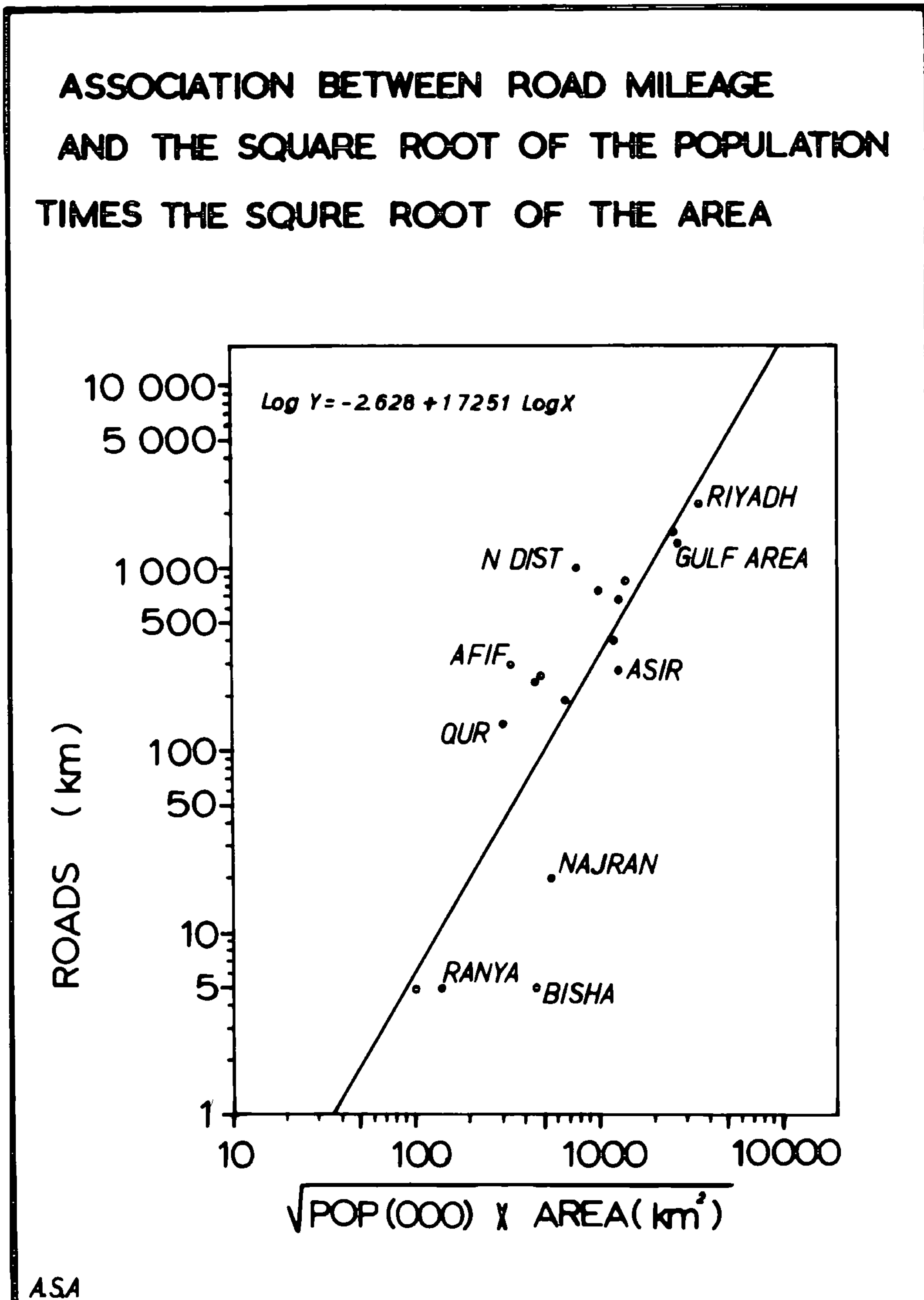

ROAD MILEAGE IN RELATION TO THE POPULATION AND AREA FACTORS
A
FIRST DEGREE TREND – SURFACE
B
SECOND DEGREE TREND – SURFACE
10km
32 km
100 km
316 km
1000 km
3162
3162 km
10000km
5 0
15 3
67 6
360 0
629 4
POPULATION (000)
12 5
30 0
49 5
110 0
227 5
AREA (000 KM²)
A.S.A

Fig 3 5

population times the square root of the population against road mileage, was similar to the results of a multiple correlation analysis using three variables (population, area and road mileage) Both correlations gave a result of r = + 83 at the 99 9 confidence level (data were normalised by log transformation) The association between the road mileage and the population and area factors is shown in Fig 3 5 by two trend - surface maps (A) first degree trend-surface and (B) second degree trend-surface On these maps the values of the population were plotted on the vertical axis, whilst the values of the area were plotted on the horizontal axis The surface, which represents the road mileage, is sloping from the bottom-right to the upper-left This association between road mileage and the population and area is also shown in Fig 3 6 in a simple regression using the square root multiplication method

Surprisingly, the findings of our analysis indicate that the effect of the population - area factor on the road mileage is similar in Saudi Arabia to the effect of this factor on road mileage in Ghana and Nigeria though the geographical characteristics of the last two countries are considerably different from those of Saudi Arabia In both Ghana and Nigeria the population factor accounted for



ASSOCIATION BETWEEN ROAD MILEAGE AND THE SQUARE ROOT OF THE POPULATION TIMES THE SQURE ROOT OF THE AREA
Log Y= -2.628 +1.7251 LogX
RIYADH
GULF AREA
N DIST
AFIF
ASIR
QUR
NAJRAN
RANYA
BISHA
ROADS (km)
10 000
5 000
1 000
500
100
50
10
5
1
10
100
1000
10000
√POP(000) X AREA(km²)
ASA

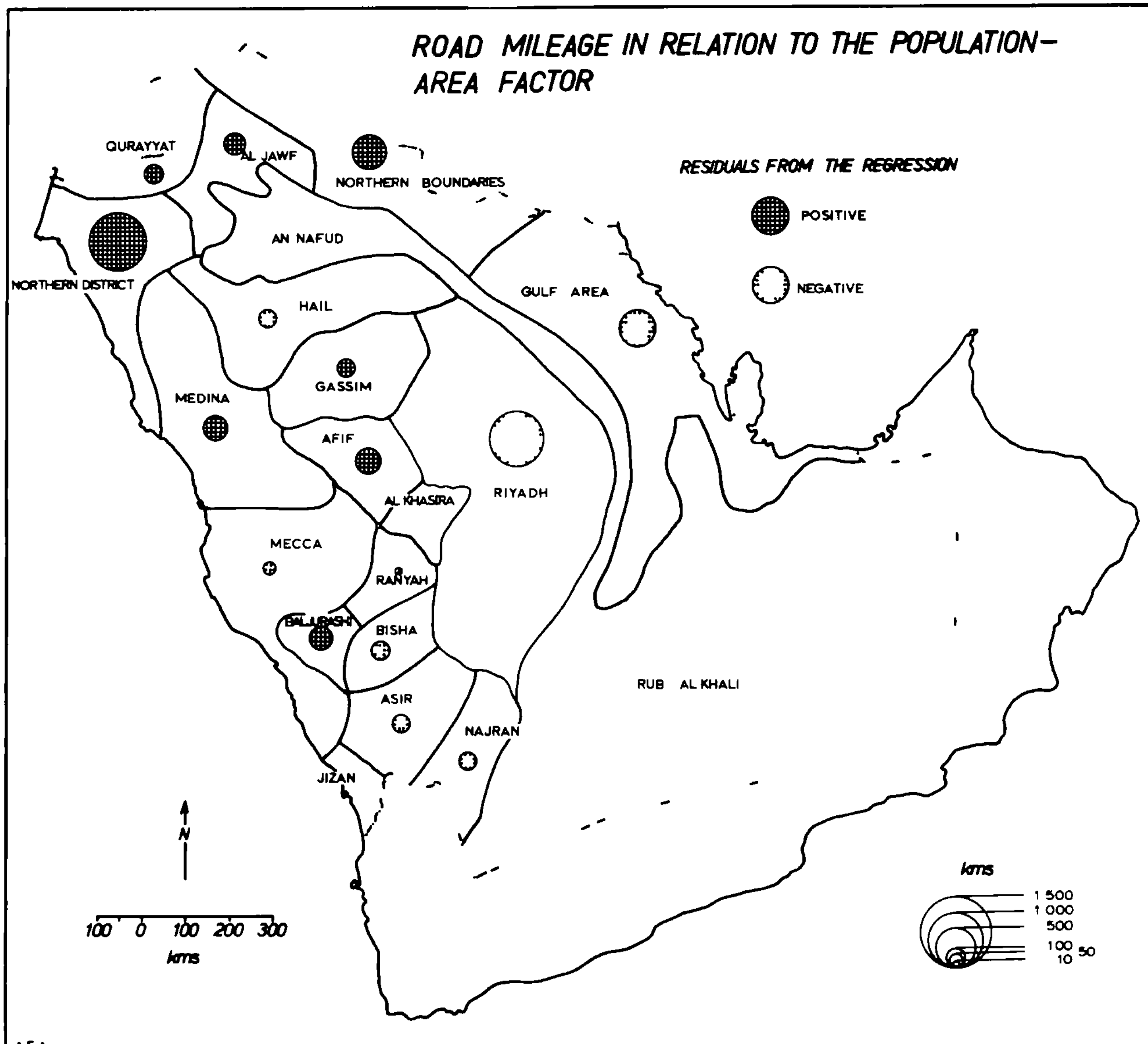
Fig. 3.6

about 50% of the variations in road mileage and the addition of area as another independent factor accounted for another 20%[5], while in Saudi Arabia the factors accounted for 57% and 15% respectively In the three countries the total explained variation was about 70% (a step-wise regression was used)

Factors other than the population and area account for about 30% of the variation in road mileage These other factors are here studied from the map which shows the residuals of road mileage from the regression (Fig 3 7) This map indicates that the main other factors affecting the road mileage are the distribution of population within each district, the location of each district (isolated or intermediate) and the social and economic activities

(A) The Distribution of Population

The main point revealed by the residual map is the influence of the distribution of the population upon the road mileage of each district or the fact that a smaller population scattered in a large area needs more roads than its share from the regression - while if the population is concentrated in a number of big cities or a cluster of towns it needs less roads than its share from the regression The districts on the east - west axis (Mecca, Riyadh and


ROAD MILEAGE IN RELATION TO THE POPULATION-
AREA FACTOR
RESIDUALS FROM THE REGRESSION
POSITIVE
NEGATIVE
QURAYYAT
AL JAWF
NORTHERN BOUNDARIES
NORTHERN DISTRICT
AN NAFUD
HAIL
GULF AREA
GASSIM
MEDINA
AFIF
RIYADH
AL KHASIRA
MECCA
RANYAH
BALJURASHI
BISHA
ASIR
NAJRAN
JIZAN
RUB AL KHALI
N
100 0 100 200 300
kms
kms
1 500
1 000
500
100
50
10
A.S.A

F 3 7

the Gulf district) all have negative residuals though they are the areas with the best road services This results from the fact that most of the population of the district of Riyadh is concentrated in one city (Riyadh) Also most of the population of the Mecca district is concentrated in three cities separated by very short distances (Mecca, Jedda and Taif with a distance of 72 kms between the first two and 88 km between the last two) In the Gulf area almost all the population is concentrated in two clusters of towns (the Dammam and Hufuf clusters) with a maximum distance of about 20 km between the towns of each cluster and 70 km between the two clusters In the three districts, a few short but first class roads are sufficient to serve the large population because of their concentration On the other hand a scattered population needs more roads (per capita) to be served adequately and thus we find the districts of Jizan, and Buljurashi have positive residuals in spite of their inadequate road services (In case this point is still not clear, the reader should consult Fig 1 2 and Fig 1 3 for information about the distribution of the population in the various districts) It is because of this factor (the distribution of the population) that a country like Saudi Arabia needs high per capita roads to be served adequately, which is a major problem of transportation in this country

(B) Hostile Environment or Isolation / intermediate or strategic location

These are two factors which have different effects upon the road mileage The hostile environment or isolation factor usually results in a total absence of the population factor and thus of roads as is the case in the Rub' Al Khali, An Nafud and the Dahna Isolated location often leads to fewer roads than expected from the regression because such districts are not crossed by the main national or international roads, Najran, has a negative residual mainly because of its location on the edge of Rub' Al Khali On the other hand the districts with intermediate locations are passed by the main national or international roads inspite of their small area or small population and thus such districts tend to have positive residuals Afif, which is traversed by the Riyadh - Taif road, has a positive residual only because of this factor When such a district with an intermediate location has a longish shape which makes its boundaries parallel to the traversing road (such as the Northern Boundaries district which is traversed by the Tapline road), the district concerned tends to have a higher positive residual Also when such an intermediate location is accompanied by some strategic importance, the district concerned (the Northern District) tends to have a high positive residual So this district has the highest positive residual, despite an insignificant population size, mainly ~~has the highest positive~~ because it overlooks the Gulf of Aqaba Owing to this strategic location roads were built to link the inland town of Tabuk with both Haql and Ash Shaykh Humayd on the coast of the Gulf of Aqaba Tabuk is the largest military town in the northwest, Haql is the nearest Saudi seaport to Ilat (the only Israeli port on the Red Sea) and Ash Shaykh Humayd overlooks the southern entrance to the Gulf of Aqaba

(C) The Economic and Social Activities

Broadly, districts with low economic and social activities (and with no intermediate or strategic location) tend to have negative residuals though they have no population concentration Hail, Najran, Asir, Ranya and Al Khasira all have negative residuals because socially and economically they are backward districts

Conclusion

This study has shown the validity of the hypothesis put forward at the beginning of this chapter, that modern roads in Saudi Arabia were a product of human activities, built to serve certain requirements of life and came into existance only when and where they were needed and could be afforded The spatial development of modern road network followed an east - west axial pattern which is also the pattern of the socio-economic development and in its overall growth modern roads have been closely associated with the discovery of oil, with the increase in the oil revenues and more directly with the growth of the government budget Some of the findings in this chapter are of significant geographical interest, mainly the fact that the early development of roads in Saudi Arabia was not associated with the pattern of the density of population but with the location of the primate cities Also interesting is the finding that the relationship between road mileage and the population - area factor has a similar degree of association in Saudi Arabia, Ghana and Nigeria inspite of the geographical differences between Saudi Arabia and the other two countries Future research, it is hoped, will attempt to reject or support the general applicability of the regression model to underdeveloped countries

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2 The Arabian American Oil Company Handbook of Aramco The Netherlands, 1960 pp 146-8

3 Central Department of Statistics, Statistical Yearbook, 1385 AH 1965 AD, Riyadh, p 252

4 Taaffe, E J , Morrill, R I , Gould, P R , Transport Expansion in Underdeveloped Countries A Comparative Analysis, The Geographical Review, October, 1963 pp 503-524

5 Ibid, p 516

CHAPTER FOUR

Some Physical Problems in Road Location

Roads are always considered to be the most independent media of transport as far as physical factors are concerned [1] They are not as sensitive to relief as canals or even railways, neither are they as sensitive to climate as airways In fact one can say that with modern technology roads can be built under any physical circumstances

Nevertheless the physical environment does affect the location of roads It does so by affecting the construction cost, the design speed, the safety standard of roads as well as the cost of transport

The construction of a direct road between settlement 'A' and settlement 'B', for example, may be technically possible, even though there is a physical barrier in the area between them But because of such physical barriers, the direct road may not be economically acceptable due to the high cost of the earthwork required in order to overcome that barrier Such a direct road may also be unacceptable because of its low design speed and safety standard which result in high cost of transport

Consequently this road may be diverted from the direct line In this case the road becomes longer and thus its overall cost of construction and the cost of transport becomes higher So, whether this road is diverted or not, it cannot escape the effect of the physical barrier

The physical environment thus affects the location of roads by presenting barriers or problems in road location The aim of this chapter is to study these problems and investigate their impact on the location of roads in Saudi Arabia

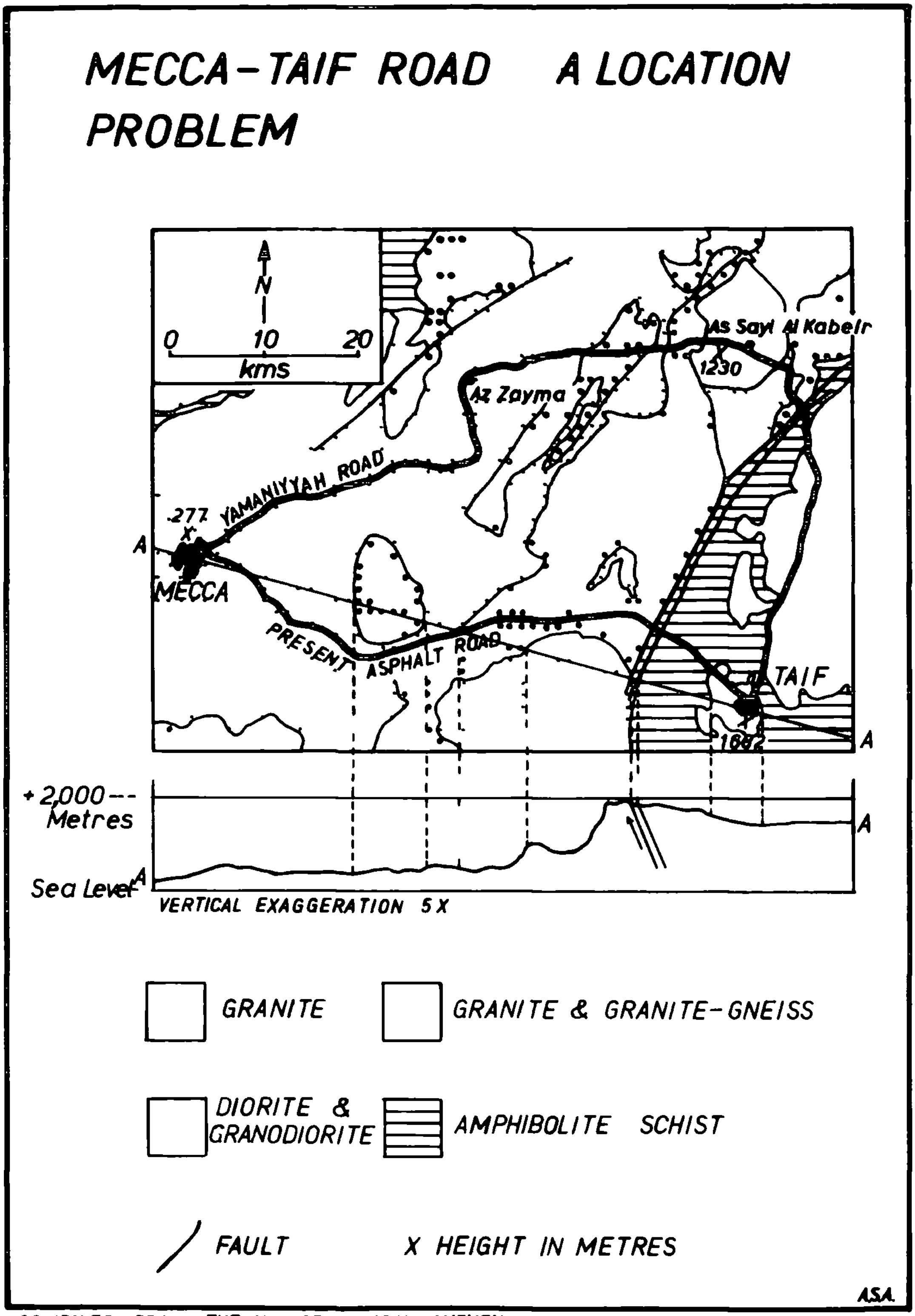
The Surat Mountains Problem

The main physical characteristic of the western region of Saudi Arabia is the Surat Mountains range These Pre-Cambrian mountains rise boldly from the narrow coastal plain along the Red Sea eastern coast They extend from the Gulf of Aqaba in the north into the Yemen in the south, ranging in elevation from 7,000 feet in the north to 8,000 feet in the South

Because of their length, structure and location, the Surat Mountains form a serious problem in road location in this part of the country Consequently throughout history roads in western Arabia have followed the coastal plain and the wadis, which are the natural ways Roads of north-south and south-north direction either follow the coastal plain or the long wadis which are cut in the mountains themselves Roads of west-east direction have no alternative but to use the wadis which suit their direction

However, most of the roads, whether ancient or modern, follow the wadis rather than the coastal plain simply because most of the settlements in the region are located along the wadis The coastal plain did not encourage settlements because of its high temperature and humidity, saline underground water and the infrequent use of the Red Sea by the Arabs in the past Further, the east-west direction and the high peak of run-off of the wadis of the coastal plain make them form a barrier to roads

The Surat Mountains problem can be best illustrated by the Mecca-Taif road The problem of this road is a problem of elevation Mecca is 277 metres above sea-level while the elevation of Taif is 1682 metres The direct distance between the two cities is 60 kilometres, therefore the average gradient is 23 4 metres per kilometre Moreover, the change in elevation is not gradual Fig 4 1 shows that about 16 kilometres west of Taif there is a steep increase from an altitude of about 1,000 metres to 2000 metres



COMPILED FROM THE U.S GEOLOGICAL SURVEY MAP 1-210 1966

Fig 4 T

Because of this problem of elevation the old road followed Wadi Al Yamaniyyah where the elevation increases gradually from 277 metres at Mecca to 429 metres at Ash Sharayi to a maximum of 1230 metres at As Sayl al Kabeir before reaching Taif which is 1682 metres above sea-level This road is 107 kilometres long or 80% longer than the direct distance between the two cities

The present road, which was completed in 1965, takes a more direct way by going from Mecca to Arafat, Shidad and then climbing the bold mountain at Jirubah only by twisting round the mountains through cuts, embankments and bridges until it reaches Al Hada which is about 2099 metres above sea-level The road then descends gradually to the elevation of Taif This road is 89 kilometres long or 29 kilometres longer than the direct distance Most of these 29 kilometres were caused by the bends necessary to climb the steeply rising mountain at Al Hada

Because of this problem of elevation the cost of constructing the Taif-Mecca road was higher than for any other road in the country, On average it costed 1,300,000 SR per kilometre and the section traversing Al Hada costed about 4,000,000 SR per kilometre The average cost of road construction in other parts of the country is about 200,000 SR per kilometre

(A)

(B)

Fig.4.2 The expensive earthwork required and the danger of landslides (Mecca - Taif road)

(C)

(D)

Fig. 4.2 (continued)

At As Sayl Al Kabeir

At Az Zayma

Fig. 4.3 The Yamaniyyah road passes via areas with agricultural potential and water supply.

Fig. 4.4. Most of the earthwork required has already been done in the deserted Yamaniyyah road.

In spite of such a high cost the design speed achieved is only 40-45 Km/h for a large part of this road Moreover, the safety standard is very low specially during rains when traffic may be stopped by landslides falling down on the road and the wadis bringing huge amounts of gravel on various points (See Figs 4 1 and 4 2)

In view of this high cost of construction and maintenance and this low design speed and safety standard, and after travelling on both the present road and the Yamaniyyah road, one comes to the conclusion that the Yamaniyyah road should have been re-constructed instead of the present road Such a conclusion is also based on various other facts (1) The Yamaniyyah road passes via areas with agricultural potential, good soil and water supply and many settlements such as Ash Sharayi, Az Zayma' and As Sayl Al Kabir (Fig 4 3) (2) Taking into account the average cost of road construction in the Western region, together with the fact that most of the necessary earthwork had already been done for the Yamaniyyah road, as seen in Fig 4 4, the cost of the construction of this road can be estimated at around 53,500,000/SR (500,000 SR x 107Km) or 63,200,000 SR less than the cost of the construction of the present road (3) The present road has the

LOCATION COST OF CONSTRUCTION AND DESIGN SPEED - VARIOUS ALIGNMENTS FOR THE TABUK - HAQL - ASH SHAYKH HUMAYD ROAD

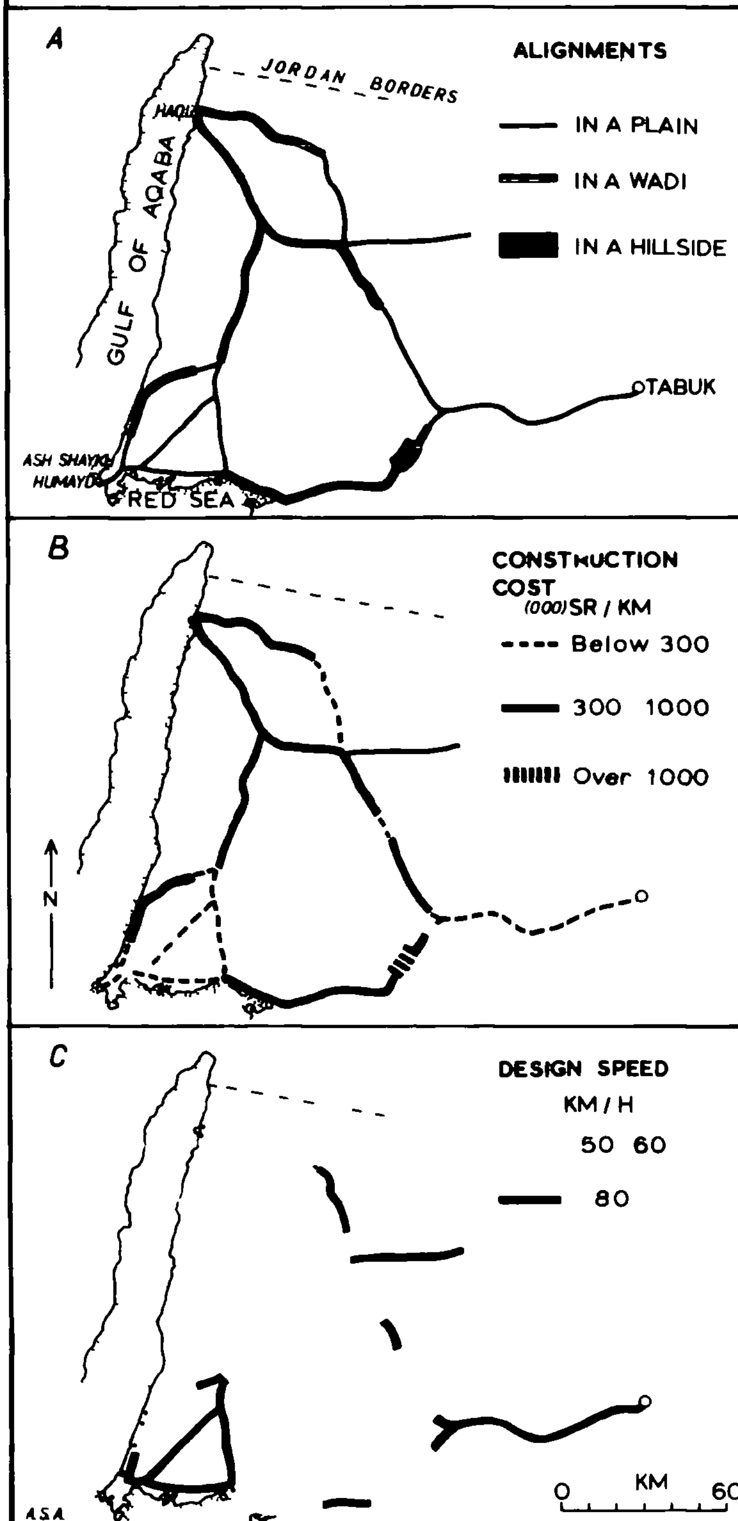


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Fig 4 5

advantage of being 19 kilometres shorter than the Yamaniyyah road but the difference in the transportation cost which resulted from the difference in length would be offset by the lower maintenance cost, lower accident cost and higher design speed of the Yamaniyyah road However, since the present road has already been built there is no need to carry this discussion any further

The impact of the Surat Mountains on road location in the Western region can be illustrated better by referring to the location of the Tabuk - Haql - Ash Shaykh Humayd road Fig 4 5 shows the impact of this problem on the cost of construction and the design speed of the possible alternative alignments Since this road was to link three towns it falls within the Steiner's problem "If one of the angles of the triangle is equal to or greater than 120° then the villages at the other vertices should be directly connected to this vertex If, on the other hand all angles in the triangle are less than 120° the solution is to connect all three villages to a junction point so located that all three roads meet at 120° angles" [2] In the case of the Tabuk - Haql - Ash Shaykh Humayd road a junction was required but the Surat Mountains problem did not permit an optimum location for this junction or the roads which link it with the three towns Because of the difficult morphology of the area the road follows the plains whenever possible, if plains are not available then the road follows the bottom of the wadis between the mountains, if such wadis are not available then the road has to be built on hill sides The 120^{o} junction theory and the availability of plains and wadis determined the location of the possible alignment of this road as can be seen in Fig 4 5 In all cases, but a section of seven kilometres, the road follows the plains or the bottom of the wadis

When A and B of Fig 4 5 are compared with each other it is easy to notice that in general roads which follow the plain cost less than 300,000 SR per kilometre, in average, roads following the valley bottom cost about 300,000 per kilometre, while roads on hillside cost over 1,000,000 SR per kilometre In fact the cost of one kilometre of this last section was estimated to be 6,000,000 SR [3]

When A and C of the same figure are compared we find that in general roads which follow the plains have a design speed of 50 - 60 Km/h

When A, B and C of Fig 4 5 are compared it is very clear that the Surat Mountains problem affected the location of the Tabuk-Haql Ash Shaykh Humayd road by limiting the possibilities of building a direct road according to the 120^{o} theory and by increasing the cost and lowering the design speed in large sections of this road The impact on the cost of transport is too obvious to need emphasising here

The Problem of Escarpments

Central Arabia is dominated by several steep, west-facing escarpments with gentle eastern slopes Most of these escarpments are 'cuestas' formed where a geologically younger strata is laid on an older one Consequently, these escarpments have a general north-south direction following one another from west to east Geologically, the further we go to the east the younger these escarpments become

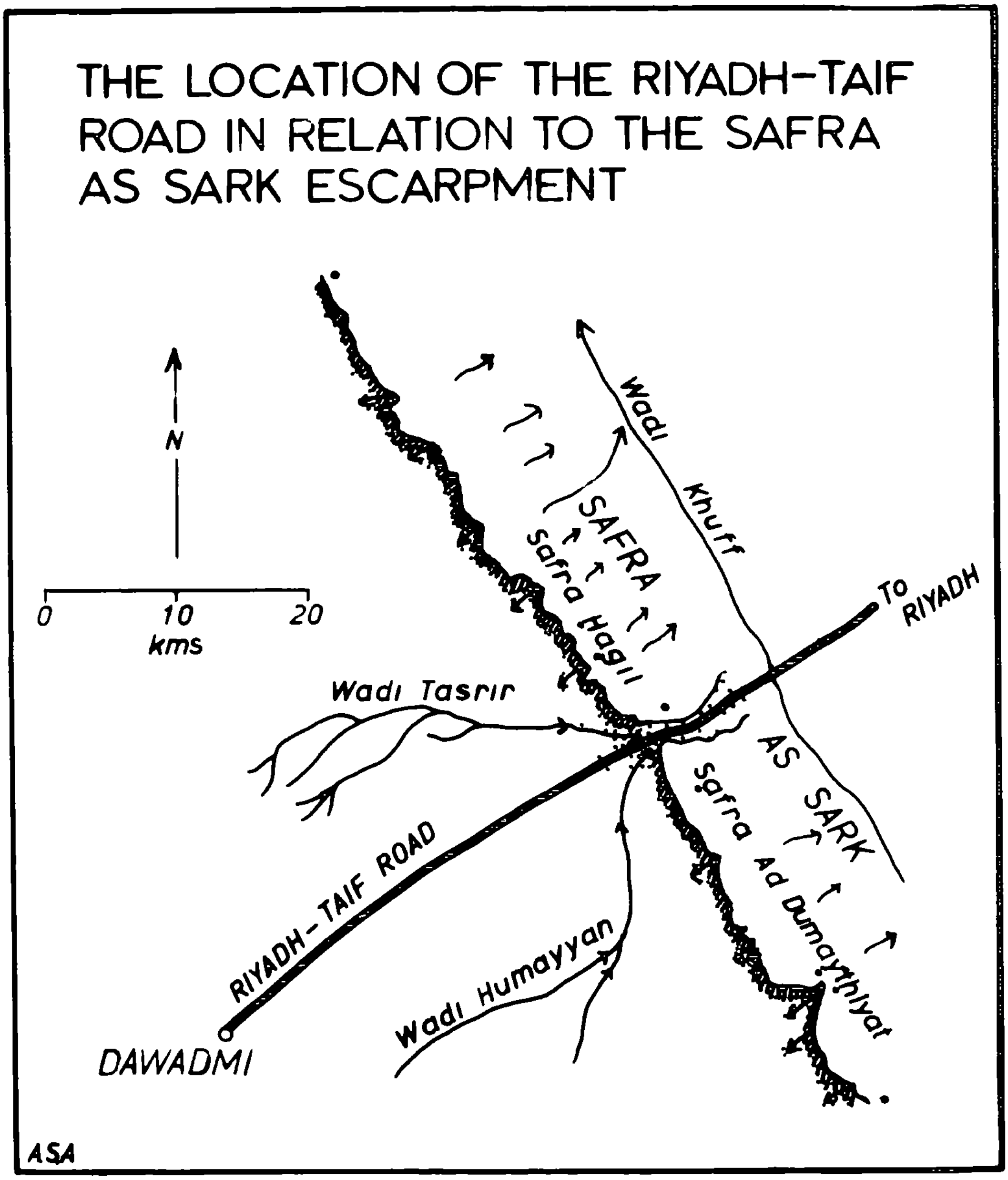
As it is the general rule in geomorphological regions dominated by cuestas, the face of each cuesta is adjacent to a subsequent plain parallel to it The face of the cuesta is usually cut by the obsequent water courses running against the general slope of the stratas from the top of the cuesta to the subsequent plain

Tuwayq (Middle Juriasic limestone) is the longest and highest of the escarpments of central Arabia It has a length of about 500 miles and its average height from the adjacent plain is 800 feet Tuwayq and all the other escarpments have a northwest - southeast direction in the part north of the 24^{o} latitude line and northeast - southwest to the south of that line

Due to their direction, these escarpments form a problem for the roads of east-west direction The only natural ways for such roads are the gaps that have been cut in the faces of these escarpments by water courses Roads of north-south direction have no choice but to follow the subsequent plains adjacent to the faces of the escarpments

All through history roads have followed the natural ways of this region not only because they provide the best morphology but also because they contain most of the settlements in the area The subsequent plains due to their morphology have more water resources, better agricultural lands and better accessibility than other parts of central Arabia

To demonstrate the impact of the escarpment problem on road location three sections of the Riyadh - Taif road are here studied in some detail the first section traverses an escarpment through a natural gap, the second traverses a much more difficult escarpment without using the best natural gap, and the third section follows a subsequent plain



COMPILED FROM THE U S GEOLOGICAL SURVEY, MAPS 1-207A 1958 & 1-207B, 1957

The escarpment of Safra As Sark which is adjacent to the Dawadmi plain is not very high, but forms a barrier to the Marat-Dawadmi road (part of the Riyadh - Taif road) As can be seen from Fig 4 6 the road traverses this escarpment through a natural gap cut in its face by Wadi Tasrir and Wadi Hamayyan The gap which is followed by the road cuts the escarpment into two parts Safra Hagil to the north and Safra Ad Dumaythiyat to the south The location of the town of Dawadmi and some other towns in the area can be related to the accessibility provided by this gap and the problem of the escarpment of Safra As Sark

The impact of this problem on road location can be seen, however, in the Adirab section of the Riyadh-Taif road This is the section which traverses the escarpment of Tuwayq without following a very clear cut natural gap The problem here is caused by the sudden rise of Tuwayq from an elevation of 670 metres to 894 metres above sea level Tuwayq thus forms a vertical wall which rises for about 224 metres above the Muzahmiya plain

The natural way through this wall is the gap made by Wadi Al Hisyan and Wadi Hanifa 65 kilometres northwest of Riyadh This gap was wisely used by the ancient caravaners and by motor vehicles until 1962 when the present asphalt road was built at Al Adirab 30 kilometres southwest of Riyadh

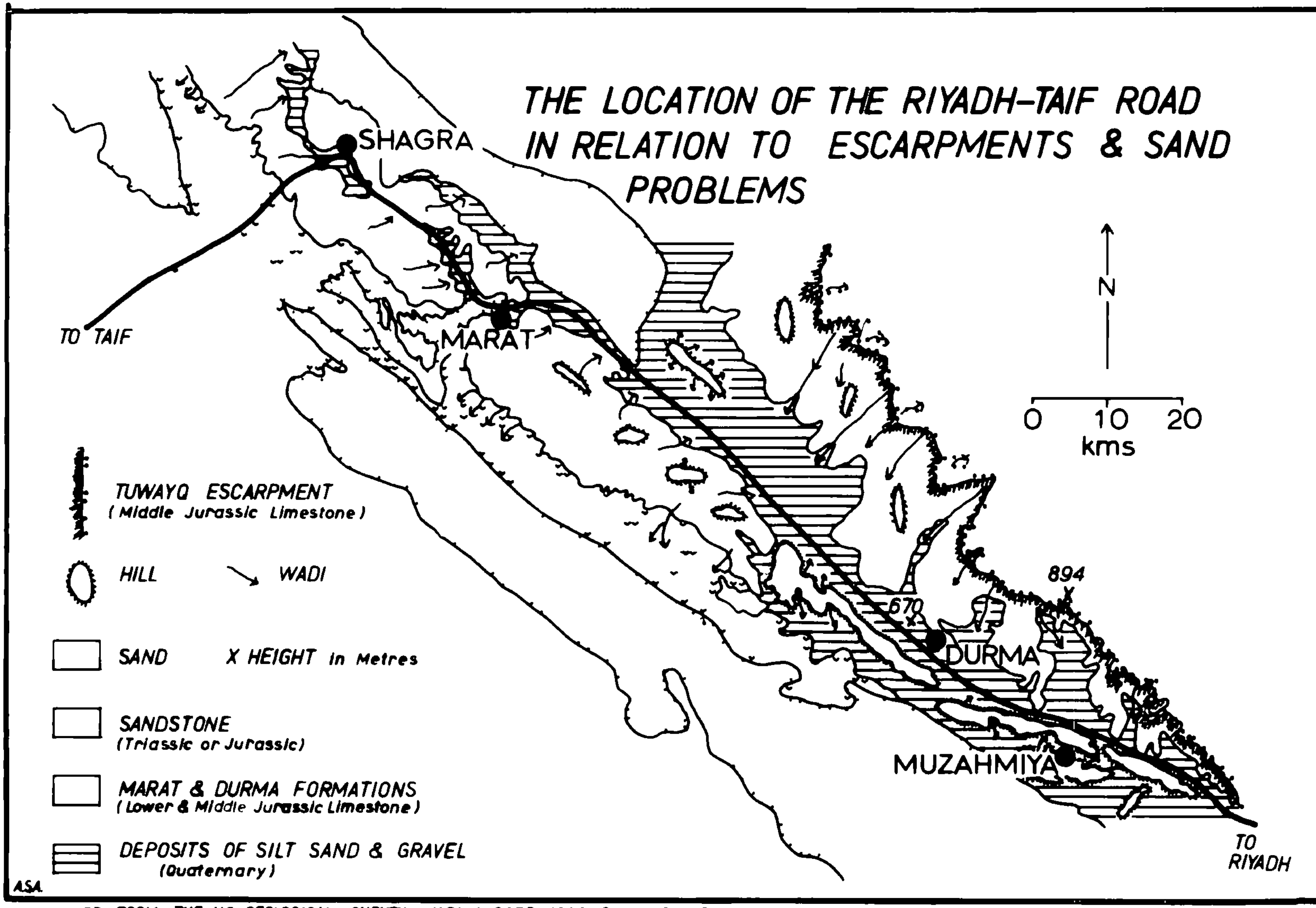
Fig. 4.7. The Adirab road descending Tuwayq escarpment to the Muzahmiya plain.

Fig.4.8. The Adirab road is sometimes called " the road of death".

At Al Adirab the escarpment of Tuwayq is cut by a fault followed by Wadi Shuib Al Ha The escarpment at this point consisted of two cliffs, the higher one is 70 metres high but with an easy side, the lower one forms a real perpendicular wall The road traverses this cliff by means of a series of channels and viaducts and then an embankment before reaching the plain of Al Muzahmiya [4] (See Fig 4 7)

The impact of the escarpment of Tuwayq on the Adirab road can be seen from different angles First, the cost of the construction of this road was 2,000,000 SR/Km against 200,000 SR/Km for the road on the Muzahmiya plain [5] Second, even with such a high cost the road has a design speed of only about 30 Km/h at the part descending Tuwayq compared with 100 Km/h for the road on the Muzahmiya plain [6] Moreover, the safety standard of the Adirab road is very low, and the citizens of Riyadh call it "the road of death" (see Fig 4 8)

The effect of the Tuwayq escarpment problem can be better appreciated when the Adirab road is compared with the Muzahmiya road This road runs on the Muzahmiya plain parallel to Tuwayq following the smooth quarternary



COMPILED FROM THE U.S. GEOLOGICAL SURVEY MAPS 1-207B 1957 & 1 207A 1958 morphology of this subsequent plain as can be seen in Fig 4 9 This road has a relatively low cost, 200,000 SR per kilometre, high design speed (100 Km/h)[7] and high safety standard which result in low cost of transport

<u>The Problem of Sand Formations</u>

Saudi Arabia's land surface is covered in many places with several huge sand formations The largest of all is Rub' Al Khali (Empty Quarter) which occupies an area of 250,000 square miles, or three times the size of Great Britain The second huge sand body is An Nafud which covers an area of 22,000 square miles Between these two remarkable sand formations there are several long, narrow belts of sands extending from north to south in central Arabia The Dahnaa is the longest of these belts as it extends for 800 miles, linking An Nafud in the north with Rub' Al Khali in the south West of the Dahnaa and in-between the escarpments of central Arabia there are several other sand belts coming from An Nafud to the south but none of them is long enough to reach Rub' Al Khali Apart from these main sand bodies sand formations are found in all regions of the country but on a much smaller scale

Thus the sand formations problem is the most common throughout the country Moreover, it is the only problem which has so far remained insoluble in two cases as far as land transport is concerned Neither Rub' Al Khali nor An Nafud have ever been penetrated by roads

However, in any barriers neither the size nor the structure are as relevant to road networks as the geographical situation of these barriers These barriers become problems when they are situated between two settlements or two sites that need to be linked with each other by a road or a railway Rub' Al Khali, though the largest sand body in the country does not really form a barrier between any two parts of Saudi Arabia On the other hand An Nafud, though much smaller than Rub' Al Khali forms a more serious problem for the road network since it separates the northern region from the rest of the country In fact, the northern region, because of An Nafud barrier is geographically part of the Syrian rather than the Arabian desert Its linkage with the rest of Saudi Arabia is only possible via two corridors one at the eastern end 40 kilometres wide and the other at the western end 20 kilometres wide The eastern gap is used by the Tapline road and the western gap is due to be used by a new road' according to present road programmes So far, there is no intention to link central Arabia and the north region with a more direct road and thus the traffic from say Al Gassim to Ar'ar has to go around via Medina-Tabuk or the other way via Riyadh and the Gulf region

It is due to their geographical situation that the sand belts of central Arabia form a more serious problem than either of the two huge sand bodies By having a general north-south direction these sand belts stand in the way of the most important link in the road network between the oil area, the political centre and the holy cities

Certainly the Dahna is the most serious physical barrier for the Dammam - Riyadh asphalt road and railway This sand belt has no gaps that can be used by routes and thus the two routes had to be built over the sands with some degree of protection

The sand belts west of Riyadh are not as continuous as the Dahna but are cut in some places by gaps which are sandless These gaps have long formed natural routes, and consequently we find some relatively important towns located on them For example, Shagra and most of the settlements of Al Washm are located at a gap in the most difficult sand barrier west of Riyadh

The problem of sand belts west of Riyadh is enlarged by the problem of the escarpments since these sand belts usually cover the subsequent plains which form the natural ways in this region

It is mainly due to the sand belts of Nufud Qunayfida and Nufud Assir that the Riyadh - Taif road was diverted to pass through the gap that separates these two sand belts, thus becoming 150 kilometres longer than the direct line Fig 4 9 shows how this road traverses this obstacle through a sandless gap of 17 kilometres in width

It may be interesting to mention that the government is considering the construction of a more direct road which would cross Nufud Assir through metal-walled tunnels [8] The construction cost of this direct road was estimated by a consultant firm to be as follows

Table 4 1 Cost of Road Construction in Six Different Types of Terrain, exclusive of engineering supervision cost

Description	SR per Kilometre
Aeolian sand in depth	993,000
Dikaka (static sand valley)	486,000
Silty Wadi Beds	403,000
Outcropping rock including dyke systems	387,000
Fragmented and boulder-strewn surfaces	321,000
Pebble sheets overlying well graded sands	258,000

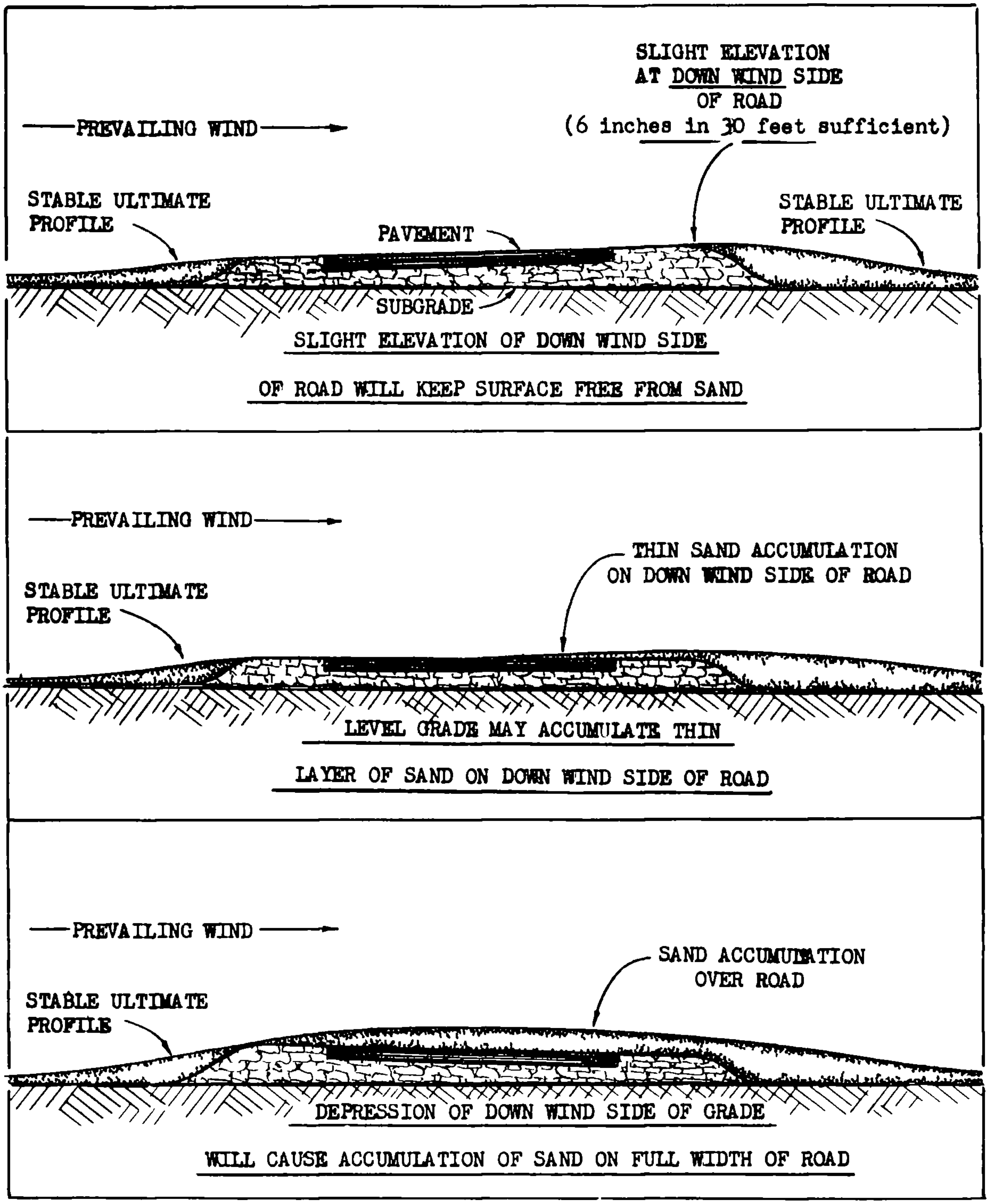
Source Howard Humphreys, Keeble and Partners, Riyad-Al' Quwayiyah - Zalim Road, p 15 (unpublished preliminary report submitted to the Road Department in January, 1967)

Riyadh - Dammam road (at the Dahna)

Jedda - Medina road

Fig. 4.10. The problem of sand.

ACCUMULATION OF SAND ACROSS ELEVATED HIGHWAY GRADES



After Kerr, R. C. & J. O. Nigra, Analysis of Eolian Sand Control, 1951

Fig. 4 II

Fig. 4.12 Oil spraying is used to protect the roads from drifting sand. (The two photographs are for the Riyadh - Dammam road.).

Drifting sands are one of the most common problems in road maintenance Fig 4 1D shows some types of hindrance from drifting sands in various parts of the country This problem has been seriously considered by Aramco which undertook some experimental research on the best way of protecting roads and oil installations from sands These experiments proved that there is a relationship between the gradient of the road and the amount of sands that may cover it by the force of the wind [9] Fig 4 11 shows that the best gradient for roads in sandy areas is with slight elevation at down wind side Six inches in 30 feet was found to be sufficient The worst gradient was found to be that with depression of the down wind side as this will cause accumulation of sand on the full width of the road

Stabilization of sand on the sides of the roads was found to be very effective, and may be done by the spraying of any liquid or by plantation In Saudi Arabia the spraying of high gravity penetration oil has been used to a remarkable extent in the eastern area (see Fig 4 12)

<u>Other Physical Problems</u>

Apart from the main problems discussed above, the physical environment of Saudi Arabia presents many minor problems in road location and construction The huge size of the country for example makes the distance involved between road projects and sources of steel and asphalt supplies very great Thus roads which are located in the north-western part of Saudi Arabia cost more to build than roads in the eastern area In the first case asphalt has to be transported from Dhahran for a distance of about 1,500 kilometres and steel has to be transported from Jedda for a distance of about 800 kilometres In the second case both asphalt and steel can be provided locally from Dhahran and Dammam In fact, the distance involved between the site of road projects and the main cities has a clear effect on the cost of engineering and design studies The large distance involved is also a problem in administration as it makes communications between project sites and main headquarters a difficult and expensive matter The international consultant firms use telecommunication systems but unfortunately the Road Department has no such systems yet

Aridity is another problem as water is needed for work and the workers at the site of road projects Very often water has to be transported from a long distance In some cases the cost of transporting water becomes so high that the drilling of wells at the site becomes justifiable

(A) The Tapline road (at Wadi Al Batin)

(B) The Mecca - Az Zayma road

Fig. 4. I3. The soil erosion problem.

(C) The Mecca Deviation (Jedda - Taif road)

(D) The Mecca - Medina road

Fig. 4.13 (Continued)

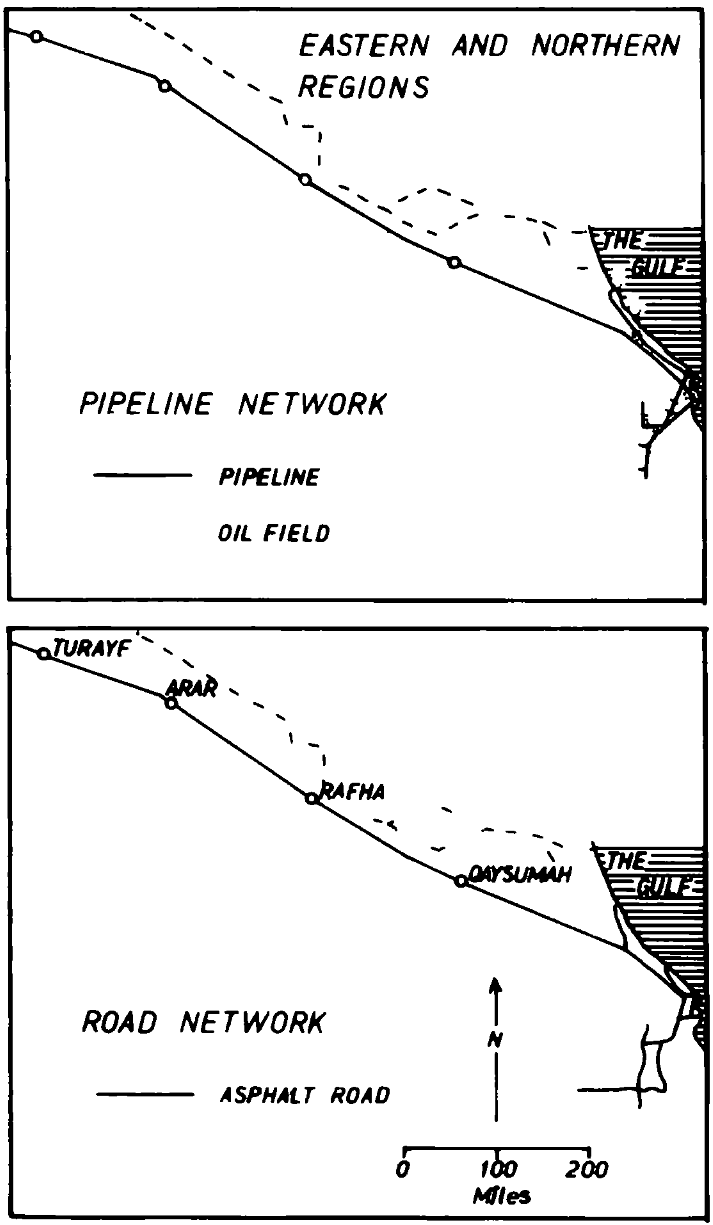
In ancient times the aridity problem was the most important single factor that decided the location of roads

Soil erosion is also a problem for roads in Saudi Arabia The photographs in Fig 4 13 were taken from different roads in different parts of the country to demonstrate this problem It was surprising to find such effects on roads built recently according to the design and supervision of some international consultant engineers

In fact, it was due to extensive soil erosion that wadis in Saudi Arabia are very wide and very deep (Wadi As Sirhan, for example forms a depression of 200 miles long and 20 - 30 miles wide) So, although the country is a desert some big and expensive bridges have to be built when a road is traversing a major wadi What makes this problem more difficult is the fact that desert rainstorms and floods are unpredictable, especially where data is scarce

The shape of the sea coasts of Saudi Arabia do not present a problem for road location since they are fairly regular Yet in the case of the Safwa - Ras Tannurah road the shape of the sea coast forms a locational problem

LOCATION OF ROADS IN RELATION TO OIL FIELDS AND PIPELINES



ASA

The direct distance between the two towns is only 18 kilometres, but the road, because of the shape of the coast line is 33 kilometres long

Conclusions

The physical environment of Saudi Arabia has presented some problems in road development and road location through history as well as at present By affecting the cost of construction, the design speed, the safety standard, the cost of transport and the cost of maintenance these problems have affected the location of roads in different ways and have presented different problems in different regions

It must be said, however, that in spite of all the problems mentioned above, the physical environment of Saudi Arabia is in general favourable for road construction Suitable soil materials are usually available anywhere in the country The general morphology of the country is also favourable In fact it was this general morphology which allowed the shape of the road network in the eastern and northern areas to be similar to the shape of the oil pipeline network The tapline road which extends from the Arab/Persian Gulf to the Jordanian border is in general as straight as the Tapline itself (Fig 4 14)

In general, roads are parallel to the Surat Mountains in the Western Region and to the escarpments in central Arabia The two huge sand formations of Rub' Al Khali and An Nafud are completely avoided by the roads In the eastern and northern regions road locations are not related to a particular physical problem but to the oilfields and the pipeline network

Finally the Road Department should, however, try to diminish the effects of physical problems on roads through utilization of the advances in technology Such problems can be best solved only by sufficient locational and engineering studies based on reliable and sufficient data

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CHAPTER FIVE

Some Human Problems in Road Location, Construction and Maintenance

The previous chapter shows a close relationship between the location, construction and maintenance of roads and the physical environment of Saudi Arabia, but the physical characteristics of the country are not the only factors influencing roads

There are several human factors which affect in one way or another the location, design, construction and maintenance of roads According to the rule which says roads appear where they are needed and can be afforded (see Chapter Two), the function of a road is the factor that decides its general location For example if there is a need for a road to link settlement A with settlement B then the general location of this road will be within the A/B area It was this function factor which decided the east-west axis pattern of road development in Saudi Arabia

Human factors, like physical factors, may justify deviations in the A/B road from the direct line in order to serve one or more settlements in the area between A and B This type is a positive deviation while the one caused by physical barriers is negative The clearest example of this type of deviation in Saudi Arabia is that of the Dammam - Riyadh railway The direct distance between Riyadh and Dammam is 390 kilometres, but the railway was diverted to pass via Hufuf, Harad and Al Kharj, thus becoming 565 3 kilometres long, or 175 kilometres longer than the direct distance

However, deviations caused by human factors are not always of a positive type The deviations around Mecca and Medina were built because non-muslims are not allowed into the two holy cities In these two cases the religious barrier acted exactly as a physical barrier

It is most important to realize that it is people who decide the location of roads and it is people who design and build them Road location thus depends on the judgement of the people, while its design, construction and maintenance depend on their technical and labour efficiency

In Saudi Arabia as well as in most other underdeveloped countries this factor of labour force and technical ability forms the most difficult problem in transport development The main aim of this chapter, therefore, is to investigate the dimensions of this problem, its impact on road location, construction and maintenance and then the ways in which

Saudi Arabia has dealt with it

With a population of only 3 3 million (1962-3) Saudi Arabia has a problem of inadequate labour force Further, according to the 1963 population census, men of working age numbered only 822,000, of whom 165,000 were nomads

Another problem is the quality of the labour force, the number of Saudis with a university degree was 1,818 in 1963-64 and only seven of them had specialized in civil engineering [1]

With such an inadequate labour force the development of transport was handicapped in spite of the financial resources for a very high rate of development When the government decided to build an average of one thousand kilometres of new roads every year it was found that all the local constructors were unable to build more than an average of three hundred kilometres a year Even then local constructors were shown to be unable to fulfil their contracts with the government and projects were always many years behind schedule For example, though the Mecca-Taif road was given to the most capable constructor, this road was only completed in 1965 instead of 1960 as was stated in the contract which was signed by the constructor in 1958 Another example is the Medina-Tabuk road which was supposed to be completed in 1961 according to the contract but was only completed in 1965 Though these two examples are the most extreme ones, almost all roads built with contracts signed before 1963 were not completed in the right time Such delays not only prevented high rate of road development but also resulted in economic loss owing to the immobilization of the capital invested in road construction as well as to delay in the use of the roads

It was because of the lack of know-how that most of the roads built before 1963 were badly located The Medina - Tabuk road is said to have been located on the trail of the vehicle of the general director of the Road Department at that time without any study Consequently a large part of this road (the Medina - Khayber section) had to be relocated only one year after its construction, and a study has also been completed for the relocation of the Adirab road, a part of the Riyad - Hijaz road The locational error of the Taif - Mecca road was discussed in the previous chapter Such locational errors were a result of the decision-making policy In the early 1950's the decision to build a new road used to be taken by His Majesty the King himself who might also decide the location of the road by ordering that it should pass via a certain settlement or cut through a certain physical barrier Later the judgement of the general director of the Road Department became of a considerable importance in the location of roads, though, until 1963 the precise location used to be left for the constructor to decide without any previous studies

The design, construction and maintenance of roads were all also affected by the problem of labour force and technical ability Some sections of the Jedda - Medina road had to be rebuilt after each desert rain storm, and the Medina - Khayber road had to be rebuilt only one year after it was constructed Further, until very recently roads had very little or no maintenance at all and the Road Department was about to face a major reconstruction programme

This problem was solved in 1963 by importing the required technical ability from abroad In 1962 the government asked the United Nations for technical assistance In the same year a team of some United Nations experts visited the country and since 1963 a permanent team of experts have been responsible for the overall planning and programming of road development and works in Riyadh for the Road Department

In 1963 some international engineering consultants were also hired to undertake the necessary studies for each new road project and to supervise the local constructors during their building of roads

At first the government did not want to bring in foreign road constructors simply because such steps would put local constructors out of business Later, it was found that even with the assistance of the United Nations experts and the consultant firms the local constructors were unable to carry out the road construction programmes as planned Many roads were behind schedule Consequently a limited number of foreign constructors were given some of the road projects

At present both the Road Department and the local constructors are highly dependent on foreign technicians and engineers Apart from the United Nations experts and the foreign consultants the number of non-Saudis working for the Road Department in 1968 were 56 civil engineers, 34 surveyors, 16 draughtsmen and 11 other technicians

In this way Saudi Arabia solved the problem of an inadequate labour force and technical ability, using some of the foreign currency gained from the export of oil, skilled personnel from abroad were employed Other underdeveloped countries who lack the financial resources would not be able to solve this problem in the same way or at least not on the same scale especially if they have a balance of payments problem

About 11 1 percent of the money spent on road construction in Saudi Arabia goes to the foreign consultant firms Consequently road construction now costs on average about 35,000 SR per kilometre more than it used to cost before 1963 About 20,000 SR of this amount is the cost of foreign consultant engineering services For some roads (Al Hanakiya - Al Nugrah Road) the cost of the foreign consultant services was as high as 38,000 SR per kilometre or 18 6 percent of the total cost In return for this additional cost the roads which had been built in Saudi Arabia since 1963 are probably among the best in all underdeveloped countries in location, design and construction

However, even with the assistance of the team of United Nations experts and the 117 non-Saudi technicians and engineers, the roads which were built directly by the Road Department (without local or foreign constructors' assistance) are very poorly located, designed and constructed The Mecca-Az Zayma road was totally destroyed by rain in the same year of its construction Fig 5 1 shows some of the defects in this road During an investigation by the

Fig. 5.I. Some of many defects in the Mecca - Az Zayma road.

author in May 1968 it was found that the longest distance between the sites of two defects was as short as five hundred metres

Conclusions

Human factors are by no means less important in road location than physical factors They decide the general location of roads, justify positive deviations and in some cases they may impose negative deviations

In road design, construction and maintenance the lack of technical ability and adequate labour force is no doubt the most difficult problem as far as Saudi Arabia is concerned However, having the required money Saudi Arabia solved this problem by importing experts, consultant firms and constructors as well as technicians and engineers from abroad

Is the high financial cost, with which this problem has been solved, justified? And how much should the country depend on imported experts, consultants and technicians? No definite answers can be given to these questions Yet it seems that at present there is no alternative but to depend on imported technicians Further, it would be wrong to stop or slow down the development of transport merely because of a dislike of the use of the hired assistance, for this would hinder the social and economic growth of the country Furthermore, the contact with foreign experts, consultants and technicians should help to improve the local efficiency not only in the transportation field but in social and technical matters in general

The step which should be taken, however, is to encourage the local technical ability to develop at the quickest possible rate Objective educational courses should be encouraged more, and high wages to the efficient Saudi technicians and administrators should be given According to the present wages policy a foreign engineer at Sauti (one of the foreign consultant firms) gets a salary of 15,513 to 16,881 SR per month[2], while a Saudi engineer with the same qualifications is given a salary of 1800 SR a month, or only one-ninth of the salary given to the foreign engineer Obviously this is not very encouraging

Another step which could help in solving the problem of the lack of technical ability is the participation of various university departments in transport development A university team formed of economists, geologists, geographers and engineers could work as consultant for the Road Department The possibility of the university participation in transport development has not yet been explored

Finally it must be said that this problem of inadequate technical ability is not limited to road development but exists also on the Riyadh - Dammam railway and particularly in the Saudi Arabian Airlines, which depend on T W A for most of the technical and even administrative work

References

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CHAPTER SIX

The Motor Vehicle Stock

This chapter is devoted to the study of the motor vehicle stock It deals with its size, its composition growth, supply and geographical distribution All these aspects are studied in relation to the general economic development and the other influencing factors

The Size of the Motor Vehicle Stock

Regrettably, the number of motor vehicle in use is not yet accurately known Only two attempts have so far been made to estimate the size of the vehicle stock but both have been based on unconvincing bases One consultant firm (Sauti)[1] estimated the average vehicle life to be five years and thus came to estimate the number of vehicles in the country to be 14,000 cars and 8,000 trucks, a total of 22,000 (1961) Joubert,[2] the chief of the U N advisors working for the Roads Department, in Riyadh made the only other attempt by estimating the number of vehicles to be 16,000 cars and 12,000 commercial vehicles, a total of 28,000 (1965) The method he used to come to that estimate was, however, unconvincing, too, (22% per year retirement or 10% the first year, 20% for three successive years, then 30% per year) Both Sauti and Joubert used the vehicle import figures as the base of their estimates

Vehicle import records and an estimated vehicle lifetime were also used here for a new estimate of the number of vehicles in use But taking into account the conditions of roads, driving, traffic and types of vehicles used in Saudi Arabia as well as the average vehicle lifetime in some other underdeveloped countries,[3] we estimate the average lifetime of vehicles in Saudi Arabia to be six years for passenger cars, five years for trucks and ten years for buses Buses were given such a long lifetime because most of them are used only during the Hajj season which is a period of only two to three months a year (See Chapter Nine)

On the above basis the actual numbers of vehicles in use were estimated to be about 35,000 passenger cars, 22,400 trucks and 2,800 buses, a total of 60,200 in 1966 The growth of the number of vehicles in use can be seen in table 6 1

One should now ask if 60,000 motor vehicles are too many or too few or optimum for a country like Saudi Arabia, since 60,000 by itself means very little To give the motor vehicle figures more meaning they were compared with their counterparts in some Middle Eastern and other selected underdeveloped countries in Asia, Africa and

Table 6 1 Estimated No of Vehicles in Use

Year	Passenger Cars	Trucks	Buses	Total
1955	?	14,358	?	?
1956	14,566	14,751	?	?
1957	15,455	14,285	?	?
1958	15,584	13,335	?	?
1959	16,016	11,164	?	?
1960	16,716	8,052	2,308	27,076
1961	16,278	7,681	2,578	26,537
1962	18,075	8,936	2,632	29,643
1963	20,745	12,672	2,980	36,397
1964	25,589	15,491	2,521	43,601
1965	30,422	19,308	2,524	52,254
1966	34,941	22,381	2,809	60,131

1 Based on the vehicle import records, Statistical Yearbook 1387 A A , 1967 A D Central Department of Statistics, Riyadh, Saudi Arabia, p 189

2 Average lifetime was estimated to be 6 years for passenger cars, 5 years for trucks and 10 years for buses

South America as well as some highly developed countries The size of population was taken into account but the area was considered to be equal (table 6 2)

Table 7 2 shows that Saudi Arabia has more motor

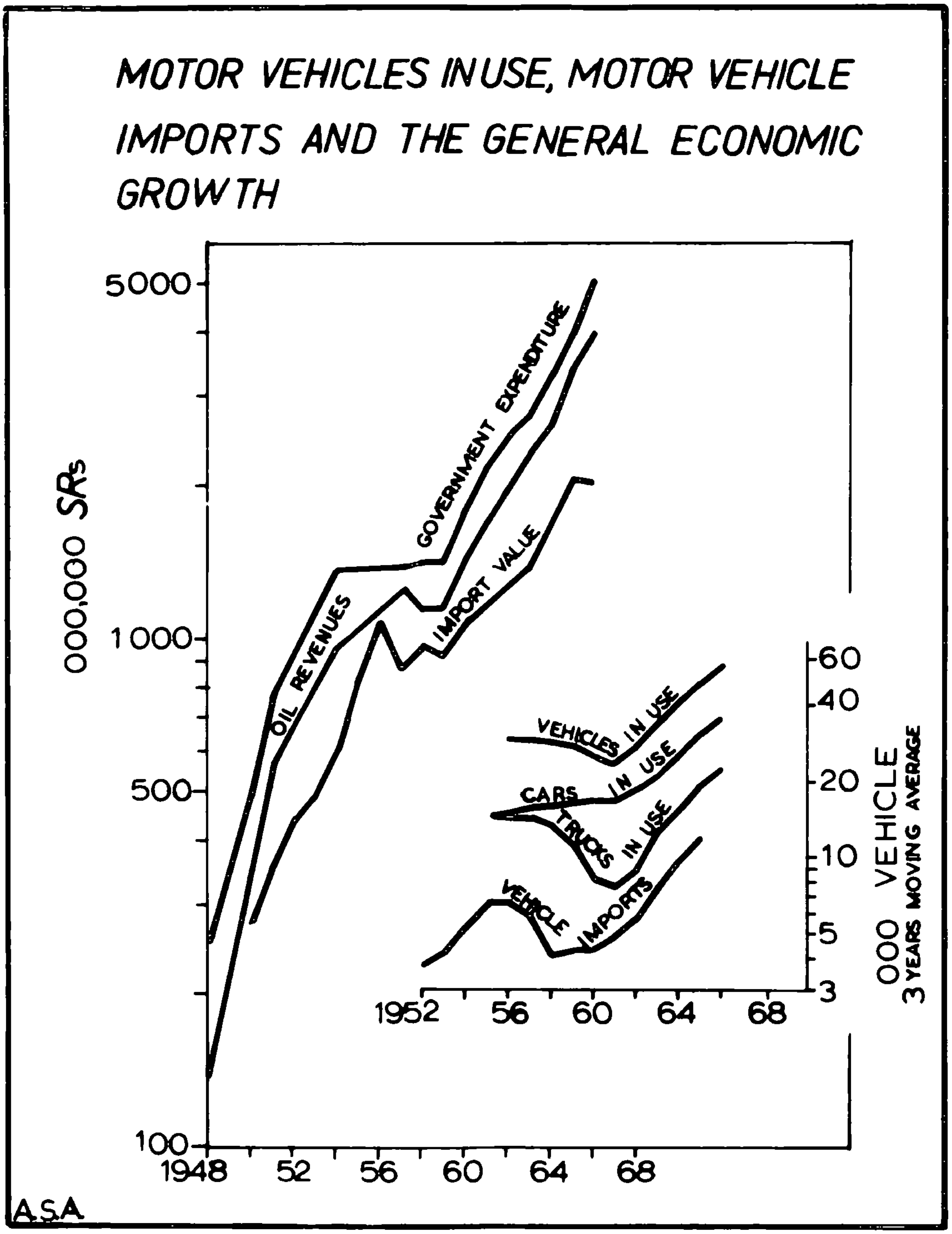
MOTOR VEHICLES IN USE, MOTOR VEHICLE IMPORTS AND THE GENERAL ECONOMIC GROWTH
000,000 SRs
5000
1000
500
100
1948
52
56
60
64
68
GOVERNMENT EXPENDITURE
OIL REVENUES
IMPORT VALUE
VEHICLES IN USE
CARS IN USE
TRUCKS IN USE
VEHICLE IMPORTS
60
40
20
10
5
3
1952
56
60
64
68
000 VEHICLE
3 YEARS MOVING AVERAGE
A.S.A.

Fig. 6 I

vehicles in relation to the size of its population than many other underdeveloped countries However, Libya which is the country in world most resembling Saudi Arabia in size, wealth, climatic and population conditions is much higher than Saudi Arabia in the table with only 25 persons per automobile Further, as Saudi Arabia has no internal waterways and only one railway line 565 Kms long, and as most of the other countries named in the table have one or both of these other media of inland transport, Saudi Arabian motor vehicle stock can be considered to be a small one even in comparison with other underdeveloped countries

The analysis of the growth of the motor vehicle stock in Saudi Arabia has indicated a very close relationship between transport development and economic development (Fig 6 1) The main factor behind the growth of motor vehicles is the importation which is the only source of vehicle supply Import in general and vehicle import in particular are dependent on the general economic situation, and particularly on the government expenditure which in turn is mainly dependent on the oil revenues The years with an increase in oil revenues mean increased government expenditure which leads to increased imports in general and increased

Table 6 2 Standard of automobilization in some Middle Eastern and other selected underdeveloped countries and in some of the most developed countries 1964

Country	No of persons per automobile	Country	No of persons per automobile	Country	No of persons per automobile	Country	No of persons per automobile	Country	No of persons per automobile
U S A	2	Lebanon	22	Tunisia	53	Ghana	136	Mali	436
		Israel	22	Zambia	62	Sierra-Leone *	166	Afghanistan	628
France	4			Saudi Arabia	76				
		Libya	25	Iraq	93	Turkey	167		
U K.	5	Peru	39	Kenya	103	Iran	172		
		Algeria	40	Syria	110	Sudan *	255		
Kuwait	6	Morocco	51	Jordan	116	U A R	299		
						Laos	342		

* No of motor vehicles for 1963

Source U N Statistical Yearbook, 1965, pp 428, 36 imports of vehicles in particular (see Fig 6 1) It is clear from Fig 6 1 that although the growth of both cars and trucks were affected by the interruption in the economic growth in the period 1956-60, the effect on trucks was much harder than it was on cars The reason behind this can only be explained by examining the function of cars and trucks in transport Cars are used for passenger transport while trucks are used for freight transport mainly from the main ports to the inland cities Since Saudi Arabia has no other large industry except oil, the freight road transport in the country is mainly used for the distribution of imports A decline in imports means a decline in the use of trucks and in the demand for trucks

Although the 1956-60 economic crisis has made the relationship between the general economic growth and the size and growth of the motor vehicle stock very clear it made the prediction of future growth difficult and less reliable The growth of the motor vehicles in use since 1961 was higher than average because of the decline between 1957 and 1961 Trucks because of their strong decline in 1957-61 showed and increase of 38% per annum in the period 1962-66 while passenger cars because they were less affected by the economic crises showed an increase of 24% per annum On the other hand if we include the period of decline 1957-61 without considering the previous period of growth we shall get a less than average rate of growth This point is discussed further in the following section where prediction has been attempted

Motor Vehicle Supply (Motor Vehicle Imports)

Motor vehicles were first imported to Saudi Arabia in 1926 (see Chapter One), but the number and types of vehicles imported during that year and until 1949 is unknown However, we have figures for the period 1950-1966 (table 6 3) and this is an excellent indicator for the trend of vehicle supply over a period of 17 years

A comparison between the number of vehicles imported in 1950 and 1965 shows an increase from 3393 to 13695 or 304% increase This increase corresponds to the general transportation and economic growth witnessed by Saudi Arabia since 1950, which can be seen in the increase of the length of modern roads from 111 Kms in 1950 to 4616 Kms in 1965, in the increase of oil revenues from SR 340 million in 1950 to SR 3182 million in 1965 and in the government expenditure which rose from SR 490 million in

Table 6.3 Number and Value of Vehicles Imported in Relation to the Growth of oil revenues, government expenditure and imports 1931-66

Year	Oil Revenues * (000,000SR)	Govt Expenditure (000,000SR)	Total Value of Imports (000,000SR)	No of Imported Motor Vehicles (Absolute Number)	Value of Imported Vehicles (000,000 SR)	Value of Imported Spare Parts (000,000SR)	Value of Imported Vehicles and Spare Parts (000,000SR)
1931	?	10	?	?	?	?	?
1948	140	251	?	?	?	?	?
1950	340	490	278	3393	?	?	?
1951	572	758	351	3535	?	?	?
1952	?	?	436	4216	?	?	?
1953	?	?	486	4939	43	12	55
1954	967	1355	597	6939	100	13	113
1955	?	?	834	8125	104	26	130
1956	?	?	1073	4953	65	47	112
1957	1241	1375	878	4475	52	?	?
1958	1145	1410	965	2983	48	?	?
1959	1149	1405	918	5514	65	26	91
1960	1410	1786	1053	4172	55	?	?
1961	1682	2166	1155	5028	77	4	81
1962	1951	2452	1266	7987	89	30	119
1963	2303	2686	1358	10396	132	40	172
1964	2608	3112	1693	11678	157	54	211
1965	3182	3961	2058	13695	171	70	241
1966	3987	5025	2007	12451	167	?	?

* Income tax and Tapline fees included

Sources (1) Information published in the Statistical Yearbooks of 1965, 1966 and 1967
(2) Unpublished Information collected from (A) General Directorate of Customs (B) Central Department of Statistics and (C) Various Motor Vehicle Dealers in Saudi Arabia

1950 to SR 3961 million in 1965 (Table 6 3) This economic growth has resulted in increases in the per capita income, purchasing power and consumption of food and goods, as well as the construction of many projects Hence, more motor vehicles were required to meet the needs of this social and economic development

However, vehicle supply has also proved to be very sensitive to the wars between the Arabs and Israel which usually reduce vehicle imports even if Saudi Arabia is not directly involved in them

History has shown that one outcome of the wars in the Middle East is the closure of the Suez Canal This happened in 1956 and repeated itself in 1967, not only during wartime but for a very long time after the war Since 95% of the imported vehicles come from North America and Europe through the Suez Canal, such wars result in a decline of vehicle imports.

The financial assistance which Saudi Arabia usually provides to the Arab countries directly involved in the wars with Israel, and the feeling of unrest and military preparation inside Saudi Arabia during such wars also have negative effects on vehicle supply though to a much less extent than the closure of the canal

In 1956 it happened that the economic crisis in Saudi Arabia coincided with the outbreak of the Suez War which lasted from late October until the end of 1956, and the closure of the Suez Canal which lasted from October 1956 until March 1957 [4] It was for these reasons that the general increase in vehicle imports which characterized the period 1950-55 turned in 1956 into a drop of 3,172 or 39 0% from the previous year

The Suez crisis ended in 1957 but the economic crisis remained until 1960 and thus the decline in vehicle supply continued but on a smaller scale In 1957 the number of imported vehicles was 478 less than in 1956, a drop of 9 7% After an increase of 84 8% in 1959, the import restrictions caused a decrease of 24 5% in 1960

In view of the above discussion it can be said that the decline in vehicle supply which occurred in 1956 and 1957 was caused by both the closure of the Suez Canal and the economic crisis, while the decline of 1959-60 was caused by the import restrictions

The trend of vehicle imports for the period 1950-66 (1370-86 A D) with a forecast of the future trend until 1980 is attempted in Fig 6 2 and Appendix A using the exponentially weighted averages technique This method

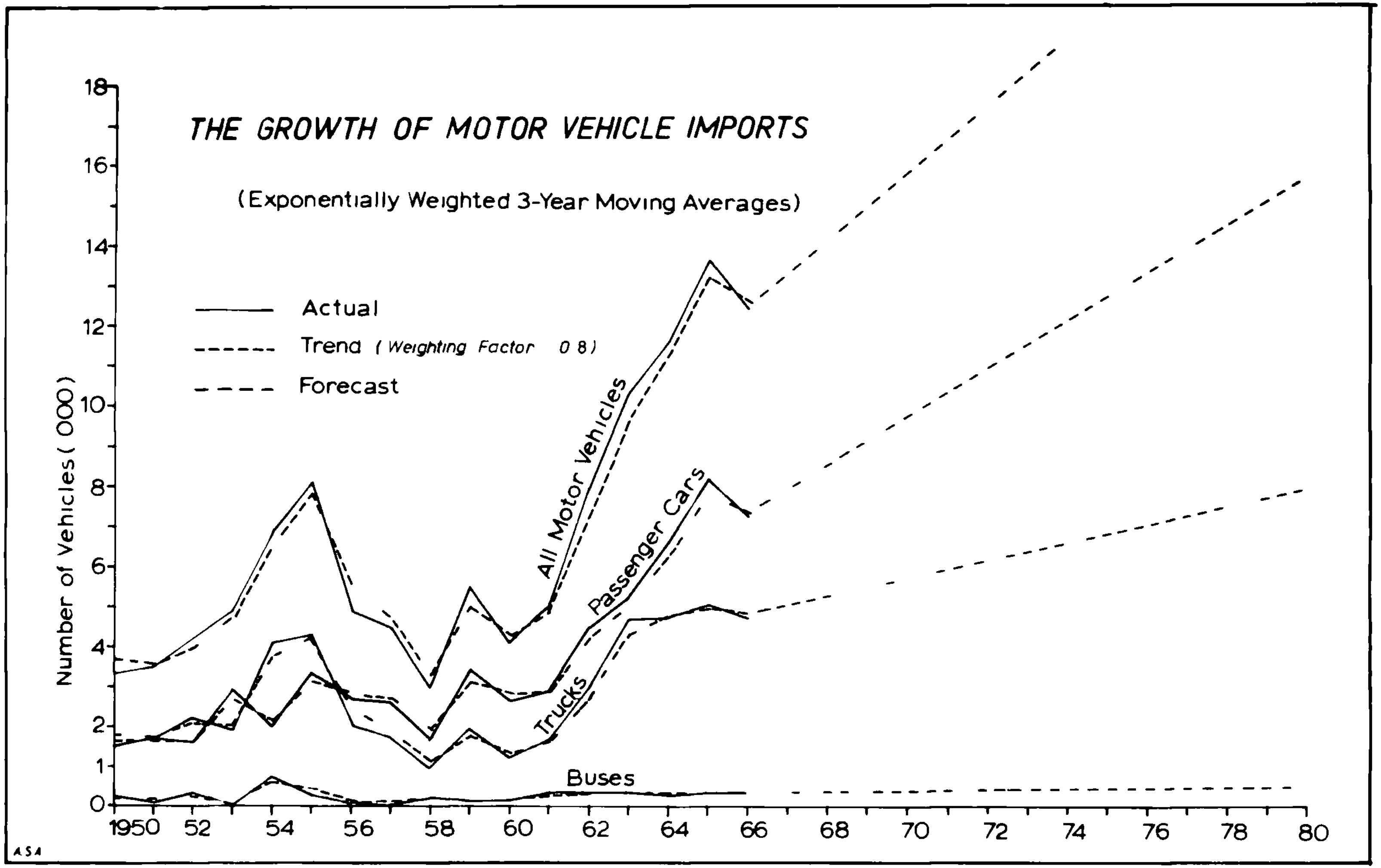
THE GROWTH OF MOTOR VEHICLE IMPORTS
(Exponentially Weighted 3-Year Moving Averages)
Actual
Trend (Weighting Factor 0 8)
Forecast
Number of Vehicles (000)
All Motor Vehicles
Passenger Cars
Trucks
Buses
1950
52
54
56
58
60
62
64
66
68
70
72
74
76
78
80
ASA

Fig 6.2

Table 6 4 The Trend of Motor Vehicle Imports in the Period 1956-60

(A) The Impact of the 1956-8 economic crises, the Suez War and the closure of the Suez Canal 1956

Year	Passenger cars	Decrease %	Trucks	Decrease %	Buses	Decrease %	Total	Decrease %
1955	3375	-	4365	-	385	-	8125	-
1956	2774	18	2084	52	95	184	4953	39
1957	2625	5	1768	15	82	14	4475	10
1958	1772	33	992	56	219	+167	2983	33
Average	2637	18 7	2302	41	281	1.0	5134	27 3

(B) The Impact of the Import Restrictions 1958-60

Year	Passenger cars	Decrease %	Trucks	Decrease %	Buses	Decrease %	Total	Decrease %
1959	3404	-	1955	-	155	-	5514	-
1960	2766	19	1253	36	153	1	4172	24

Source Based on the Statistical Yearbook 1387 A H , 1967 A D, Central Department of Statistics, Riyadh, Saudi Arabia, p 189 was prefered as it gives more weight to the more recent years in predicting the future trend [5] A weighting factor of 0 8 was used in the calculation The trend of growth per annum was calculated from the figures of the first and last six years as follows

The trend of growth per annum =

$$\frac{\text{the last six years/6 - the first six years/6}}{6}$$

the trend of growth was found to be 599 for passenger cars, 228 for trucks and 9 for buses, a total of 836 motor vehicles per annum (see Appendix A) The period 1956-1960 (1376 - 1380 A D) which was characterised with growth interruption and decline was treated sep8rately in table 6 4 which irdicates what effects future wars, closure of the Suez Canal or economic crisis may have on the import of motor vehicles

However, Saudi Arabia imports motor vehicles mainly from four countries 46% from the U S A , 9% from West Germany, 8% from England and 5% from Japan Looking at each type of vehicle individually (cars, buses and trucks), the above four main suppliers remain at the top in the same order

As for the trend Japan and France, are having a larger increase than the other three countries France is improving her position steadily as a supplier of cars, the eight-passenger Peugeot has proved to be popular as a taxi between the major cities Japan is also improving its situation, the Toyota cars, jeeps and pick ups all have become increasingly popular in the last few years

It is worth noticing that the numbers of all types of cars imported from the U S A show a decline in 1968, probably because of the boycotting of Ford by Saudi Arabia and the rest of the Arab countries The drop in the number of vehicles imported from West Germany in 1965-6, notably cars and buses, also was probably caused by the critical political situation which prevailed between West Germany and the Arab World after the recognition of Israel by West Germany

In 1965 Saudi Arabia spent 170 8 million SR on vehicles import and another 69 8 million on vehicle spare parts, a total of 240 6 million This was 297% higher than the amount spent on vehicles imported in 1953, and 495% higher than what was spent on spare parts, the total was 339% higher than the amount spent in 1953

The 1956-8 economic crisis and the 1958-60 import restrictions were reflected very clearly in the drop of the value of imported vehicles in relation to the total value of imports In 1953 the value of imported vehicles represented 8 9% of the total value of imports while in

1965 it was only 5 0% The trend of economic growth returned to normal after 1960 and thus the value of imported vehicles grew to 8 3% of the total imported value in 1965 (table 6 5)

Table 6 5 The Effect of 1956-8 Economic Crises and 1958-60 Import Restrictions on the Money Spent on vehicles Imported

Year	Value of Imported Vehicles	Total Value of Imports	Value of Imported Vehicles to total Import Value
1953	42,977,000	485,600,000	8 9%
1958	48,308,000	964,700,000	5 0%
1965	170,785,000	2,058,100,000	8 3%

Source Based on table 6.3

This shows how vehicle imports were affected more than the total import by the interruption in economic growth between 1956 and 1965

Most of the money Saudi Arabia spends on vehicle imports, however, goes to the main four vehicle suppliers which with France account for as much as 80% of the total value (1965) The United States 43%, West Germany 29%, England 5%, Japan 2% and France 1%

Looking at each individual type of vehicle we find that the situation is almost similar to the one explained above, though, England, Japan and France come higher than West Germany in the value of imported cars and Jeeps

This however is a result of the fact that a larger proportion of the cars imported from West Germany are V W s which have a low price in comparison with cars of other makes However, the reverse is true when we look at the value of trucks imported from West Germany and compare it with the value of trucks imported from the U S A West Germany supplies the huge diesel Mercedes type which cost on average 30,800 SR per truck, while a large number of the trucks supplied by the U S A are pick ups which cost about 14,500 SR per vehicle For this reason we find West Germany takes 14% of the value of trucks imported to Saudi Arabia while it supplies only 6% of the total number of trucks imported

The Composition of the Vehicle Stock

Broadly, the history of transport in the last two decades indicates that passenger cars in all countries have been increasing with a higher rate than commercial vehicles (table 6 6) The situation in Saudi Arabia is in line with that general trend The proportion of passenger cars in use increased from 50% in 1957 to 61% in 1966 Further, the proportion of passenger cars to total vehicles imports increased from 48% in 1951-3 to 58% in 1963-65 This change reflects more than one factor but mainly the improvement of roads in the country (asphalt roads increased from 191

Table 6 6 The Proportion of Passenger Cars to the Total No of Vehicles in Various Countries 1948 and 1965

Country	1948	1965	Country	1948	1965
Algeria	65	69	Lebanon	72	88
Ghana	48	61	Syria	46	66
Kenya	82	87	Zambia	56	79
Libya	32	67	Venezuela	47	70
Kuwait	67	72	Afghanistan	34	50
Laos	67	76	Iraq	59	71
Mali	35	48	Turkey	36	46
Morocco	55	72	U K.	71	83
Sudan	43	51	France	71	81
Tunisia	58	61	U S A	81	85

Source U N Statistical Yearbook , 1965, pp 428,36

kms to 4616 kms in the same period), the improvement in the economic situation which enabled many people to own cars, and the growth of urban centres which made the car a necessity rather than a luxury in life A more detailed breakdown of the composition of the motor vehicle stock can be obtained from the traffic surveys of vehicles using the major roads (table 6 7)

However, the absence of internal water transport or railways and the vast distances involved resulted in a

Table 6 7 Percentage of Different types of Vehicles Using the Roads 1968

Private Cars	Taxis	Pick Ups	Trucks	Tankers	Buses	Others	Total
21 7	26 1	17 0	22 3	5 3	6 6	1 0	100

Source Calculated from the traffic surveys undertaken by the Road Department, Ministry of Communication and various consultants working for the Road Department

relatively higher proportion of trucks in Saudi Arabia than in other Middle Eastern Countries (table 6 8) But, since Saudi Arabia has no mass agricultural or industrial production, about 38% of its trucks are of the small pick-ups type (1 5 ton), the remaining are lorries (50%) and tankers (12%)

Table 6 8 The Composition of the Vehicle Stock in Some Middle Eastern Countries

Country	Passenger cars	Trucks	Buses	Total
Iraq (1964	60	29	11	100
Syria (1963)	59	35	6	100
Jordan (1963)	63	30	7	100
Israel (1964)	66	31	3	100
Egypt (1965)?	72	22	6	100
Lebanon (1965)	88	10	2	100
Average	68	26	6	100
Saudi Arabia (1966)	58	37	5	100

Source (1) Europa, The Middle East and North Africa, 1966-67 and 1967-68
(2) Table 6 1

The Geographical Distribution of Motor Vehicles

The analysis of the geographical distribution of motor vehicles shows a close relationship to the pattern of regional economic development and the pattern of the development of the road network which were summarised in a previous chapter More than 90 0% of the total number of vehicles are in the cities of the east - west axis Dammam, Hufuf, Riyadh, Taif, Mecca and Jedda The pattern of socio-economic development is also reflected in the fact that Mecca was the city with the largest number of vehicles until 1959, a position which was taken by Dhahran in the period 1960-62 and by Riyadh since 1963

Comparing the present geographical distribution of motor vehicles with the density of population we find no positive relationship between them (compare Fig 6 3 with Fig 1 2) On the other hand a comparison between Fig 6 3 and 1 3 indicates that town size is the most important, though not the only factor, in the geographical distribution of motor vehicles In analysing the factors influencing the geographical distribution of motor vehicles locational quotient analysis is used instead of correlation or regression analysis because of weaknesses in the data The eight cities which have more than 1,000 vehicles were

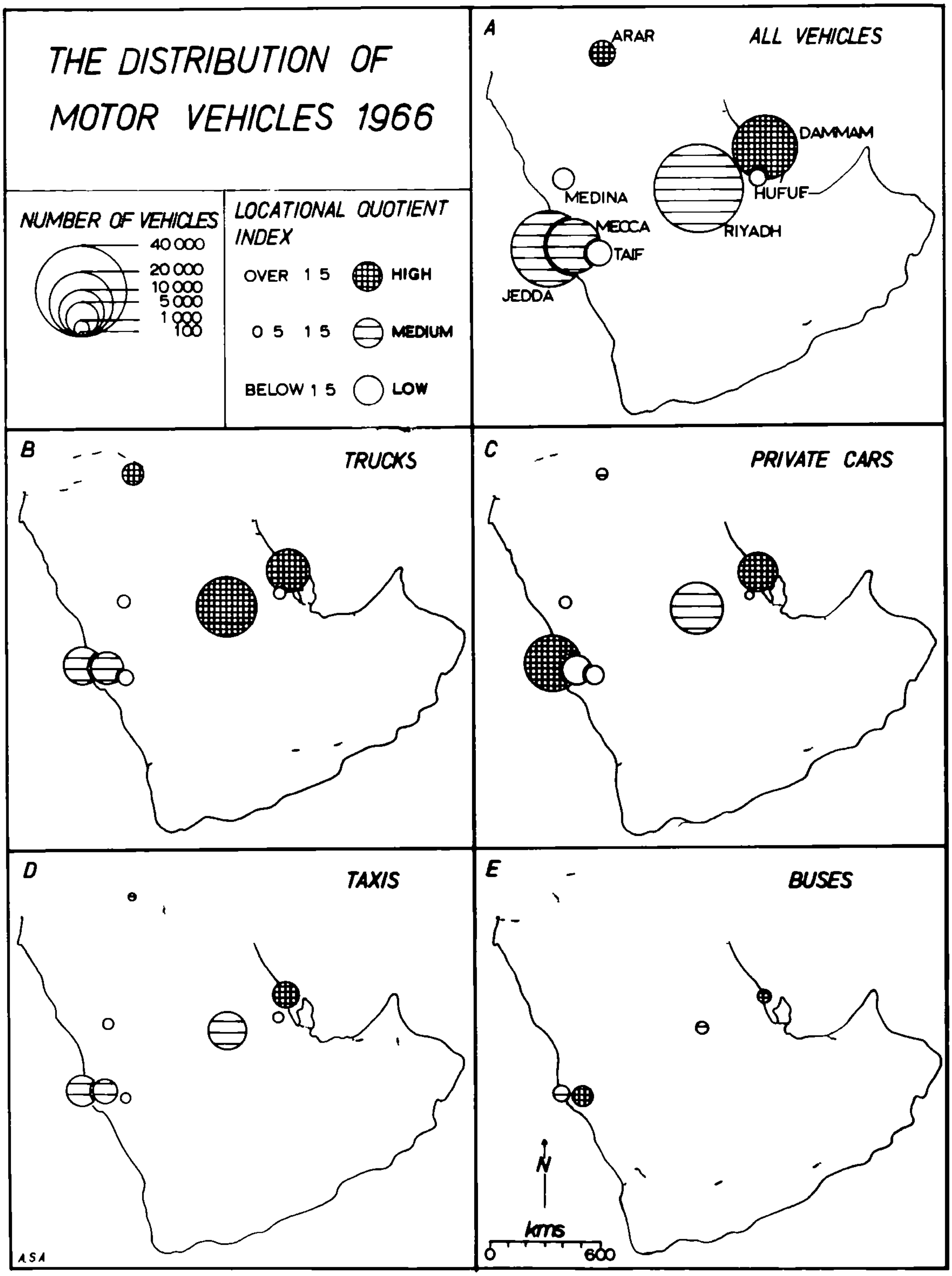
THE DISTRIBUTION OF
MOTOR VEHICLES 1966
NUMBER OF VEHICLES
40 000
20 000
10 000
5 000
1 000
100
LOCATIONAL QUOTIENT INDEX
OVER 1 5
HIGH
0 5 1 5
MEDIUM
BELOW 1 5
LOW
A
ALL VEHICLES
ARAR
DAMMAM
HUFUF
RIYADH
MEDINA
MECCA
TAIF
JEDDA
B
TRUCKS
C
PRIVATE CARS
D
TAXIS
A.S.A
E
BUSES
N
kms
0
600

Fig 6 3

compared The location quotient for each city and for all and each type of motor vehicles was calculated (table 6 9) and then maps were drawn (Fig 6 3) to show the geographical distribution of motor vehicles and the number of motor vehicles in each city in relation to its population The locational quotient index is divided into high (more than 1 5) medium (1 to 0 5) and low (less than 0 5)

This analysis indicates that not only town size but also the function and location of cities are involved in the geographical distribution of motor vehicles High economic activities, political power, close location to other major urban centres, and key location in communication with the rest of the world are four major factors with positive effect The locational quotient tends to rise when a city such as Dammam, Ar'ar, Riyadh and Jedda, is more affected by those factors It is very clear, however, that the Hajj has now become a secondary factor, Mecca has a medium index (0 59) and Medina has a low index (0 21) It is equally clear that cities where agricultural activities form the main function have a low index Hassa has the lowest index (0 9) In cases where such cities are far away from the east-west axis the number of the motor vehicles becomes negligible

Table 6 9 Location Quotient of the Motor Vehicle Distribution 1966

City	All Automobiles	Private Cars	Trucks	Buses	Taxis
Riyadh	1 28	1 12	1 73	0 57	1 31
Mecca	0 59	0 45	0 62	1 86	0 69
Jedda	1 25	1 74	0 90	1 43	1 23
Medina	0 21	0 17	0 21	0 29	0 31
Taif	0 37	0 5	0 37	0 14	0 31
Hassa	0 19	0 1	0 25	0 04	0 35
Dammam	3 75	3 57	3 23	3 14	3 54
Ar'ar	1 88	0 74	4 0	1 0	1 0

Looking at each individual type of vehicle we find that different functions and different locations lead to the concentration of certain types of vehicles in certain cities Private cars are concentrated in cities that are more urbanized, with high standard of living and located within short distances from other major urban centres Dammam (3 57) and Jedda (1 74) have high indices in private cars Riyadh enjoys all these advantages but is far away from other major urban centres and thus has a medium and not a high index (1 12) Cities with poor economic life such as Medina have a low index (0 17) while agricultural cities have even lower indices Hassa (0 1)

With trucks the situation is a little different

Active cities which are located far inland and their ports have high indices Riyadh has 1 73 and Dammam, its port, has 3 23 Ar'ar which is located on the longest road (The Tapline Road) has even a higher index 4 0 (The relationship between the distance travelled and the type of vehicles is discussed in detail in a later chapter) In the case of Mecca and its port Jedda the distance between them is only 73 Kms and thus these two cities have either low or medium indices in trucks Jedda 0 90 and Mecca 0 62 It is worth noticing, however, that agricultural cities, such as Hassa, have higher indices in trucks (0 25) than in private cars (0 1) or buses (0 04)

For buses the Hajj is an important factor Mecca, where the Automobile Association which is responsible for pilgrim transport is located, has the largest number and also a high index (1 86) Dammam, which is surrounded by many developed urban centres, has less buses but a higher index than Mecca (3 14) Jedda has more buses and higher index than Riyadh as it is the centre of some pilgrim transport companies

Factors influencing the distribution of taxis are, however, less clear Dammam has the highest index 3 54, because it is surrounded by many urban centres between which taxi services have developed a great deal Riyadh and Jedda have medium taxi indices because of their size and because of the bus-like taxi services which is used in Riyadh (see Chapter Nine), while Mecca has a low index probably because of the presence of public bus services

It is interesting to compare the findings of our locational quotient analysis with that of the regression method used by Ajo[6] in studying the geographical distribution of motor vehicles in 36 communes in Sweden Both studies indicate that although population is the main factor influencing the distribution of motor vehicles, other factors such as distance, geographical location, social and economic activities and the availability of other transportation facilities are also important However, it is more relevant to find that in Ajo's study the correlation between the distribution of automobiles and the population factor was as high as (r = 0 973) In Saudi Arabia the correlation between those two variables was not worked out because almost all the vehicles are concentrated in only eight cities, and because of other weaknesses in our data Nevertheless, it is very clear that the association between these two variables in Saudi Arabia could not be expected to be as high as it is in

Sweden because of the difference in the level of development between the two countries In Saudi Arabia the distribution of population has not yet adjusted itself to the newly discovered economic resources and newly established economic, social and political activities Consequently, the population factor tends to be of less importance than one may expect This limitation in the effect of the distribution of population was found also in the study of the development of the road network in an earlier chapter As a result of this fact the development of a predicting model to estimate the number of automobiles in a certain city or town by knowing its population becomes impossible without the use of an extensive weighting system to eliminate the effect of the economic, social, political and other factors In Sweden, where, the population distribution and other factors such as economic and social activities are highly balanced, Ajo was able to develop such a model after eliminating the effect of the geographical location alone

However, the above locational quotient analysis took the findings of Ajo a step further by showing that cities of different functions and different locations attract certain types of motor vehicles This was not found in

Ajo's study which dealt with the distribution of the total number of motor vehicles without consideration for their types (cars, buses or lorries)

Conclusion

The analysis in this chapter indicates a close relationship between the motor vehicle stock and both regional and national socio-economic development in Saudi Arabia This finding is in line with the index of mobility which was calculated on an international scale by Owen [7]

The application of the east-west axis pattern of development to the changes in the geographical distribution of motor vehicles is of great interest Equally interesting are the findings that it is the size of cities and not the density of population which affected the distribution of motor vehicles, and the finding that cities of different functions and different locations attract certain types of motor vehicles

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CHAPTER SEVEN

Road Traffic

Traffic is the movement of people or materials from where they are to where they want or need to be This movement is an interaction between two points on the earth's surface created by economic, social, political and other factors The stronger these factors are the greater is the traffic However, a volume of traffic which is created between two points is deterred or encouraged by the distance, in both absolute and economic senses, separating those two points

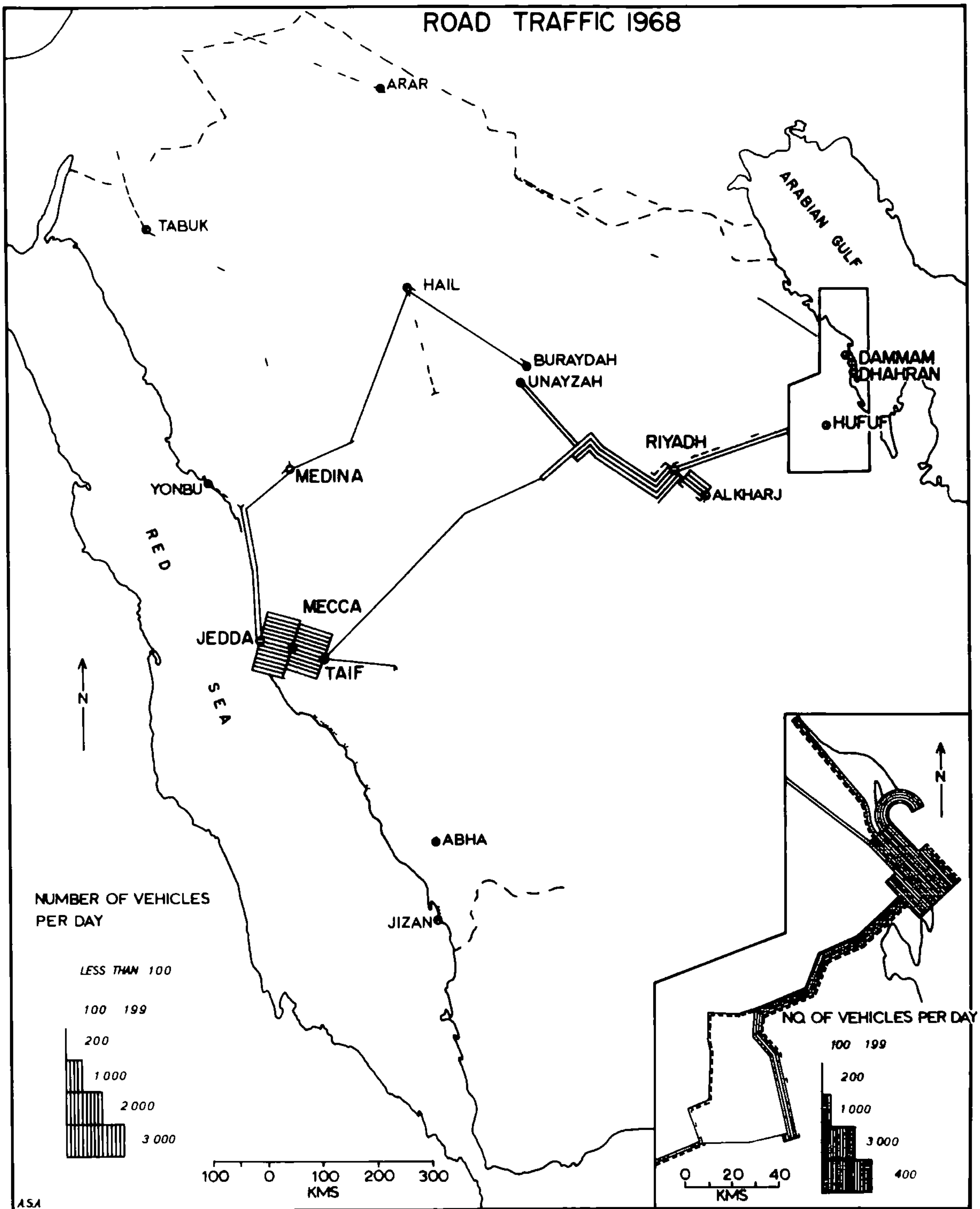
In many cases even if we assume that the creating factors and the distance are constant, traffic may vary between two points in time as a result of factors such as climate, or day and night, or weekdays and weekends Such factors only work during a limited period in which they change the average pattern of traffic

The Pattern of Traffic (Absolute Number of Vehicles)

Road traffic is closely related to the pattern of the modern road network and to the geographical distribution of motor vehicles, which in turn are related to the pattern of social and economic development The largest volume of traffic is found in the three east-west axis regions the

Hijaz, Riyadh and the Gulf area The Dammam - Al Khobar road has 4479 vehicles per 24 hours, The Mecca - Jedda, Mecca - Taif and Dammam - Qatif roads have traffic volumes of 2,000 - 3,000 vehicles a day, and the Dhahran - Abqaiq and Riyadh - Marat roads have an average of 1,000 - 2,000 vehicles a day The further we go from the east-west axis the less the traffic volume becomes Medina - Tabuk 58 vehicles per day and Tabuk - Jordan border only 40 vehicles per day To the south of the axis the Taif - Jibub road has 80 vehicles per day, Jibub - Jurabah road, less than 48 vehicles per day, the Turabah - Bisha road, 28 vehicles per day and the Bisha - Khamis Mushait road, less than 14 vehicles per day (See Fig 7 1) Thus the three axis regions which have the greatest social and economic development, the largest cities, most of the vehicle stock and the modern roads also have the largest volumes of road traffic On the other hand, the economically backward regions have a very small proportion of the present road traffic in the country, as a result of bad road conditions and limited social and economic activities

The traffic between the different regions forms the national traffic which is also concentrated on the east - west axis 500 vehicles per day between Riyadh and the Gulf region and 200 vehicles a day between Riyadh and the



COMPILED FROM VARIOUS TRAFFIC SURVEYS UNDERTAKEN BY THE ROAD DEPARTMENT & SOME OF ITS CONSULTANTS.

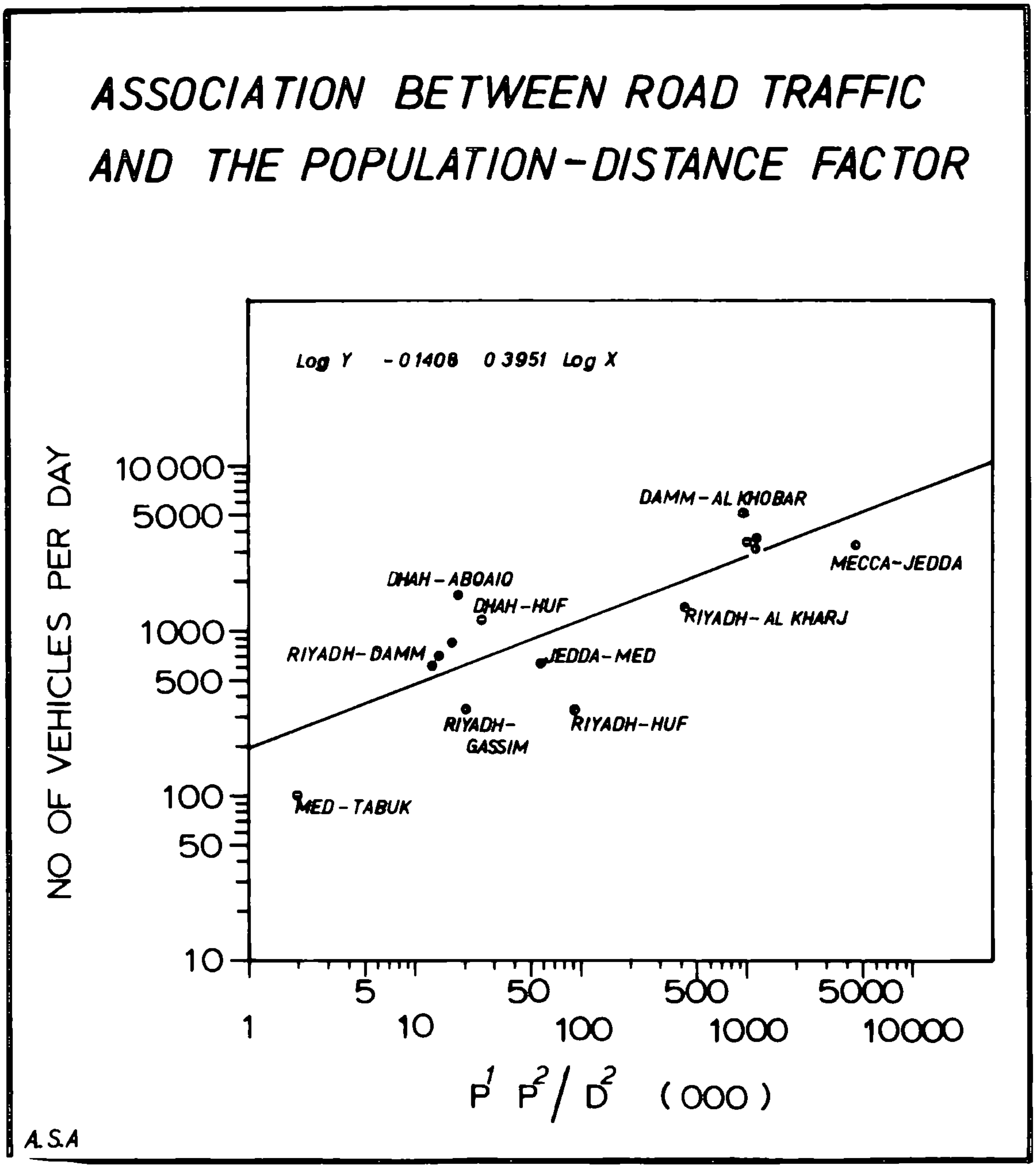
Fig. 7.1

Hijaz Region The only exception is the relatively high traffic between the various regions of central Arabia 400 vehicles a day between Gassim and Riyadh and 300 vehicles a day between Riyadh and Ha'il The traffic with the southern region is unknown, though in the western part of the country it is less than 50 vehicles per day (see Fig 7 1)

Apart from the Hajj traffic, international traffic is very small and limited to some neighbouring countries in the north, particularly with Lebanon, Syria and Jordan an average of 140 vehicles a day of which 100 on the Tapline road and 40 on the Medina - Tabuk road However, more than one half of the traffic volume with Lebanon, Syria and Jordan is a transit traffic carried across Saudi Arabia to the Gulf States A traffic survey in 1964 showed that 52% of the Tapline road traffic goes to Kuwait, 4% to Qatar and only 44% to Saudi Arabia It can be safely said that the traffic with Iraq, Yemen or South Yemen hardly exists except during the Hajj season

Factors Influencing Road Traffic

As in the case in the geographical distribution of motor vehicles (Chapter Six) and in the development of the modern road network (Chapter Three), a comparison between Fig 7 1 and Fig 1 2 shows no positive relationship between



ASSOCIATION BETWEEN ROAD TRAFFIC AND THE POPULATION-DISTANCE FACTOR
Log Y - 0 1408 0 3951 Log X
NO OF VEHICLES PER DAY
10000
5000
1000
500
100
50
10
DAMM-AL KHOBAR
MECCA-JEDDA
DHAH-ABQAIQ
DHAH-HUF
RIYADH-AL KHARJ
RIYADH-DAMM
JEDDA-MED
RIYADH-GASSIM
RIYADH-HUF
MED-TABUK
5
50
500
5000
1
10
100
1000
10000
P1 P2 / D2 (000)
A.S.A

Fig 7 2

the pattern of road traffic and the population density, indicating that the density of population is not as important as the social and economic activities in road traffic generation Agricultural regions may have a high density of population but low mobility and thus the overall traffic generated in these regions is low in comparison to the more socially and economically active regions even though these may have a relatively low density of population

However, a visual comparison between Fig 7 1 and Fig 1 3 indicates that the two most important factors in road traffic generation are distance and town size This relationship is here measured to determine first, the importance of the distance factor and second, the influence of distance and town size as one combined factor using a modified gravity model Other factors involved in traffic generation will then also be investigated In all these analyses traffic is expressed in car equivalents using a coefficient of 1 0 for cars , 1 5 for pick ups and 2 0 for all types of trucks and buses

(A) <u>Distance</u>

Distance seems to be the most important factor in road traffic Broadly, the further we go from the main cities the lower becomes the volume of traffic (table 7 1)

Also the longer the roads the lower are the volumes of traffic (table 7 2) To try and measure the extent

Table 7 1 Volume of Traffic in Relation to Distance from Main Cities

(A) Riyadh - Dammam Road

Distance from Riyadh	Number of Vehicles per Day
Km 10	2378
Km 18	956
Km 163	488

(B) Riyadh - Taif Road

Distance from Taif	Number of Vehicles Per Day
Km 30	1163
Km 170	488
Km 340	414
Km 508	246

Source Based on various unpublished traffic data from surveys undertaken by the Road Department and some consultants

of the effect of the distance factor on road traffic, a simple correlation coefficient was computed for fifteen different roads The correlation coefficient between the two variables (length of roads and traffic) was found to be as high as r = + 81 at the 99% confidence level (Data was normalized by log transformation) Consequently, it

Table 7 2 Volume of Traffic in Relation to Length of Road

Road	Length of Road Km	Number of Vehicles per Day
Tapline	1272	137
Riyadh - Taif	901	246
Riyadh - Dammam	467	488
Jedda - Medina	424	352
Mecca - Taif	88	2680
Dammam - Al Khobar	24	4479

Source Ibid

can be said that the distance factor alone accounts for about 65% (the correlation of determination) of the variations of road traffic

(B) Town Size

Distance though very important, is not the only factor involved in road traffic generation Town size also seems to be of a great importance in this respect In order to combine the two factors (distance and town size) in one and then measure the effect of this combined factor on road traffic, a simplified form of the gravity model was used The combined factor was considered to be the product of the multiplication of the population of the two towns linked by the road divided by the distance (the length of the road) squared, or $\frac{P_1 P_2}{D^2}$ The value of this combined factor was calculated for fifteen different roads and then computed against the volumes of road traffic The result of a simple correlation coefficient (data was normalized by log transformation) was found to be as high as r = + 83 at the 99% confidence level, which means that distance and town size account for about 69% (the correlation of determination) of the variations in road traffic Fig 7 2 is a regression model exhibiting the association between the volume of road traffic and the distance - town size factor Traffic (the dependent variable) is plotted on the Y axis and the $\frac{p^1 \; p^2}{D^2}$ value (the independent variable) is plotted on the X axis The regression equation is thus, the gravity model for road traffic in Saudi Arabia and can be written in the following formula

$$\log T = - 1408 + (0\ 3951 \quad \log \frac{p1 \quad p2)}{D^2}$$

where T is the average daily traffic in car equivalents, p^1 and p^2 the population of the two towns linked by the road and D is the distance which is the length of the road concerned

(C) <u>Other Factors</u>

The regression model (Fig 7 2) indicates that the volume of traffic is, proportional to the gravity model in the formula stated above This gravity model can thus be used to estimate the traffic on roads which have no traffic data or on future roads It should, however, be noticed that the gravity model accounts for only about two thirds of the traffic variations (69%) and thus about 31% of the variation is caused by other factors, mainly by the economic and social activities As can be seen from Fig 7 2 roads which link the towns and cities with relatively high economic and social activities are located above the regression line, meaning that they have positive residuals Among these roads are Dammam - Al Khobar, Dhahran - Abqaiq, Dhahran - Hufuf and Riyadh - Dammam roads (Notice that most of these roads are located in the oil area) On the other hand, roads which link places with relatively low economic and social activities are located below the regression lines meaning that they have an unexpectedly low traffic Among these roads are Medina - Tabuk, Riyadh - Gassim, Riyadh - Hufuf, Jedda - Medina, Riyadh - Al Kharj and Jedda - Mecca road Notice that the attraction between any two ends of each of these roads is limited by the fact that at least one of the two towns has a small amount of social and economic activities except for the Jedda - Mecca road which has low traffic because its traffic data belong to an earlier date (1964) than for the other roads

Factors Influencing the Composition of Road Traffic

Traffic analysis, however, should not only deal with the absolute number of vehicles but also with the various types of vehicle using the roads The average proportions of cars, buses, pick ups and trucks on the roads of Saudi Arabia are shown in the previous chapter (see table 6 7) In this section we study the composition of traffic as divided into cars and trucks The proportion of trucks to the total traffic on the roads of Saudi Arabia varies from 100% to 6% for a number of reasons examined below

(A) Road Conditions

Road conditions have a clear effect on the composition of traffic Cars are very rarely used on unimproved desert tracks Some consultants have described the composition of traffic on desert tracks in terms such as "no passenger car - traffic" [1], "as regards the composition of the present traffic it is exclusively made up of heavy commercial and military vehicles (trucks, pick ups, jeeps)" [2]

(B) Distance

When we examine the composition of traffic on asphalt roads, distance becomes the most important influence Broadly, longer roads have higher proportions of trucks and vice-versa The association between distance (the length of roads) and the proportion of trucks is here measured for 15 different roads The result of a correlation coefficient analysis proved a very high - association with r = + 0 83 at the 99% confidence level (data was normalized by log transformation) It can, thus, be said that the distance factor accounts for about 69% of the proportion of trucks or in other words, for the composition of road traffic

A regression model for the association between the proportion of traffic and distance was also computed and graphed in Fig 7 3 The proportion of trucks are plotted on the Y axis and the distances were plotted on the X axis

The regression equation may be of value in estimating the propoition of trucks on roads where detailed traffic data are lacking This is important because automatic traffic surveys only show the number of vehicles passing the census points without showing the types of vehicles In such cases the proportion of trucks can be estimated with the use of the following formula

$$\log T = 1\ 1632 + (0\ 2401 \times \log D)$$

ASSOCIATION BETWEEN COMPOSITION OF ROAD TRAFFIC AND DISTANCE

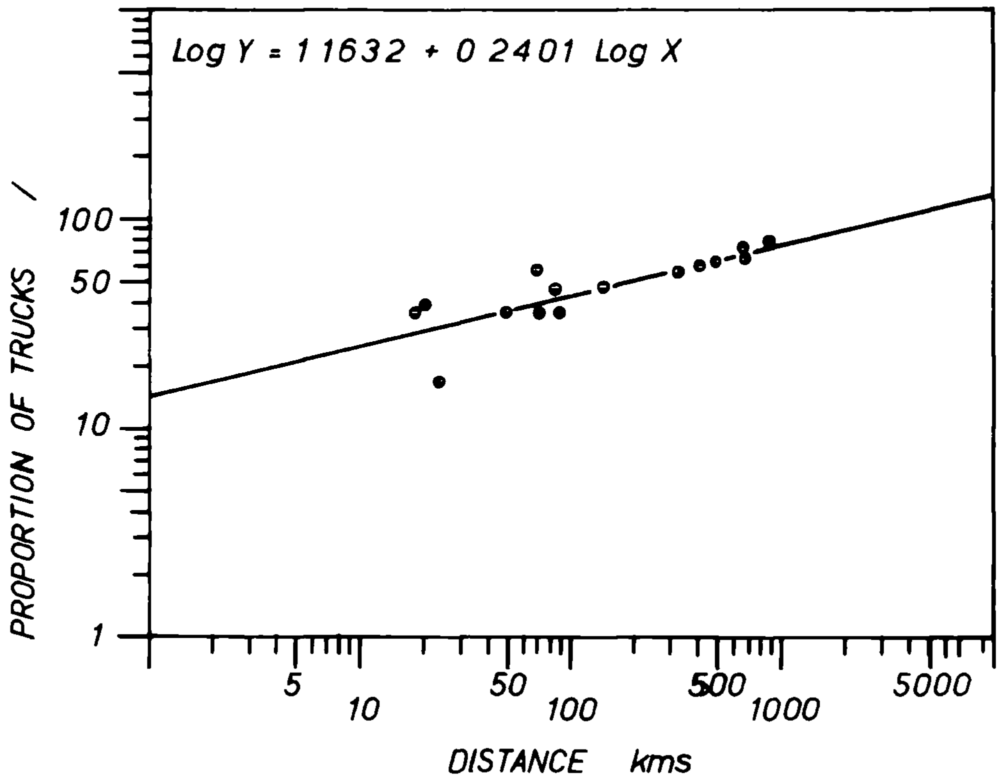


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Fig 7 3

Where T is proportion of trucks and D is the distance (length of road)

(C) Other Factors

It must be noticed that the above formula explains only about 69% of the variation in the traffic composition and thus it can be said that factors other than distance are involved The main other factor seems to be the functions of the two cities linked by the road Generally the proportion of trucks is higher than expected on the roads linking the main import seaports with the major inland cities e g the Dammam - Riyadh road

The Impact of the Hajj on Road Traffic

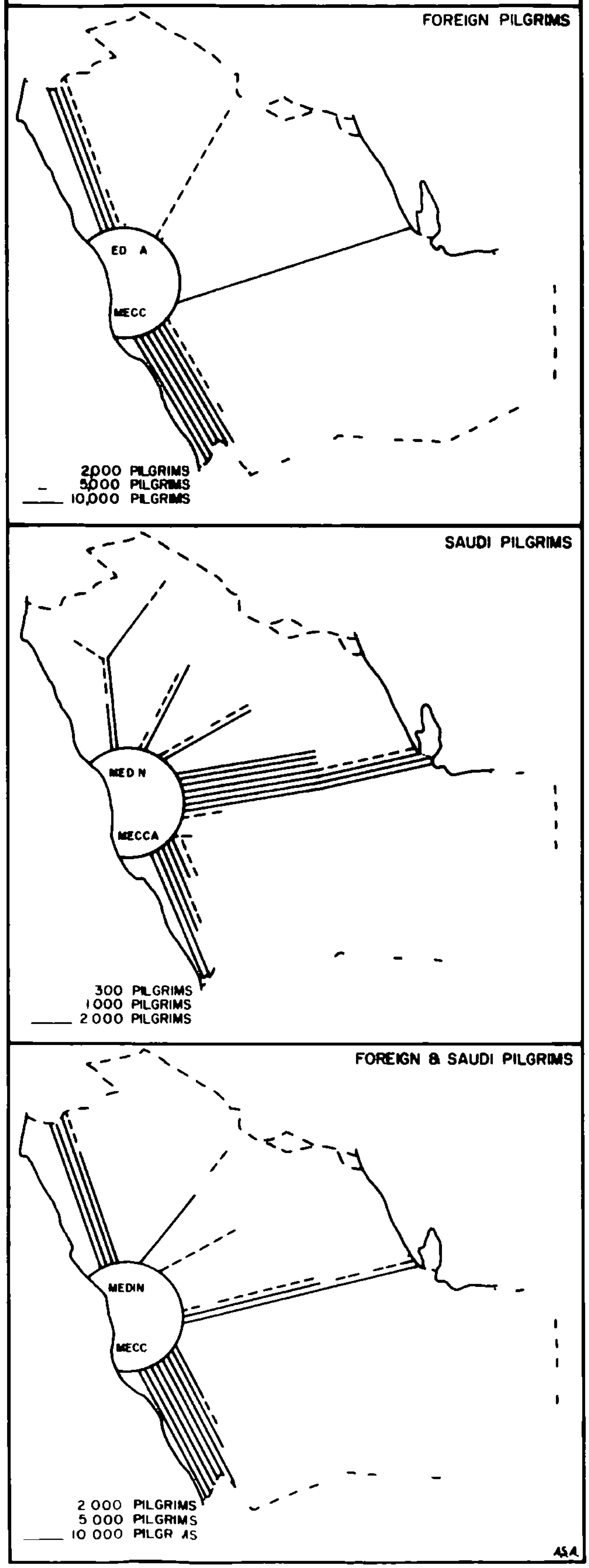
The Hajj is the most important single factor in the seasonal fluctuation of road traffic particularly on the traffic between Mecca, Jedda and Medina Unfortunately, no traffic surveys have yet been taken on these roads to show this impact and thus we have to use the monthly consumption of motor gasoline in the western region which indicates that road traffic in the region is about 25% higher during the Hajj season than in the rest of the year [3]

The Hajj effect on road traffic is, however, not limited to the Hijaz region, but can be seen on the traffic from the other regions to the Hijaz A traffic survey on the Riyadh - Hijaz road taken in 1964 showed that during the Hajj it was twice as much as normal traffic (510 vehicles per day compared with 255 vehicles per day).

The most affected of all is the traffic with the neighbouring countries since there is a large number of foreign pilgrims (102,000 in 1965) and Saudi pilgrims (50,000 in 1963) travelling by road transport Fig 7 4 shows the estimated volume of foreign and local pilgrims traffic on the various Hajj roads For foreign pilgrims the estimates are based on the number of pilgrims who come by roads from various countries and on the location of those countries in relation to the Hajj roads For the Saudi pilgrims the volume of traffic was estimated by abstracting the number of pilgrims who came by air from the total number of local pilgrims, as estimated by the Central Planning Organization [4]

Various factors seem to affect the number of foreign pilgrims who come by roads The improvement of roads has raised the proportion of the pilgrims who came by road to the total pilgrims from 28% in 1957 to 32% in 1960 and without the Yemen crises it would have reached 40% in 1965[5] Political disputes between Saudi Arabia and other Muslim Countries have had a considerable impact on the number of pilgrims who come from a certain country and thus on the pilgrim traffic on certain roads The dispute with the

THE HAJJ ROAD TRAFFIC 1963



Yemen, for example, reduced the number of Yemeni pilgrims who came by road from 59,000 in 1961 to 34,000 in 1962 and to only 414 in 1963 [6] Distance is also an important factor Broadly, the longer the distance from Mecca the less the pilgrim road traffic 2 1 pilgrims per thousand of the population of Iraq (1,500 Km from Mecca) came by road in 1966 against only 0 1 pilgrims per thousand of population who came from Afghanistan (4,000 km from Mecca) and not a single pilgrim came from Malaysia by road Observation has also shown that pilgrim road traffic is less when the Hajj occurs in a hot season and vice-versa Also the nature of the land travelled is important The high proportion of pilgrims travelling by road from the Yemen is a result of the relatively mild climate (because of elevation), high precipitation and high density of population in the area between the holy cities and the Yemen

Growth, trends and diversions of road traffic

Motor vehicles were first used in this part of the world about the time of the first world war, but motor traffic was limited to the Hijaz region until the discovery of oil which created a very high traffic volume in the Gulf area and later the development of Riyadh as the capital of Saudi Arabia generated a considerable traffic in central Arabia In response to the economic and political integration between the Gulf area, the Hijaz region and Riyadh region and in response to the high rate of social and economic growth, motor traffic was stimulated in and between these three regions The spread of traffic to regions far away from the east-west axis awaited the sense of national planning for development which appeared only few years ago

At present, such regions are experiencing many development projects among which are modern roads, and this is being accompanied by an increase in motor traffic in these periphery regions Table 7 3 indicates the growth of motor traffic between 1966 and 1967 in the southern region, through motor fuel consumption in some selected towns in this region

Table 7.3 Fuel Consumption in the Southern Region 1966-67
(Amount in U S Gallons)

Town	Gasoline		Diesel		Total Motor Fuel		
	1966	1967	1966	1967	1966	1967	Increase %
Abha	1805757	1880258	423444	561826	2229201	2442084	10%
Al Baha	19600	132900	3850	30540	23450	163440	597%
Bisha	1167306	1553435	529186	871943	1696492	2425378	43%
Jizan	1212704	1649653	262566	879038	1475270	2528691	71%
Dhahran Al Janob	7120	106532	2670	50050	9790	156582	1499%
Total	4,212,487	5,322,778	1,221716	2,393,397	5,434,203	7,716,175	42%

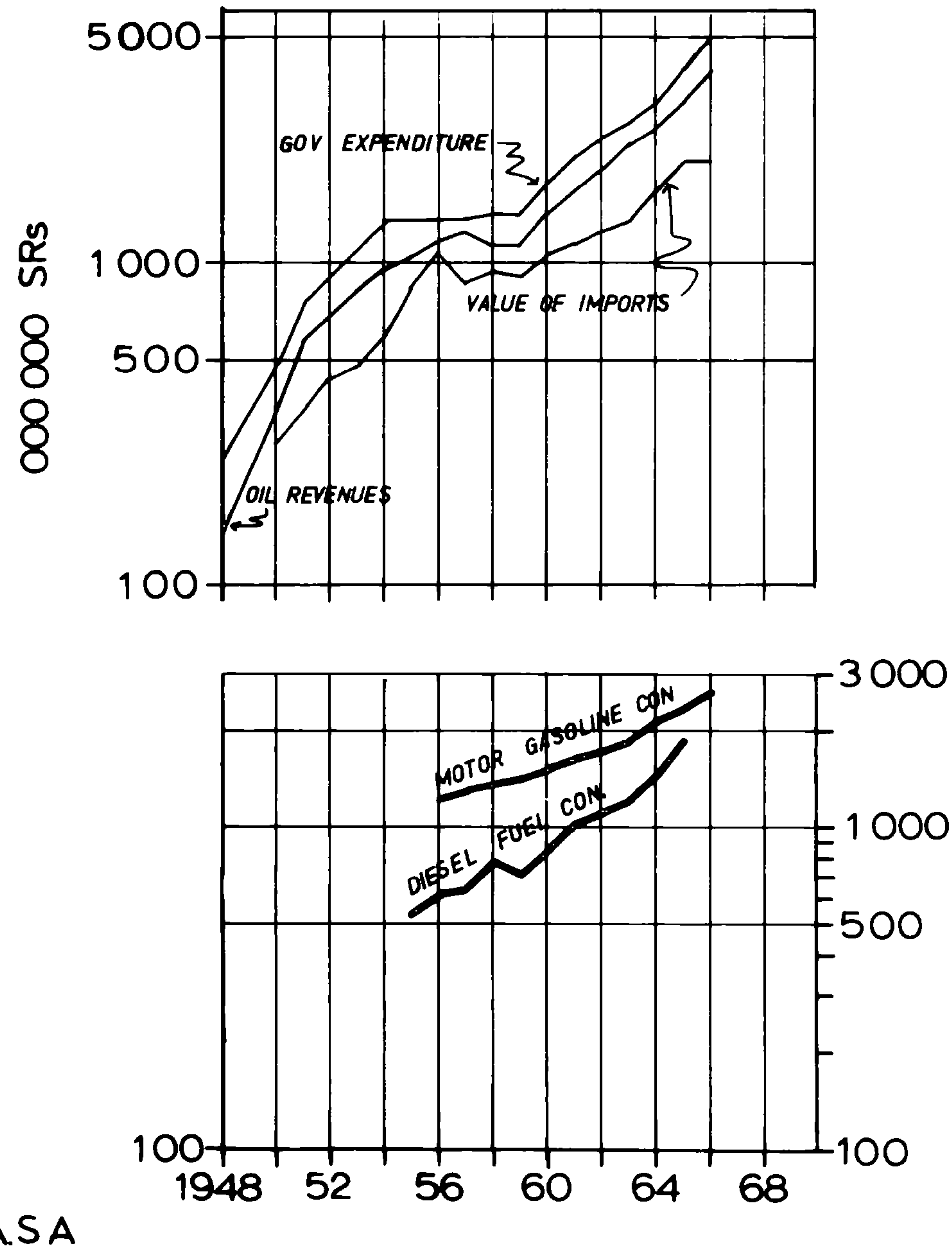
Source Unpublished data obtained from Petromin

The overall growth in road traffic can best be seen from the motor fuel consumption, as traffic data are far from adequate Motor gasoline consumption is an excellent indicator to the growth in passenger traffic just as the diesel fuel indicates the growth in freight traffic

Fig 7 5 shows the growth in motor gasoline and diesel fuel consumption for the period 1956-66 and also the economic growth as shown in oil revenues, government budget and import During this period motor gasoline consumption (passenger traffic) increased from 1,245,000 U S BBLS in 1956 to 2,680,000 U S BBLS in 1966, a growth of 11 5% per annum Diesel fuel consumption (freight traffic) increased, at an even higher rate from only 549,000 U S BBLS in 1955 to 1,890,500 U S BBLS in 1965, an increase of 24 4 per cent per annum [7] This, in spite of the fact that the figures include the amount used by farmers in their water pumps, makes it very clear that freight traffic has been increasing at a greater rate than passenger traffic

However, since freight traffic is more associated with economic growth, while passenger traffic is more associated with social development, it can easily be seen in Figure 7 5 that the freight traffic curve is to a large

THE GROWTH OF MOTOR GASOLINE & DIESEL FUEL CONSUMPTION IN RELATION TO THE GENERAL ECONOMIC GROWTH



extent parallel to the import curve In the period 1956-60, which saw an interruption or decline in economic growth, freight traffic witnessed a similar condition This is simply because freight traffic depends mainly on transporting imported materials from the main ports to the main cities inland On the other hand the growth in freight traffic at a higher rate than passenger traffic may indicate more rapid economic than social development, a situation created by the increase in government income from the oil revenues and not from manufactured or agricultural products

Regional and overall growth in road traffic have been accompanied by some traffic diversion from one road to another because of the improvement of roads Diversion occurred, for example, in the traffic between Medina and Riyadh from the Medina-Ar Rass-Riyadh road to the new asphalt road via Afif Before the construction of the Riyadh - Taif road the traffic between Medina and Riyadh used to take the short road via Ar Rass After the construction of the Riyadh - Taif road traffic was diverted to the new road via Jedda, Mecca, Taif and Afif or direct from Medina to Afif and then by the modern road to Riyadh This diversion of traffic can be seen in the decrease of motor fuel consumption in Ar Rass which was accompanied by an increase in motor fuel consumption in Afif as shown in table 7 4

Table 7 4 Motor fuel consumption in Ar Rass and Afif before and after the completion of the Taif-Riyadh Road (Amount in U S Gallons)

	Gasoline		Diesel		Total		Change
	1966	1967	1966	1967	1966	1967	
Ar Rass	18,610	8,890	26,457	21,850	45,067	30,740	-32%
Afif	37,350	382,250	12,400	27,325	49,750	409,575	+723%

Source Ibid

During the construction of the Riyadh-Taif road there was a fear that when it was completed it might divert the traffic from Dammam port and Dammam-Riyadh road to Jedda port and the new Riyadh-Taif road This fear was based on the fact that most of the imports to Saudi Arabia came from U S A and Europe, which can be brought to Jedda port cheaper than to Dammam port because this saves sailing around Arabia to the Gulf The assumption was that if the new road can make the difference in freight rate per unit from Jedda to Riyadh no higher than the difference in freight rate from the U S A and Europe to Jedda and Dammam, the goods which are consumed in Riyadh would come via Jedda and be carried on the new road to Riyadh rather than coming to Dammam and then transported to Riyadh on the asphalt road or by the railway The writer, therefore, collected information on the freight rate per unit from the U S A and Europe to both the ports of Jedda and Dammam as well as information on the freight rate per unit from both Jedda and Dammam to Riyadh These rates were compared to show the possibility of this diversion (see Table 7 5)

<u>Table 7 5 Freight Rates for Three Selected Items from the U S A to Jedda and Dammam</u>

Item	Rate to Jedda $ per ton	Rate to Dammam $ per ton	Difference $ per ton	Difference SR per ton
Cars				
Boxed	28 50	33 75	5 25	24
Unboxed	31 00	39 25	8 25	37
Wheat	23 00	27 50	4 50	20
Furniture Parts	42 00	52 75	10 75	48

<u>Source</u> Jedda and Dammam Ports Authorities

The freight rate from Jedda and Dammam to Riyadh was found to be 80 SR and 20 SR per ton respectively Thus it can be said that even in the case of furniture parts the Riyadh - Taif road can not capture the traffic from Dammam-Riyadh road because the Dammam way is still about 12 S R per ton cheaper than the Jedda way However, as there is no price discrimination in road freight traffic in Saudi Arabia the Dammam way may be as much cheaper than Jedda way as 70 S R per ton in the case of some commodities such as wheat

Commodities Carried by Roads

Ideally commodities should be studied according to type, quantity and direction, but we have to be content with few arbitrary samples, because of the lack of adequate data Actual quantities of commodities are only available for three roads the highest is 1832 tons per day on Riyadh - Dammam road, the lowest is 250 tons per day on Medina - Tabuk road, while on Riyadh - Taif road it is 778 tons per day Expression of these figures in ton-kilometre form is impossible and impractical owing to weaknesses in the data

The direction of commodity flow is based on the fact that most of the road transport cargo consists of imported materials Thus the flow of commodities is higher from the main ports to the main inland cities and from these cities to the smaller cities in their vicinities than in the opposite direction which is from small cities to big cities or from main inland cities to ports

Most of the materials carried by roads consist of vegetables and foodstuffs (71% on Riyadh - Dammam road) and petroleum or its products (39% on Medina - Tabuk road)

In brief, the materials carried by road are those which form the internal trade or which consist mainly of imported materials Data do not permit any further conclusions

Conclusion

The pattern of road traffic is closely associated with the road network, the distribution of vehicles, the location of the main settlements and the socio-economic activities Being a sensitive phenomenon, road traffic may grow, decline or deviate for a number of reasons, especially through the construction of new roads Finally it may be said that the use of the gravity model and the regression models has been of a considerable value in analysing, explaining and presenting the pattern of road traffic and the main factors influencing traffic volumes and composition

References & Notes

1 Andreas Wagner, Road 54 - Taif-Jizan, section Taif - Addarb, phase one project report submitted to the Road Department in 1964, p 33

2 Sauti, S P A , Road 61 - Mecca - Addarb, section Al Lith - Addarb, a preliminary project report submitted to the Road Department in 1967, pp 42-3

3 Central Department of Statistics, Statistical Yearbook, 1967, p 166

4 Central Planning Organization, An Economic Report, 1965 table 20 p 90

5 Central Department of Statistics, _Statistical Yearbook 1965_, pp 278-283 and 1966, p 95

6 Central Department of Statistics, _Statistical Yearbook, 1965_, pp 278-283

7 Unpublished data obtained from Aramco and Petromin

CHAPTER EIGHT

Domestic Passenger Air Transport

Owing to the sub-continental size of Saudi Arabia, its small and scattered population, its aridity, the vast unpopulated expanses which separate its main cities, and the lack of any mass production except of oil, air transport has many advantages in relation to other means of transportation The direct distance from Riyadh to the nearest seacoast is 400 Kms, to Mecca 800 Kms, to Medina 720 Kms, to Jizan 980 Kms, to Turayf 1120 Kms and to Haql 1300 Kms Yet Riyadh has a central location, and the distances between towns located near the borders or coasts are much greater The direct distance from Jizan to Turayf, for example, is about 1,700 Kms These distances are far greater than the minimum of 180-200 miles required for air transport [1] Distance is important because air transport uses a natural free way which is the air, while road or rail transport require the construction of a road or a railway Consequently over a certain distance the construction of two airports becomes less costly than the construction of a road or a railway It follows that the larger the distance the more advantages air transport has over rail or road transport

In Saudi Arabia the dramatic increase of income came suddenly to a country which had no inland waterways, no roads and no railways Because of the large distances involved the establishment of air services was found easier, cheaper and more effective for administrative and government purposes than the construction of roads or railways Thus in 1947 the government bought 3 DC-3 planes, constructed the Jedda airport and with the use of some land strips air services were established between the main east-west axis centres In this simple way the Saudi Arabian airlines (SDI) were established

However, the economic activities which resulted from the steady increase in the oil revenues, and the growing need for some political and social integration in the newly developing Saudi Arabia increased the need for air transportation services particularly as adequate land services were lacking The SDI responded to this demand by increasing its fleet of aircraft and using better and bigger aeroplanes Thus it purchased 10 Convairs (1952), 3 DC-6s (1960) 2 Boeing 720 Bs (1962), 3 DC-3s (1963), 3 DC-9 jet-planes (1967) and 2 Boeing international 707-368C jet-planes (1968) With this remarkable development the SDI met the increasing national demand for air services, crossed the borders to some other Arab countries in 1960, established routes to Tripoli, Tunis, Rabat, Geneva, Frankfurt and London in 1967, and in association with B O A C started in 1968 a non-stop twice weekly service between Jedda and London

The aim of this chapter is to analyse the pattern of the domestic air transportation traffic in which the SDI has a complete monopoly The economics of the SDI are not discussed because of the lack of sufficient data Also air traffic with other countries is not discussed except in the section which deals with the impact of the Hajj on air transportation services

Pattern of Domestic Air Passenger Traffic

Figures for the domestic passenger air traffic were published by the Central Department of Statistics for the years 1965 and 1966,[2] from which it was possible to calculate the volume of passenger traffic handled by 23 airports out of a total of 25 airports operating in the country Owing to a defect in the data, the study of traffic between any two points proved to be meaningless[3] and thus the analysis in this section is based on the volumes of traffic in each of 23 airports

Fig 8 1 depicts the present pattern of the domestic

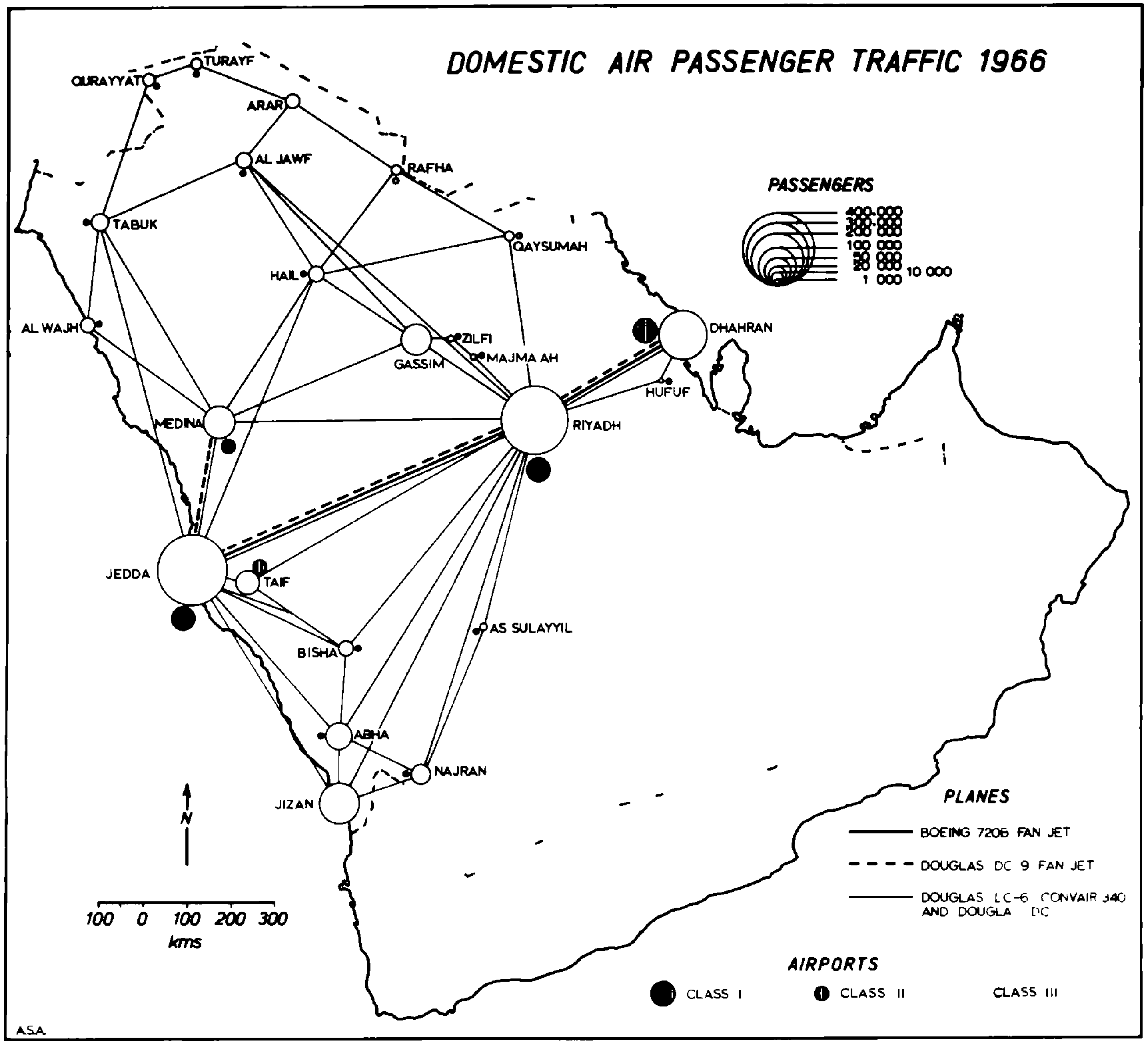
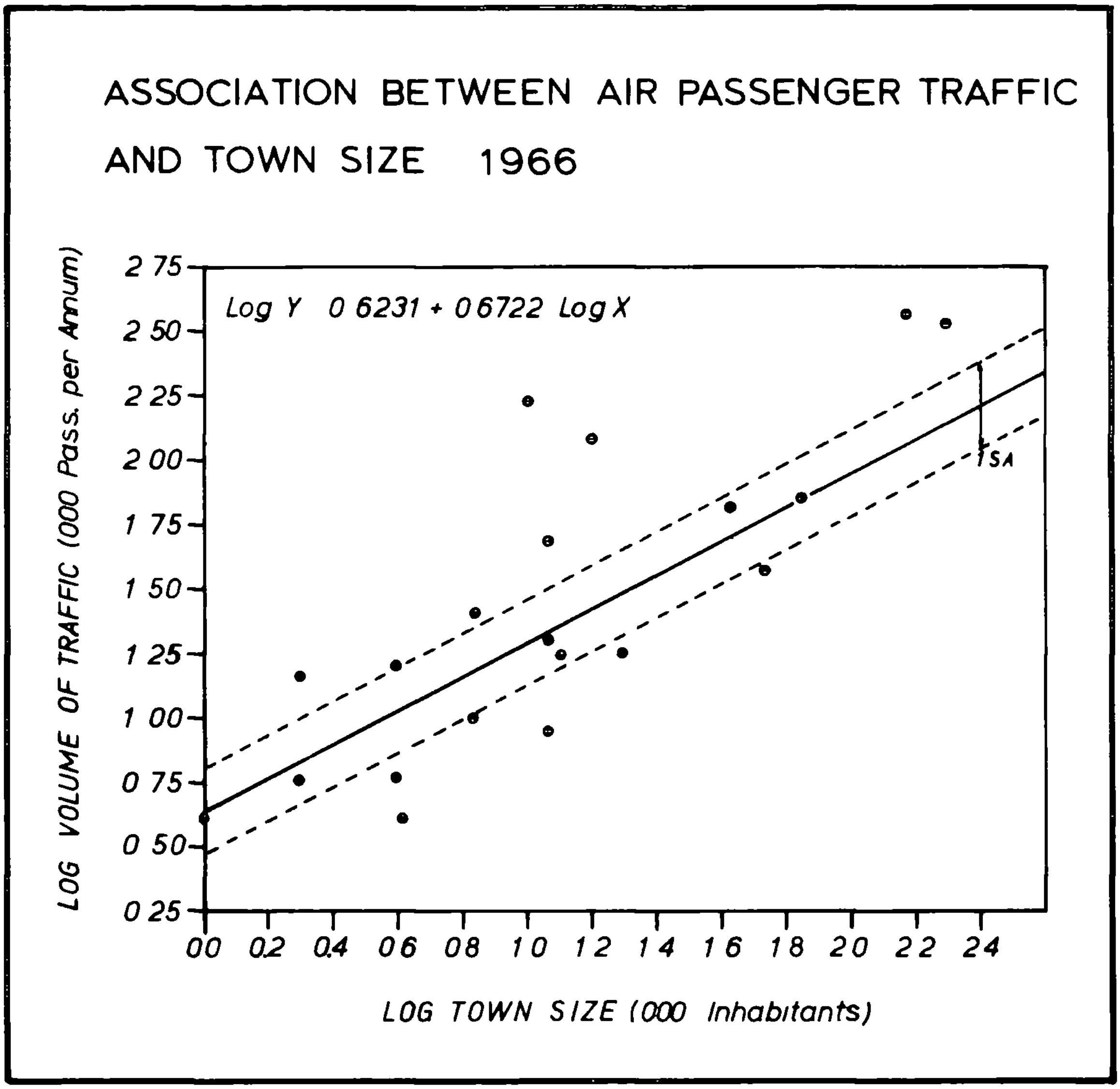

DOMESTIC AIR PASSENGER TRAFFIC 1966
PASSENGERS
400 000
300 000
200 000
100 000
50 000
20 000
10 000
1 000
PLANES
BOEING 720B FAN JET
DOUGLAS DC 9 FAN JET
DOUGLAS DC-6 CONVAIR 340
AND DOUGLA DC
AIRPORTS
CLASS I
CLASS II
CLASS III
QURAYYAT
TURAYF
ARAR
AL JAWF
RAFHA
TABUK
QAYSUMAH
HAIL
AL WAJH
ZILFI
MAJMA AH
GASSIM
DHAHRAN
HUFUF
MEDINA
RIYADH
JEDDA
TAIF
AS SULAYYIL
BISHA
ABHA
NAJRAN
JIZAN
N
100 0 100 200 300
kms
A.S.A.

Fig 8 T

air passenger traffic by showing the annual volume of traffic handled by each airport in 1966, the air route network of direct flights (based on the Timetable of June, 1967) and the standard of various airports The classification of the airports into three groups is based on the number, length and surfaces of the runways as well as the existence or absence of lights and fueling services

Fig 8 1 shows the validity of the east-west axis pattern for the domestic passenger air traffic Jedda, Riyadh and Dhahran have the largest volumes of traffic They also have the best airports Further, the Boeing services run only between those three airports In general, the volumes of traffic, the standard and frequency of services as well as the standard of the airports decrease and increase according to the distance from the axis The east-west axis, is, however, not the only factor influencing the pattern of passenger air traffic A visual comparison between Fig 8 1 and Fig 1 3 indicates a close relationship between town size and volume of traffic handled by each airport Since numerical data is available for both town size and volume of traffic the association was measured by the computation of the correlation coefficient, and a regression model was computed and graphed (Fig 8 2) The residuals from the


ASSOCIATION BETWEEN AIR PASSENGER TRAFFIC
AND TOWN SIZE 1966
Log Y 0 6231 + 0 6722 Log X
LOG VOLUME OF TRAFFIC (000 Pass. per Annum)
2 75
2 50
2 25
2 00
1 75
1 50
1 25
1 00
0 75
0 50
0 25
00
0.2
0.4
0 6
0 8
1 0
1 2
1 4
1 6
1 8
2 0
2 2
2 4
SA
LOG TOWN SIZE (000 Inhabitants)

regression (Fig 8 3) were then used to explain the effect of other factors influencing the pattern of air traffic Using this method of analysis the factors involved were found to be (A) town size, (B) traffic-shadow and (C) availability of other transportation services

(A) Town Size

We have already found that town size is a major factor in the geographical distribution of motor vehicles, (Chapter Six) in the development of the modern road network (Chapter Three) and in the generation of road traffic (Chapter Seven) For air traffic which is associated more with passengers than with freight and which is closely connected with urbanization, town size should be even more important than in any other transportation media The result of the computation of the correlation coefficient between the town size and the volume of air traffic was r = + 0 67 with a 99% confidence level (The computed data was transformed into logs) Thus it can be said that for the 23 towns the town size accounts for about 45% (the correlation of determination) of the volumes of air traffic

Fig 8 2 is a regression model of the air traffic on the town size Logarithmically transformed data were computed and the log values were plotted on both axes Confidence limits for one standard error were also drawn on the regression model As can be seen from Fig 8 2 seven towns - Medina, Gassim, Tabuk, Al Jawf, Al Gaysumah, Zilfi and Majma' - are located within the one standard error confidence limits Thus, each of these towns has a volume of traffic approximately proportional to the number of its inhabitants The other sixteen towns Bisha, Najran, Gurayyat, Badana, Hail, Taif, Dhahran, Jizan, Jedda, Riyadh, Abha, Al Wajh, Rafha, Turayf, Sulayyil and Hufuf are located outside the one standard error limits, and thus each has either unusually high or low traffic in relation to the number of its inhabitants Fig 8 3 shows the residual values of these sixteen towns The residuals were measured from the regression equation plus or minus one standard error ($\log y \pm \log 0\ 1607$) The study of Fig 8 3 leads to the other factors influencing the pattern of air traffic

(B) Traffic-Shadow

Traffic-shadow is a term which was used by Taaffe[4] in his analysis of air transportation and United States

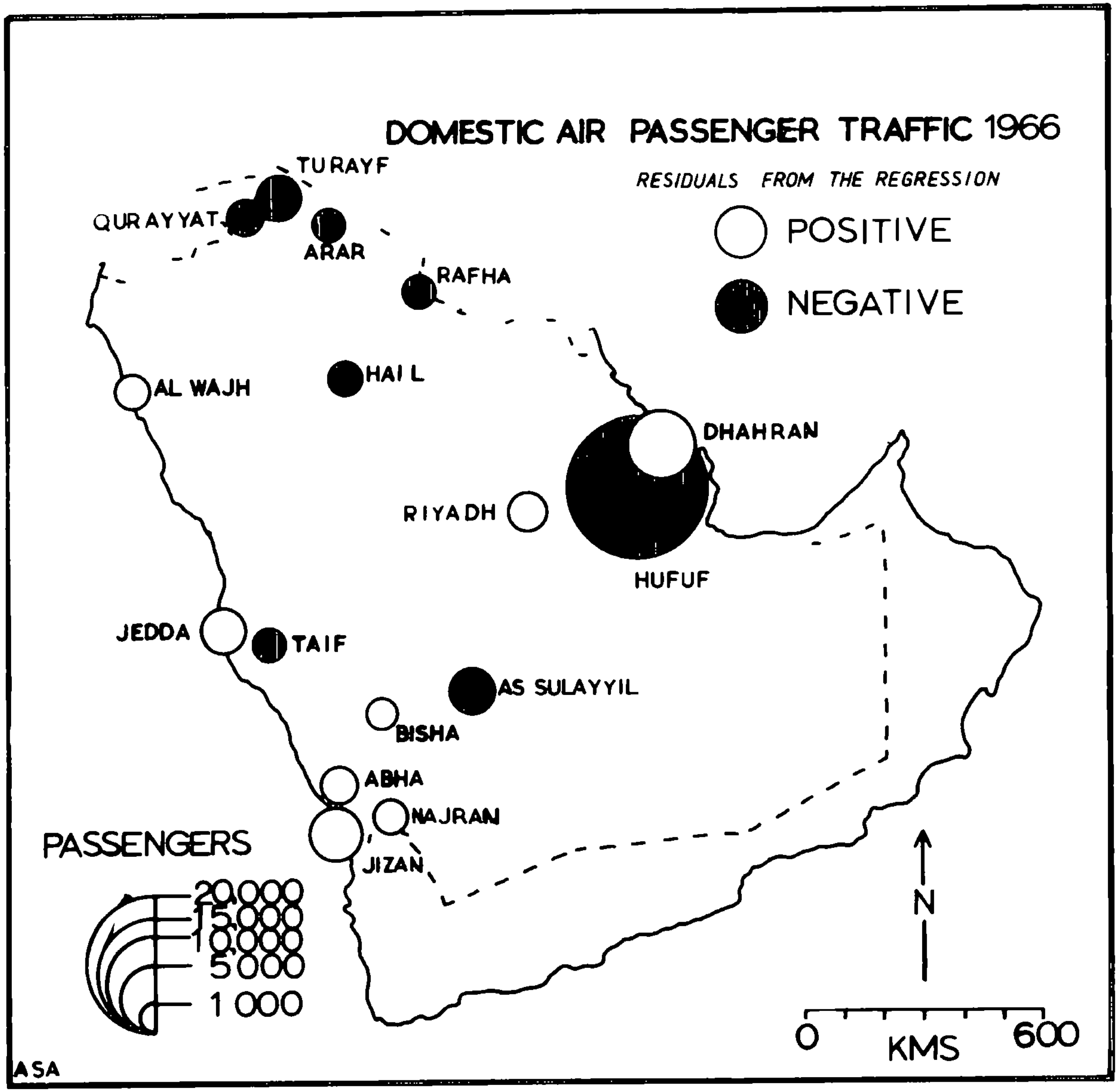

DOMESTIC AIR PASSENGER TRAFFIC 1966
RESIDUALS FROM THE REGRESSION
POSITIVE
NEGATIVE
TURAYF
QURAYYAT
ARAR
RAFHA
HAIL
AL WAJH
DHAHRAN
RIYADH
HUFUF
JEDDA
TAIF
AS SULAYYIL
BISHA
ABHA
NAJRAN
JIZAN
PASSENGERS
20,000
15,000
10,000
5000
1 000
N
0 KMS 600
ASA

Fig 3.2

urban distribution The term means the tendency of the largest city in any cluster of cities to act as the traffic-receiving point for the entire cluster This definition will later be modified on the basis of the findings of our study

Dhahran is the best example of the influence of the traffic-shadow factor on the pattern of air traffic in Saudi Arabia Dhahran is one of a number of relatively modern towns located within short distances of each other (see Fig 1 3) and linked with a modern road network Almost every one of these towns has a land strip used occasionally by Aramco planes but Dhahran airport is the only major airport in the whole area, and acts as the traffic-receiving point for the entire region It is relevant to notice that Dhahran, is not the primate city of the Gulf region With its population of 15,700 it ranks only as the seventh city in the region, much smaller than, for example, Hufuf which has a population of 51,400 In this case Hufuf is the point of traffic-losing with the lowest negative residual in the whole country while Dhahran, the small town, is the point of traffic-receiving and has the highest positive residual in the country

Jedda and Mecca form another clear example of the traffic-shadow factor with Jedda having a positive residual of about 2140 passengers and Mecca, which is only 73 Kms away, having no airport Jedda, the city with the smaller population (147,899) therefore acts as the traffic-receiving point, while Mecca, the city with the larger population (158,938) is the traffic-losing point

The analysis of air traffic in Saudi Arabia thus suggests some modification of the Taaffe explanation of the traffic-shadow It is not necessarily the town with the largest population in the cluster (the primate city) that develops as the traffic-receiving point for the entire cluster, but the town which has a major airport before the other towns in the cluster It is very likely that such a major airport is built in the largest town but this is not always the case Such a large town may be avoided because of the inability to find suitable land for the airport because of morphological or other reasons On the other hand, a small town may attract the major airport because of its geographical location or some other reason

In Saudi Arabia neither Dhahran nor Jedda is the largest town in their clusters, yet they attracted the major airports and were developed as traffic-receiving points In the case of Dhahran the airport was built by the U S Air Force as an American airbase during the second World War, near Dhahran the newly built town populated mainly by the American employees of Aramco In the second case Mecca has no airport, in spite of its size, because of its mountainous morphology and because non-Muslim pilots and engineers are not allowed into it

(C) Availability of other transportation services

The impact of this factor on air traffic is governed by the distance involved and the morphology of the area travelled In general the towns which are not yet reached by the modern road network - Jizan, Al Wajh, Najran and Bisha - have positive residuals since the passenger traffic to and from these towns is almost entirely by air On the other hand, the towns linked to the modern road network - Turayf, Badana and Rafha all have negative residuals since air traffic here competes with road services (see Chapter Eleven)

However, the importance of this factor - the availability of other transportation services - decreases with the increase in the distance travelled and vice versa

The clearest example which illustrates the impact of this factor is the traffic between the Taif and Jedda airports Due to the Surat Mountain problem (see Chapter Four) the air traffic between these two airports was as high as 19,548 passengers in the year 1965 in spite of the short distance involved, 130 Kms The inauguration of the Taif - Mecca road which linked Taif with Jedda reduced the 1966 traffic between the two airports by 6,053 passengers from that of the previous year

(D) Other Factors

Though town size, traffic-shadow and availability of other transportation services are the main factors in air traffic generation, other factors such as town functions and social and economic activities are also of some importance Such factors seem to be responsible to some extent, for the high residuals of Riyadh, Jedda and Dhahran The intermediate geographical situation is another factor which seems to have contributed to the high residuals of Al Wajh and Bisha since those two towns are located on major routes to Jedda In the case of the intermediate situation, however, most of the positive residuals are caused by the transit traffic and not the traffic generated by the town itself

The Hajj Impact on Seasonal Fluctuations

The Hajj activities bring a very high demand for air transport This demand occurs during a short period of about two months, and it is a demand in one direction at a certain time In spite of utilizing all the resources it has, the SDI usually co-operates with other airlines in order to provide the required services The Hajj effect on the seat-miles produced by the SDI can be seen in table 8 1 which shows that the traffic in a Hajj month may be higher than that of a normal month by as much as 232/ (1955)

Table 8 1, however, indicates that the difference in the traffic of the SDI between a Hajj month and a normal month has been declining during the period of study Air traffic in a Hajj month was on average 164% higher than in a normal month for the first five years compared with only 50% for the last five years This has occurred in spite of the fact that air traffic in the Hajj season has been steadily increasing during the whole period, because the normal air traffic has been increasing at a higher rate than the Hajj traffic This is supported by Table 8 2 which shows how much the monthly

Table 8 1 Seat-miles output of the SDI in normal and Hajj months, 1954 - 1966

	Normal Month (000,000)	Hajj Month (000,000)	Difference %
1954	5 58	15 15	172
1955	7 01	23 30	232
1956	8 53	22 25	161
1957	10 64	23 95	125
1958	9 9	22 75	130
1959	10 66	21 5	102
1960	10 63	28 95	172
1961	11 39	24 5	115
1962	19 17	32 7	71
1963	20 58	31 8	55
1964	32 83	46 65	42
1965	35 0	45 45	30
1966	40 2	56 35	40

Source   Based on the Central Department of Statistics, The Statistical Yearbook, 1967, p 196

hours flown by the SDI are affected by the Hajj The difference between Hajj and normal traffic was 35% in 1965 and only 28% in 1966

However, the full impact of the Hajj on the air

Table 8 2 Monthly Hours Flown by the SDI

In Normal and Hajj Months, 1965 - 1966

	Normal Month					Hajj Month					Difference %				
	DC-3	Convair	DC-6	Boeing	Total	DC-3	Convair	DC-9	Boeing	Total	DC-3	Convair	DC-6	Boeing	Total
(1965)	806	1265	332	466	2888	901	1936	532	534	3902	+12	+53	+60	+15	+35
(1966)	1207	1276	666	418	3567	1193	1983	859	538	4572	-	+55	+29	+29	+28

Source Central Department of Statistics, Statistical Yearbook, 1967, p 197 traffic in Saudi Arabia cannot be seen from the activities of SDI alone, for SDI cooperates with other airlines in meeting the traffic demands of this season Thus a comparison between the activities of foreign airlines in Jedda airport during the Hajj and during normal times should clarify the impact of the Hajj on air traffic activities in Saudi Arabia In 1965 the average number of foreign aircraft landing in Jedda airport was 113 for a normal month and 814 for a Hajj month, a difference of 620% As for the number of the passengers carried by foreign airlines to and from Jedda in 1965 this was on average 1,460 for a normal month and 64,263 for a Hajj month, a difference of 1,445% In 1966 it was 4032 compared with 76,180, a difference of 1,789%

The Hajj effect on air traffic is primarily on the airports of Jedda and Medina The figures for 1967 show that the traffic in Jedda airport was higher during the two Hajj months by 17,951 passengers than the average traffic for two normal months The traffic between the Medina and Jedda airports was 17,117 passengers higher in the two Hajj months than the average traffic of two normal months (1967) The impact of the Hajj on the traffic of other airports is not, however, very significant

Only about 7114 Saudi Pilgrims travelled by air to the holy cities during the Hajj of 1967 More than one half of this number coming from Riyadh

In contrast, the number of foreign pilgrims travelling to the holy cities by air is remarkably high 107,103 in 1966 Air traffic has been playing an increasingly important role in foreign pilgrims transport The average proportion of foreign pilgrims travelling to the holy cities by air was 32% during the period 1962-66 compared with 18% during the period 1956-60

Table 8 3 Pilgrims Travelling by Air from Various Countries - 1966

Country	Total Pilgrims	Percentage of Pilgrims Travelling by Air
S W Asia		
Iran	35334	93
Lebanon	4762	28
Syria	19208	18
Iraq	20519	14
Kuwait	6677	9
Turkey	39309	6
Jordan	7380	4
Yemen	2095	00
N Africa		
Tunisia	630	97
Algeria	6609	63
Morocco	8266	55
Libya	18326	25
U A R (Egypt)	10005	16

Country	Total Pilgrims	Percentage of Pilgrims Travelling by Air
Rest of Africa		
Guinea	2457	100
Senegal	2275	100
Niger	1255	100
Ivory Coast	430	100
Mali	1312	95
Nigeria	8535	94
South Africa	819	83
Sudan	20168	61
Somalia	1326	38
Ethiopia	2464	17
Chad	2191	12
S and E Asia		
Afghanistan	5740	73
Ceylon	570	47
Pakistan	23951	13
India	15865	8
Philippines	3713	6
Thailand	1310	5
Indonesia	23951	2
Fed of Malaysia	6718	2

Source Central Department of Statistics, Statistical Yearbook 1967 pp 120-21

Factors affecting the proportion of pilgrims who travel by air from a certain country are not clear, as can be seen from table 8 3 Distance from Saudi Arabia, the geographical location in relation to the sea, and availability of land transportation services seem, however, to be the most relevant factors, though not the only ones Unfortunately the available figures do not allow any further conclusions

<u>The Trend of Air Traffic Growth</u>

During the period 1954-66 there has been a steady growth in the seat-miles output of the SDI The period 1954-61 had, however, a rather low rate of growth (8,370,000 seat-mile per annum) while that of 1961-66 had a remarkably high growth (76,420,000 seat-mile per annum) The difference in the rates of growth of the two periods reflects the history of the SDI in a number of ways During the first period the SDI services were confined to Saudi Arabia while in the second they crossed the borders During the first period the SDI had no jet aircraft, while in the second it had Boeing 720 Bs and Dc-9 jets During the first period the SDI was directly run by the government, while in the second it became a corporation as a commercial entity

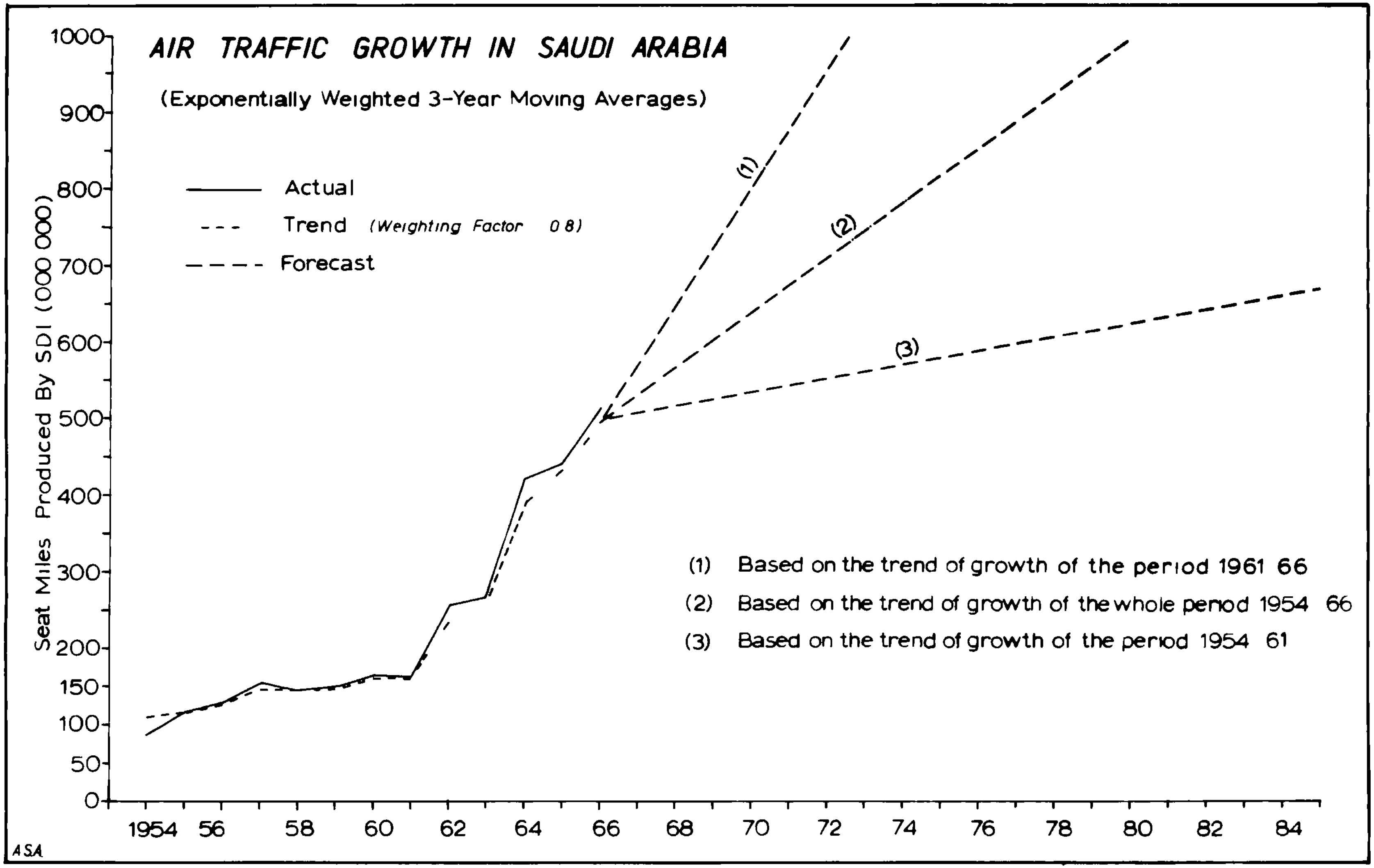

AIR TRAFFIC GROWTH IN SAUDI ARABIA
(Exponentially Weighted 3-Year Moving Averages)
Actual
Trend (Weighting Factor 0 8)
Forecast
Seat Miles Produced By SDI (000 000)
1000
900
800
700
600
500
400
300
200
150
100
50
0
1954
56
58
60
62
64
66
68
70
72
74
76
78
80
82
84
(1)
(2)
(3)
(1) Based on the trend of growth of the period 1961 66
(2) Based on the trend of growth of the whole period 1954 66
(3) Based on the trend of growth of the period 1954 61
ASA

Fig 8 4

Fig 8 4 shows the actual growth of seat-miles produced by the SDI An exponentially weighted trend line is also shown on the graph according to a weighting factor of 0 8 Three forecasts were estimated in Fig 8 4, one based on the trend of growth during the period 1954-66 (35 71 million), the other on the trend of growth on the period 1954-61 (8 37 million) and the third on the trend of growth of the period 1961-66 (76 42 million) The calculation of the exponentially weighted averages and the forecasts of future air traffic growth until 1985 can be seen in Appendix B

It is worth noticing, however, that in spite of the expansion of the road network and the fact that air transport is facing increasing competition from road transport, air traffic has been growing at a higher rate in the last five years In one way, this reflects the general socio-economic growth in the country In another way, it shows that because of the large distances which, separate the towns and cities of Saudi Arabia, the competition of roads in passenger transport has generally, not been very effective except on short routes

Fig 8 5 shows the growth of air traffic against

THE GROWTH OF SEAT-MILES PRODUCED BY SDI COMPARED WITH DIESEL FUEL CONSUMPTION, MOTOR GASOLINE CONSUMPTION & GOVERNMENT EXPENDITURE

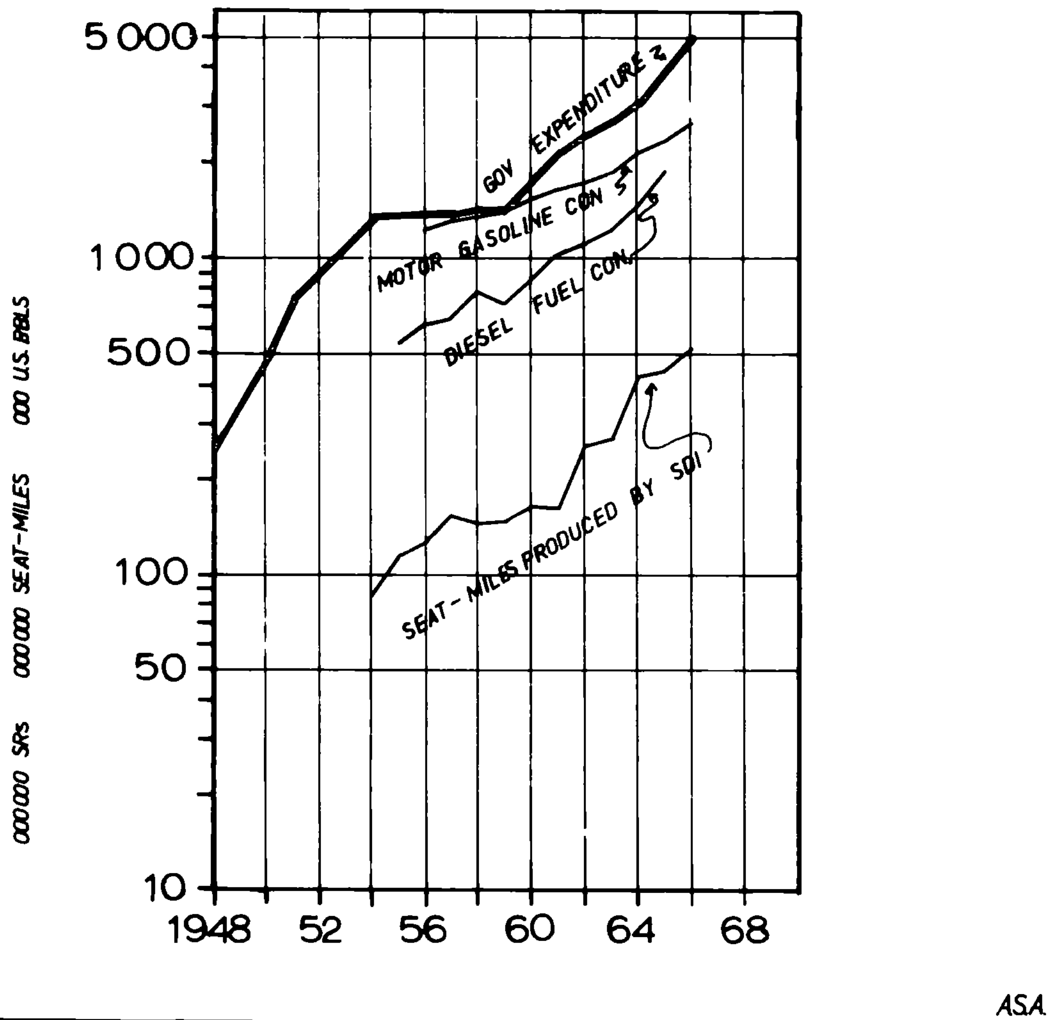


Fig. 8.5

the general economic growth, as represented by the government budget, and the road traffic growth, as represented by diesel fuel and motor gasoline consumption The growth of air traffic (as well as road traffic) was very low during the period 1956-60 when the economic growth was interrupted, but since 1961 air traffic, has, responded to the improvement in the economy and has grown commensurately with the growth of the government budget Fig 8 5 also shows that since 1961 air traffic has been growing faster than road passenger traffic and road freight traffic

Fig 8 6 shows the spatial growth of domestic air traffic from 1965 to 1966 It is clear from the map that the main increase is in the traffic of the three axis centres with Jedda having the highest increase (219,892 passengers) followed by Riyadh (158,492 passengers) and Dhahran (114,413 passengers) Next to the axis group comes the towns which have not yet been linked to the road network and which have benefited from some economic and social projects during the last few years The towns of the southwest represent this second group Jizan had an increase of 75,362 passengers, Abha had an increase of 31,170 passengers and Nagran had an increase of 16,946 passengers Al Gassim also had a

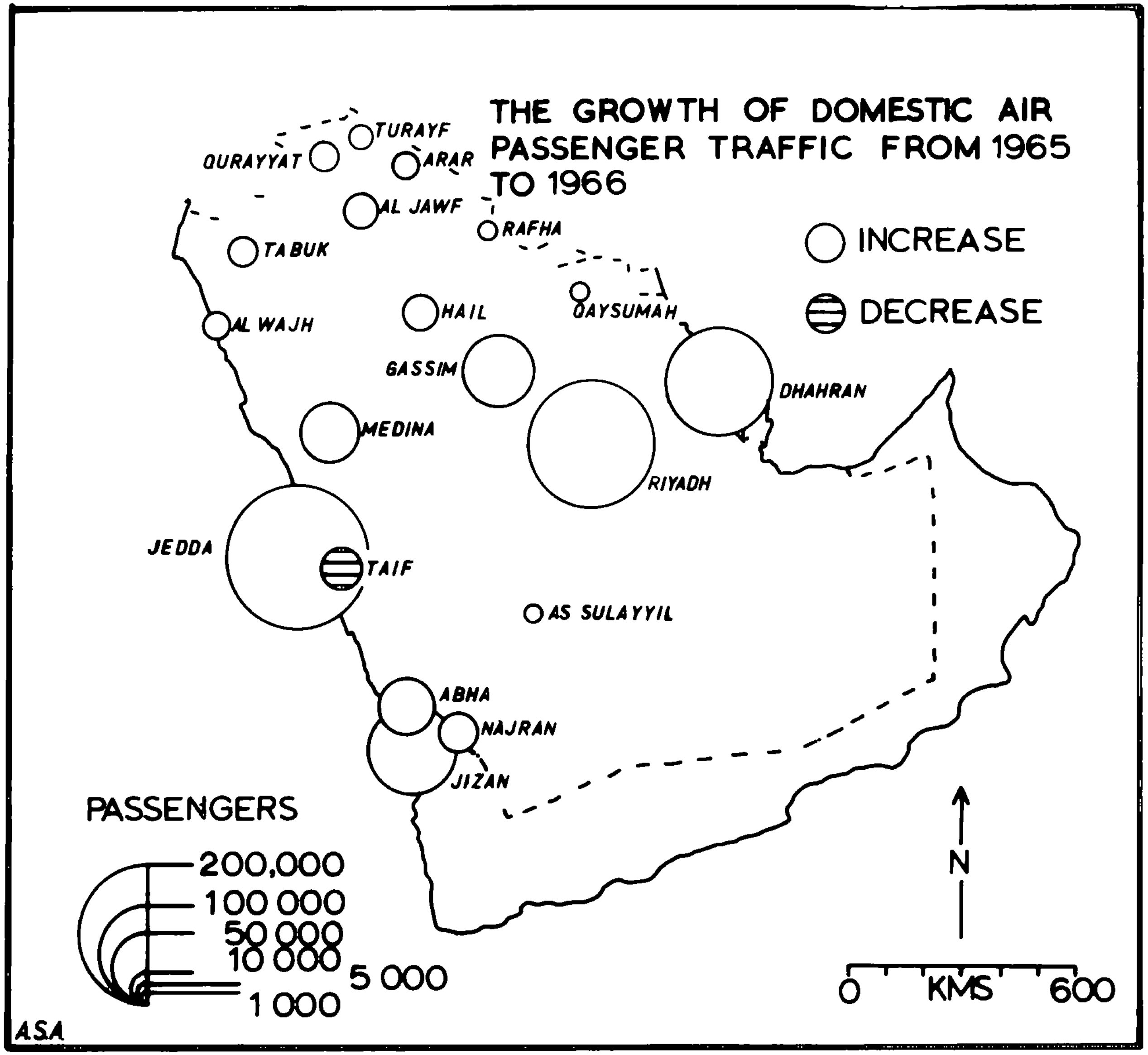

THE GROWTH OF DOMESTIC AIR PASSENGER TRAFFIC FROM 1965 TO 1966
INCREASE
DECREASE
QURAYYAT
TURAYF
ARAR
AL JAWF
RAFHA
TABUK
AL WAJH
HAIL
QAYSUMAH
GASSIM
MEDINA
DHAHRAN
RIYADH
JEDDA
TAIF
AS SULAYYIL
ABHA
NAJRAN
JIZAN
PASSENGERS
200,000
100 000
50 000
10 000
5 000
1 000
N
0 KMS 600
A.S.A.

Fig. 36

high increase (52,826 passengers) due to the improvement of its airport, its linkage with asphalt roads to the main towns in the region but also due to the remarkable agricultural development witnessed by this region over the last few years The increase in the traffic of Medina by 35,111 passengers seams to be a result of the increase in pilgrim traffic from 1965 to 1966

The only airport in which traffic decreased is the Taif airport The traffic in this airport decreased by 6053 passengers because of the opening of the Taif - Mecca asphalt road

Conclusion

The findings of this chapter can be summarized in three points (a) The increase in air passenger traffic in Saudi Arabia is associated with the general socio-economic growth (b) the pattern of air traffic is affected mainly by the town size, the traffic-shadow and the availability of other transportation services (c) Seasonal fluctuation is considerably affected by the Hajj

It may be concluded that in spite of the favourable geography of Saudi Arabia, air transport is financially very unsuccessful In 1966 about 239,000,000 SR out of SDI budget of 302,000,000 SR was a government subsidy The unsuccessful financial situation can only be caused by the problem of inadequate labour and technical ability which was discussed in a previous chapter and which has a considerable impact on the management of the airlines and in turn on the choices of policies, aircrafts and other important matters

References and Notes

1 Sealy, K R , The Geography of Air Transport, 1966, p 57

2 Central Department of Statistics, Statistical Yearbooks 1965 p 194 and Statistical Yearbook 1967, pp 203-204

3 Available data does not differenciate between transit and other traffic If their is no direct flight between A and B and a passenger has to take the route via C, then this passenger is considered - in the data available - a passenger from A to C and another passenger from C to B though he had no desire to go to C It was because of this defect that the coefficient between air traffic on the Jedda routes and the distances involved was as low as r + 0 26 with r^2 value of only + 0 0685

4 Taaffe, E J , 'Air Transportation and United States Urban Distribution, in Mayer, H M and Kohn, C F , Readings in Urban Geography, 1967, pp 346-61

CHAPTER NINE

UTILIZATION OF ROAD TRANSPORT

In this chapter three problems of underutilization in road transport are discussed The problems are first summarised then discussed in more detail Each problem represents a different type of underutilization in road transport, ~~under-utilization~~, the only common factor between them is the employment of more than the necessary resources to produce a certain output

So far the construction of new roads has been taking the attention of the government away from the other aspects of road transportation such as the problems of underutilization Road transport, except pilgrim transport, has been left to work and develop without government intervention, or even awareness The authorities never realized the existence of two of the problems discussed in this chapter, while they never understood the problem connected with pilgrims This study, therefore, throws some light on some unknown or misunderstood problems of road transport

The High Dependence of Passenger Transport on Taxi Services

One aspect of underutilization in road transport in Saudi Arabia is the high dependence of passenger transport on taxi services both in inter and intra-city services

On average, taxis account for 26 percent of the total traffic on roads linking the various cities In some cases this proportion reaches 37 percent (Safwa - Jubayl road), and it is 30 percent or above on another nine roads In contrast to this high proportion of taxis on the roads, buses account for only 6 6 percent of the total traffic volume In fact, surprisingly, bus services do not exist between some major cities of Saudi Arabia, for example, during the period of personal investigation by the author between January and May 1968 no bus service existed between Mecca and Taif nor between Riyadh and Hufuf

Further, intra-city passenger transport in Riyadh depends entirely on taxi services Riyadh has a bus-like taxi system where passengers go to the taxi stations or stand on the side of the roads to call a taxi Taxis from the centre of the city go to the various parts of Riyadh carrying passengers each of whom pays only for his seat and may be dropped at any point he wants on the way In most of the other cities, particularly Jedda, taxis also play a major role in intra-city transport

Such high dependence on taxis in inter and intra-city passenger transport is no doubt a waste of resources since the same services could be provided at less cost with the use of buses Further, such high dependence on taxi services has an unfavourable effect on the imports of cars and spare parts and thus on the balance of payments

The passenger traffic on three main roads are here investigated in an attempt to measure the amount of money which could be saved if the present volume of passenger transport between cities were done by bus services rather than by taxis The comparison between the two services is based on the cost as seen by the users that is the fares The information on the volume of passenger traffic on the Taif - Riyadh and the Taif - Mecca roads was obtained from the Taif Traffic Police during April 1968 The traffic on the third road, the Dammam - Khobar road, was obtained from the traffic survey carried out by the Road Department in January 1967

The number of passengers travelling between Taif and Riyadh is about 200 a day The taxi rate is 30 SR on average and the bus rate is 15 SR on average Thus with the use of bus services the present volume of passenger traffic can be carried with only 50% of the cost Hence the transformation to a bus service on this road would save about 3,000 SR a day

On the Taif - Mecca road the average passenger traffic is about 3,000 passengers a day During the summer the number is certainly higher than this since Taif is the summer resort of Saudi Arabia However, the taxi rate on this road is 4 SR per passenger on average Taking the bus rates on other roads into consideration it can be assumed that a bus service rate would be about 2 SR per passenger Thus a change to a bus service would save about 6,000 SR a day at the present level of traffic

According to a traffic survey carried out in January, 1967, there is an average of 7,665 passengers a day travelling by taxi between Dammam and Al Khobar with a rate of 1 SR per passenger A bus service does not exist on this road but it can be assumed that a bus rate would be 0 5 SR per passenger Thus a change to a bus service would save about 3832 SR a day

On the three roads examined above a change to a bus service would save about 13,000 SR a day or about 4,758,000 SR a year on the present level of traffic Obviously, if the traffic on other roads and the intra-city traffic are considered the amount saved would be much higher

It must be stressed, however, that as Saudi Arabia does not manufacture cars the change from a taxi to bus service would not only mean achieving the same output with only about 50 percent of the present cost, but would also mean a better balance of payments because of the reduction in cars and spare parts imported

It is very important to ask how such a problem can develop in a fully competitive market since competition should lead consumers to buy the least costly service Obviously, the Saudis are buying the taxi service because it gives them some services which they want and which the bus services are unable to provide Taxis are more comfortable and faster However, since the type of buses used in Saudi Arabia have a reasonably high standard of comfort it is more likely that the time saving is the decisive factor From Taif to Riyadh, for example, a bus takes 12 hours while a taxi takes 8 hours A passenger also travels by taxi because he can be sure that he will set off shortly after coming to the station, since taxis travel at short intervals as a result of their load capacity The case is different by bus, since he them may have to wait all day or probably until the next day if the number of available passengers is less than the capacity of the bus So, while two buses may travel from Taif to Riyadh one day, not a single bus may be travelling on the next day (information from the Traffic Police in Taif) In fact travelling by bus is like going to a restaurant hungry but without knowing when you are going to be served Such a situation has resulted from low demand and disorganization of the bus services

In view of this situation it can be said that a regular bus service with a fixed time-table should encourage more people to use buses rather than taxis However, the present sole proprietor ownership of buses and the present small demand of passenger transport will no doubt make the organization of bus services a very difficult task

The Underutilization of Load/Capacity in Road Transport

Another main aspect of underutilization in road transport is the fact that on average freight vehicles are 53 percent underloaded In principle the problem is very easy to understand since if a truck of 5 ton capacity is loaded with only 2 5 tons this truck is 50 percent underutilized Obviously, such underutilization has its impact on the cost of transport per unit of output (see Chapter Eleven) and consequently on the prices, supply and demand of services In spite of this underloading problem there is also a problem of overloading in some cases

The attention of the Road Department has not been drawn to this problem yet Many reports have referred to the problem of truck overloading but not underloading Both problems do exist, but since the Road Department is only responsible for the construction and maintenance of roads, underloading, unlike overloading, is not a problem since it does not damage the roads or increase their maintenance bill

To discuss this problem load/capacity utilization is here examined on four roads located in different parts of the country Medina - Khaybar road, Riyadh - Dammam road, Riyadh - Marat road and the Tapline road

Table 9 1 shows the proportion of empty vehicles to the total volume of traffic in each direction for each of the four roads Table 9 2, however, shows the load capacity problem in a more meaningful way by showing the actual load carried on each type of motor vehicle in each direction The two tables show that the proportion of empty vehicles is 23% on average and may be as high as 89% (Khayber to Medina traffic) and that the actual load to capacity ratio is only 47% on average and vehicles run empty in some cases tankers and trailers from Khayber to Medina and trailers from Taif to Riyadh Table 9 2 also shows that there is a problem of overloading on some of the roads The actual load to capacity is over 100% for the truck and tanker traffic from Dammam to Riyadh, for tankers from Medina to Khayber and for trailers from Riyadh to Taif Both problems, underloading and overloading, are affected by two major factors the direction of traffic and the type of vehicle Underloading exists in both directions of the traffic on all the roads studied but it is greater in the direction from the small settlements to the main inland cities than in the opposite direction The proportion of empty vehicles is 89% in the direction from Khayber to Medina against 35% in the opposite direction, and the actual load in capacity is 12% against 71% in the other direction of the same road Underloading is also greater on the traffic from the main inland cities to their main ports than in the other direction The proportion of empty vehicles is 75% from Riyadh to Dammam against 28% in the opposite direction and the actual load to capacity is 19% against 82% in the opposite direction for the same road On the Tapline road the proportion of empty vehicles is 39% on the traffic going from the Gulf to the Mediterranean against 7% in the opposite direction Thus, whether on the Tapline road or on any of the other roads the problem of underloading is affected by the unequal demands for freight transport in the different directions of each road (see Chapter Eleven) The problem of overloading exists

Table 9 1 Proportion of Empty Vehicles to the Total Traffic (%)

Riyadh - Dammam Rd[x]			Riyadh - Taif Rd[+]			Medina - Khayber Rd[*]			Tapline Rd		
R to D	D to R	Total	R to T	T to R	Total	M to K	K to M	Total	To the Gulf	From the Gulf	Total
75	28	51	35	55	37	35	89	65	7	39	23

Table 9 2 The Actual load to Capacity Per One Vehicle (%)

Type of vehicle	Riyadh - Dammam Road[x]		Medina - Khayber Road[*]		Riyadh - Taif Road[+]		Average/Both Directions
	R to D	D to R	M to K	K to M	R to T	T to R	
Pick Ups	20	20	10	4	20	20	16
Trucks	43	102	67	44	72	65	66
Tankers	1	108	106	-	100	4	53
Trailers	15	99	100	-	111	-	54
Average one direction	19	82	71	12	76	22	47

x Survey point at Khurays
+ Survey point at Marat
* Survey point at Khayber

Source Unpublished Traffic surveys undertaken by the Road Department and the Tapline Company only in the directions from the small settlement to the main inland cities and from these cities to their ports

The type of vehicle is another important factor in the underloading and overloading problems Tankers and trailers are the types most affected by these problems Due to their specialization tankers run empty from Khayber to Medina and carry only one percent of their capacity from Riyadh to Dammam and 4 percent from Taif to Riyadh In the opposite directions tankers are either 100 percent full (from Riyadh to Taif) or overloaded their load to capacity is 106 percent from Medina to Khayber and 108 percent from Dammam to Riyadh Trailers run empty from Taif to Riyadh and from Khayber to Medina and carrying only 15 percent of their capacity from Riyadh to Dammam In the other direction trailers run either fully loaded 99 percent loaded from Dammam to Riyadh and 100 percent loaded from Medina to Khayber or overloaded (from Riyadh to Taif) Table 9 2 shows that the problem of overloading is more common among the bigger vehicles (trailers) and the more specialized vehicles (tankers) The table also shows that pick ups are the least utilized type of freight vehicle carrying on average only 16% of their capacity This is mainly because this type of vehicle is privately owned more than any other type of freight vehicle

It is far more difficult to try to analyse the load/capacity utilization for passenger traffic Private cars are only 50 percent utilized whilst taxis are 100 percent utilized, but this is only as expected In the case of buses it is even more difficult to reach any meaningful results since the capacity of buses is not known from the available data

However, it is clear from the above analyses that the high load/capacity underutilization in freight traffic is partly caused by the pattern of transportation demands which is unbalanced in both directions

The problem of underutilization of the Hajj transportation companies is more difficult to analyse, explain or solve than the other two problems of road transport A non-Muslim reader will find it more difficult to understand its causes though an attempt is made here to explain it in as much simplicity as space and time may permit

The problem itself can be summarized by stating that the Hajj transportation companies have 2,302 buses and 565 motor cars with a capacity of 105,095 seats stored in garages in Jedda and Mecca for most of the year and only employed during the Hajj season which is about two months On average each of these vehicles does only about 1,026 kilometres a year, on a trip from Jedda to Mecca and Arafat Only between 20 and 60 percent do another trip to Medina and thus make a mileage of about 2,000 kilometres a year Since the cost of road transport is closely related to the extent to which facilities are used (see Chapter Eleven) it can be easily appreciated that the Hajj transportation vehicles are very underutilized

The cause of this problem is the nature of the Hajj traffic itself All pilgrims who come to Mecca (about half a million in the 1967 pilgrimage) have to be transported from Mecca to Arafat (about 19 kilometres from Mecca) on the early morning of the ninth of the month of Zul Hijja During the night of the same day those pilgrims have to be transported to Mena which is near Mecca and after spending three days in Mena they are transported to Mecca

This heavy transportation demand in a very limited time led to the appearance of many Hajj transportation companies to provide foreign pilgrims with the required transport These companies were formed purely because

Saudi Arabia has special responsibility towards foreign pilgrims who travel thousands of miles to come to Mecca To spoil the Hajj of these people because of inadequate transportation services between Mecca and Arafat would mean a very bad name for Saudi Arabia and its government

However, underutilization in the Hajj transportation companies has resulted in a very high cost per unit of output (0 125 SR per seat kilometre according to the records of one Hajj Company) This in turn has resulted in very high rates Table 9 3 shows the rates charged by the Hajj transportation companies in comparison to the normal rates As can be seen the difference may be as high as 3 05 SR per passenger/kilometre

These high rates have been criticised by newspapers especially in the last few years The Hajj transportation companies have been accused of having excessive profits and were asked to lower their rates especially as they were fixed in 1952 when road conditions were not as good as they are today The government has been asked many times in the newspapers to allow anybody and not only the Hajj transportation companies to carry foreign pilgrims, or to lower the rates of these companies by legislations The present system has very often been accused of being

Table 9 3 The Rates Charged by the Hajj Transportation Companies in Relation to Normal Rates

The Bus Rates

Road	Length Km	Rate SR	Km/Rate SR	Normal Rates Km/Rate SR
Mecca-Medina-Jedda	920	101 25	0 11	0 019
Mecca-Jedda	72	11 25	0 16	0 021
Mecca-Medina	496	56 25	0 11	0 023
Mecca-Arafat	19	35	1 84	0 05

The Motor Car Rates

Road	Length Km	Rate SR	Km/Rate SR	Normal Rates Km/Rate SR
Mecca-Medina-Jedda	920	160	0 17	0 044
Mecca-Jedda	72	16	0 22	0 042
Mecca-Arafat	19	67 5	3 55	0 50

Source Based on Pilgrim transportation rates as collected from a Hajj Transport Company a monopoly which is badly organised and run by some capitalists In this section, therefore, information was specially collected and analysed to answer the two following questions (1) are the Hajj transportation companies really making excessive profits and (2) should the present system of Hajj transport be changed by government legislation?

The author was kindly given access to the financial records of one of these companies

<u>Table 9 4 The Balance of a Hajj Transport Company (SRs)</u>

	Surplus	Deficit
1955	366,950	-
1956	63,043	-
1957	-	78,364
1958	-	80,604
1959	58,144	-
1960	-	100,428
1961	112,316	-
1962	-	109,062
1963	121,748	-
1964	421,826	-
1965	312,364	-
1966	416	-
1967	395,155	-

Table 9 4 indicates that the company had a total profit of 1,483,504 in the whole period of 1955-67 Table 9 4 is, however, a misleading indicator since it is not based on accurate economic calculations The cost of capital immobilization for example was not considered among the costs of this company If we consider the cost of capital immobilization this firm is losing and not making a profit The 3,000,000 SR employed in this firm in the beginning of 1955 could have made a profit of 2,202,209 SR by the end of 1967 if it was put in a bank with 5% interest The profit made by employing the money in the Hajj transport business was only 1,483,504 SR, a sum of 718,705 SR less than even a 5 percent annual interest

In a country like Saudi Arabia with lots of economic opportunities for capital employment and considering the fact that the records examined here belong to the most efficient of the Hajj transportation companies there can be no doubt that the Hajj transport businesses are not financially successful in spite of the present high rates, and this is the answer to the first question

In answering the second question which deals with changing the present system of Hajj transport the importance of the present Hajj transport business must be adequately appreciated as it forms an important sector in the national economy The amount of money employed in this business is at least 51,000,000 SR (this estimate is based on the records of one of the Hajj transport companies) The advantages of the present system should also be appreciated before any new government legislation to reduce the rates or change the system is considered The present system has an admirable standard of efficiency which was possible to achieve only by long experience and different sorts of difficulties in the past Lessons from history are very important here

At present there are five Hajj transport Companies and only these five have the right to carry foreign pilgrims So the present system is not competitive but also it is not a monopoly Practically anyone who has a minimum of 80 buses and 20 cars can enter the business and form another company

Before 1935 there were as many as 30 small companies working in the Hajj transport business The free competition between these companies led to the reduction of rates to a level that led many of these companies to financial difficulties, and thus affected the ability of those companies to fulfill their duties towards the pilgrims. Moreover, it was difficult for the government to inspect or supervise them For these reasons and in view of their influence on the pilgrim transport and the name of the country and the government in the Muslim World, the government established an official body - Naqabat Assayyarat -

(the Automobile Association) to legislate for fixed rates and organize the Hajj transport Since then, vehicles that carry pilgrims have had to pass a fitness test and Naqabat Assayyarat has distributed the pilgrims according to the capability of each company

In 1935 those 30 small companies were united by government decree into one big firm under the name of Ash Sharika Al Arabiyya Li As Sayyarat (The Arabian Automobile Company) The new big company was given a complete monopoly of the transport of pilgrims It is important to note that the new company in its first year made a profit of 10 percent which was very considerable in the conditions in Saudi Arabia and the world at that time Two thirds of the share of this company was bought by the government and the company was also given a monopoly of all the government transportation requirements However, the government control was lifted after the end of the second world war and the company started a new phase with a capital of 12,000,000 SR This company made a profit of 37 percent in 1946 and the price of shares rose from 800 to 900 SR [1]

Although the situation was so profitable for Ash Sharika Al Arabiyya Li As Sayyarat, the services provided by this company were far from adequate The company's seating capacity was far below the number of pilgrims it had to transport, and thus each vehicle had to do three to four trips between Mecca and Arafat In view of the nature of the Hajj such multiple trips used to result in traffic chaos, inconvenience to pilgrims and when the Hajj occurred in the summer pilgrims were liable to sun stroke and death

For these reasons in 1952 the government allowed new firms to enter the Hajj transport business According to the 1952 law[2] each firm or person with a minimum of 80 buses and 20 cars became eligible to carry foreign pilgrims Ash Sharika Al Arabiyya Li As Sayyarat became one of five firms responsible for the transport of pilgrims The 1952 system increased the number of vehicles and seats employed in the Hajj business in a dramatic way By 1965 the seat capacity of the Hajj transport companies became capable of transporting all the pilgrims they are supposed to carry between Mecca and Arafat with only one trip per vehicle This admirable efficiency has been as shown above, accompanied by unfavourable financial conditions

The most important fact which this historical summary reveals is the fact that fewer vehicles in relation to the number of pilgrims means a better financial position for the firms but inconvenient services for the pilgrims whilst a large number of vehicles in relation to the number of pilgrims means an efficient service for the pilgrims but a financial deficit for the firms The Hajj transportation business has developed from a state of financial difficulties and inadequate service which prevailed before 1935 to a state of financial gain but inefficient service which prevailed during the monopoly of Ash Sharika Al Arabiyya Li As Sayyarat, and since 1952 to a state of efficient service - particularly since 1965 - but with a slightly unfavourable financial position The failure of the free competitive system before 1935 and the partial success of the monopoly of Ash Sharika Al Arabiyya Li As Sayyarat and the (semi-monopoly) system of the present time may indicate that the Hajj transport business requires some sort of government control and supervision

Another important fact shown in the above historical summary is that within the present system both the financial situation and the efficiency of the Hajj transport business, is gradually improving Table 9 4 shows that with the improvement of organization and experience the financial situation of the company has been improving considerably

In view of the above analysis the possibilities of improving the Hajj transportation business seem to be limited by the nature of the Hajj itself The difficulty is how to improve the financial situation of the business without lowering the present standard of efficiency Three possible ways of achieving this aim are explored here

1 An increase in the rates from their present level to a level that ensures a reasonable profit to the Hajj transport enterprise Such an increase cannot affect the number of foreign pilgrims since this will be very minor to their total Hajj expenditure

2 Improving the road system between Mecca and Arafat to a level that allows a reasonable speed in the traffic Sufficient improvement of the road system would enable vehicles to do more than one trip without causing any inconvenience to pilgrims If this could be done it would mean that the seating capacity in relation to the number of pilgrims could be reduced and this would ensure a profit with the present rates or even with lower rates without reducing efficiency

3 The employment of the Hajj transport companies vehicles during non-Hajj time should be tried but without causing any inconvenience to other transport enterprises or lowering the present efficiency in Hajj transport service The possibility of employing some of these vehicles in government projects, or schedule trips to Taif during the summer, or in some other projects should

be examined and exploited The 1952 law does not prevent the Hajj transport companies from such activities, though it makes it difficult, because of the date and period of the vehicles test A change in the law would give the Hajj transport companies more free time in which they could employ some of their vehicles in non-Hajj business If this is done then vehicles would be better utilized and profit would become possible with the present rates

It must be admitted, however, that the problem of pilgrim transport is very complicated and difficult to solve For religious and sentimental feelings, raising pilgrim transportation rates would not be a popular step Moreover, the improvement of the road system between Mecca and Arafat to the required standard may be economically unjustified, and employment for the Hajj vehicles during non-Hajj time may be difficult to find

Conclusion

The analysis of each of the problems discussed in this chapter has been hindered by the lack of sufficient information In the problem of the high dependence on taxis, it was impossible to estimate the overall amount which could be saved by using buses to transport the people who at present use taxis What is said about the problem of high dependence on taxis can be said about the load/capacity and the pilgrim transport problems Information on the problem of load/capacity has been limited to the weight factor which is obviously not enough to make a profound judgement on this problem A truck fully loaded with hay, for example, would still be of a very low load/capacity ratio if only weight is considered though this does not mean that it is underutilized So, underutilization in load/capacity should be considered not only from the point of view of the weight but also the size and nature of the cargo In the analysis of the pilgrim transport problem it was impossible to see financial records for more than one company, since these are considered confidential Consequently, in spite of the belief that conclusions on the financial situation of the Hajj transport business are correct, no precise estimate of the overall profits and losses can be made If this chapter, however, succeeded in proving that such problems do exist and in throwing some lights on the dimensions of each problem, it would have achieved its purpose

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CHAPTER TEN

The Impact of Transport Development on Settlements and Social Changes

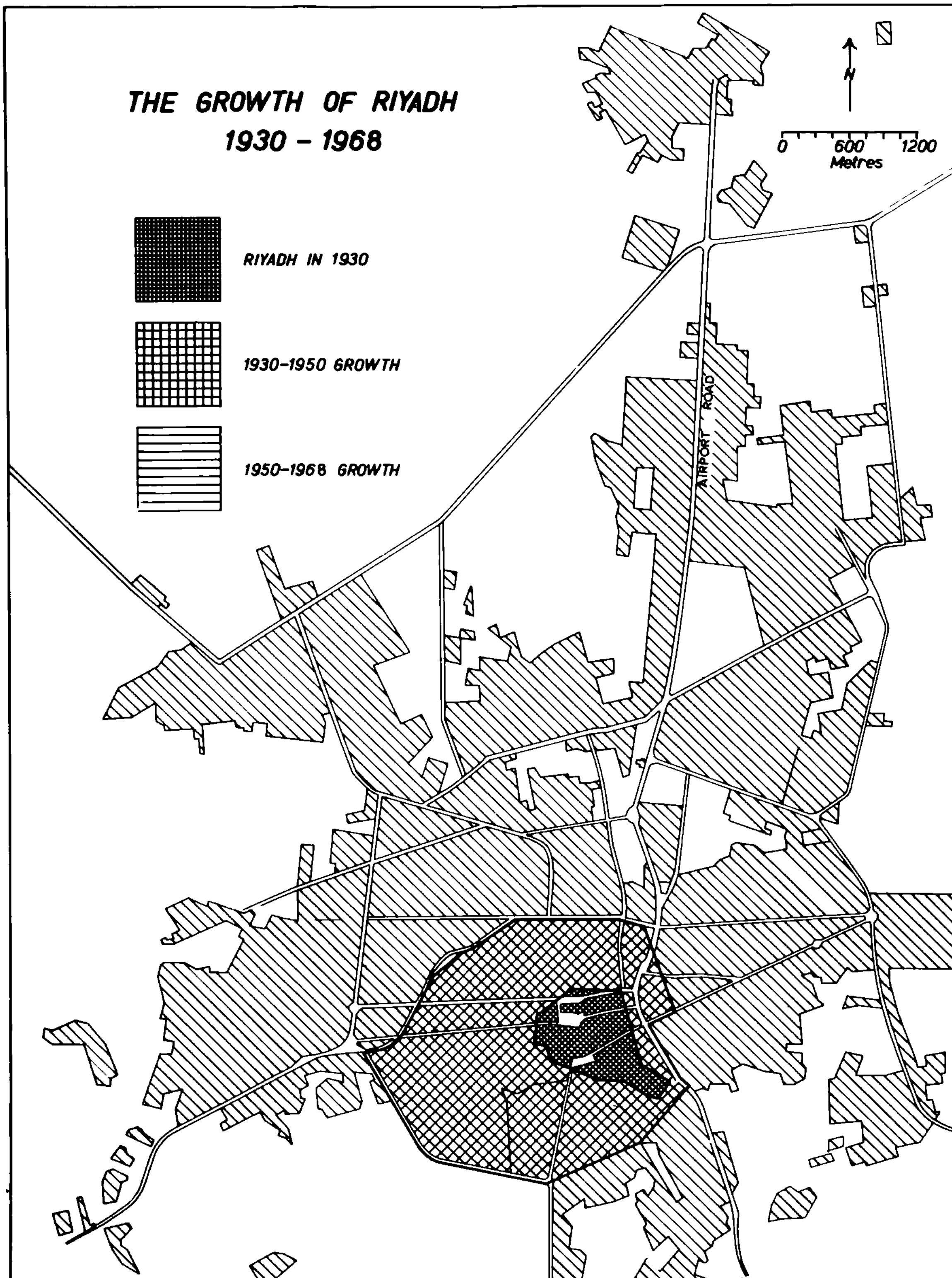
The development of transport in Saudi Arabia which was started in 1948 by the construction of the port of Jedda has been accompanied by a remarkable development in settlements and social life The aim of this chapter is to investigate how much settlement and social changes have been affected by transport development This chapter, therefore, is divided into two main sections, the first deals with settlements and the other deals with social changes In each of these two sections an attempt is made to show how different means of transport have different impacts on settlement and social changes and how different settlements and communities responded differently to the development of transport

The Impact of the Development of Transport on Settlements

The growth of settlements is the most obvious and expected impact of transport development, the growth of Jedda, Riyadh, Al Khobar and Dammam exemplify this impact Due to the discovery of oil and the economic activities which followed its exploitation, the growth of settlements in Saudi Arabia since 1950 has been rapid Riyadh is studied here as an example of the impact of the development of transport on the growth of settlements

Riyadh through history was an isolated little town about 400 Kms away from the nearest sea coast and surrounded by physical barriers in all directions the Dahna to the east, the escarpment of Tuwayq to the west, An Nafud to the north and Rub' Al Khali to the south In the 1930's this, was changed and Riyadh became, with the formation of the Kingdom of Saudi Arabia, the capital of the new country The main problem of the new capital was apparently that of transport Sufficient transport facilities were essential if Riyadh was to support itself and rule the large Kingdom King Ibn Saud was the first to realize this fact In fact it seems that President Roosevelt realized it too when he presented King Ibn Saud with a Dakota plane in 1945 [1]

At that time especial attention was given to the transport problem The government controlled The Hajj Transport Automobile Company which had 234 motor vehicles (1945), and the Minister of Finance was directly responsible for the transport of supplies to Riyadh [2] Thus King Ibn Saud had no illusion about the importance of transport to the growth of his capital In fact, just after the second world war when his financial situation improved from the oil revenues, his first main project was the construction of a modern port at Dammam and a railway from Dammam to Riyadh Though some experts argued that the railway could never pay its way, and that the country could not afford such luxury, "the King brushed them all aside"[3] and built the railway which he had the pleasure to inaugurate in 1952 Efforts were also made by King Ibn Saud to improve motor vehicle transport to and from Riyadh to the other parts of his country but mainly to the port of Jedda and to some extent to the port of Kuwait Consequently, Riyadh expanded from a town with a population of 30,000 in 1935 to 80,000 in 1950[4] the area of the town also expanded as can be seen in Fig 10 1 However, the real growth of Riyadh started with the construction of the Riyadh-Dammam railway and the Dammam port in 1952 From 1950 to 1962-3 the population of Riyadh increased from 80,000 to 196,000, an annual increase of about 8% per cent compared with a 2 5 per cent annual increase in the period 1935-1950 The growth of the area of Riyadh was also great after 1950 as can be seen in Fig 10 1 More important is the fact that before 1950 Riyadh consisted of mud brick houses, but since 1951 most of the new buildings have been of modern



COMPIL FROM AL JA IR, THE HI OR OF RIY DH, 96 Arab d OF PE ROLEUM NER SOURCES, MAP OF ADH 68 Ara

Fig 10 1

western styles This trend was only possible with the cement and steel which came via the port of Dammam and were transported to Riyadh along the Riyadh - Dammam railway The impact of motor transport, the port of Dammam and the Riyadh - Dammam railway on the growth of Riyadh is a remarkable example of the relationship between transport development and settlement growth

However, the development of transport has been accompanied by the appearance of a considerable number of new settlements in Saudi Arabia particularly in the oil area and the northern region Dhahran, Abqaiq, Ras Tannurah, Thuqba and many other settlements in the oil area did not exist before the oil exploitation and the development of transport The Tapline towns in the northern region were purely a result of the transport development in the region which took place with the construction of the Trans Arabian Oil Pipeline (Tapline) and the Tapline road in 1947-50 The Tapline towns are here chosen for detailed study as new settlements which appeared in conjunction with Transport development

The four pumping stations on the Tapline Turayf, Ar'ar (Badana), Al Qaysumah and An Nuayriyah now form four towns with the same names stretching along these transportation lines with a similar distance between each pair of them Personal investigation by the writer showed that none of these settlements existed before 1950 Yet one of them Ar'ar has been developed enough to be the capital of the northern region taking this position from Al Jawf, which had a long history but now is about 170 Kms from the modern road Ar'ar by 1962-3 had a population of 11,171 and at the time of the writer's visit (April, 1968) it had a bank, a health centre, a hospital with 150 beds (under construction), three elementary boys' schools, an intermediate boys' school, an elementary girls' school and an intermediate girls' school (Fig 10 2)

The development of the Tapline towns took a special pattern which was observed also in the new settlements of the oil area The four Tapline towns were merely four pumping stations in 1950 The drilling of some artesian wells beside these pumping stations soon followed with the appearance of some tents and <u>sandagas</u> (cottages made of wood and metal sheets) The second stage of development was the building of some mud, brick houses The third stage was the construction of modern houses The drilling of wells was, however, a prerequisite for the appearance of any settlement Ar'ar, the biggest

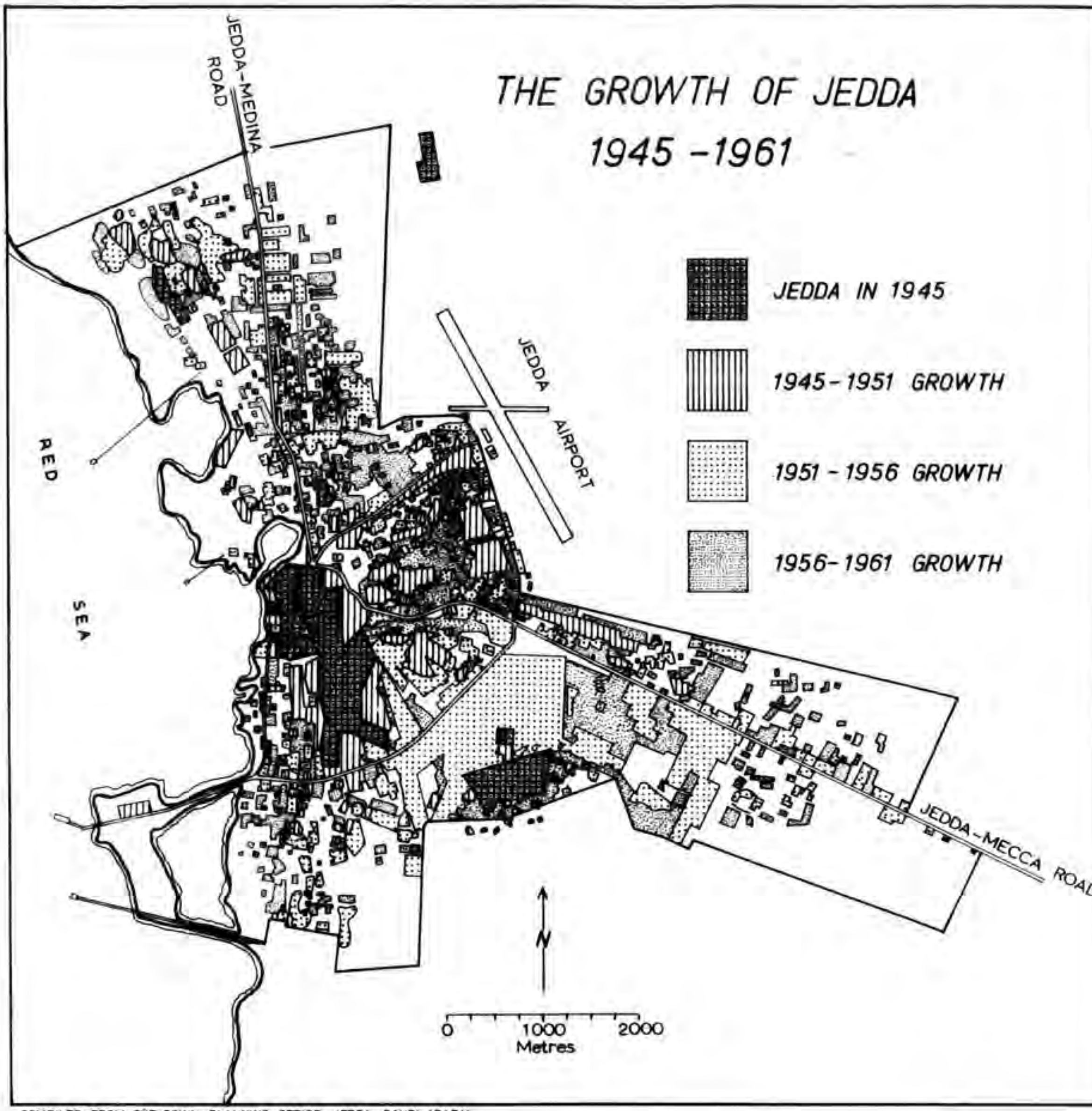
Fig. IO.2. Arar, one of four towns which appeared as a result of the construction of the Tapline and the Tapline road.

of the Tapline towns, was just a pumping station at Badana in 1950 The drilling of two artesian wells in the same year was followed by the appearance of a shanty-town consisting mainly of <u>sandagas</u> Mud-brick houses started to appear very soon after, and by 1954 this type of building replaced most of the <u>sandagas</u> Since 1956, cement had been used in building, and modern houses supplied with water and electricity had become very common in Ar'ar by 1968 The other Tapline towns are less developed than Ar'ar though both Rafha and Al Qaysumah have reached the stage of modern houses An Nuariyah is the least developed and is still in the stage of a shanty town It must be stressed that the Tapline towns were created merely by the construction of the Tapline road and the Tapline, while for the new settlements in the oil area transport was not the only factor though a very important one

Due to the west-east axis pattern of transport development, the growth of settlements and the creation of new towns were until the present time confined to the main axis regions and the northern region In fact the growth of settlements also followed an east-west axis pattern Jedda was the first to grow, then some oil towns in the Gulf, then Riyadh Apart from the northern region, settlement growth has not taken place in the rest of the country simply because transport networks did not penetrate those regions In fact, it can be said that the settlements of these periphery areas have been growing with less than a normal rate of growth because of the migration to the axis settlements However, the present penetration of modern roads into the regions far away from the east-west axis particularly to the southwest region will certainly lead to the growth of some main cities in these areas which until now had no major cities

Transport development, however, did not only lead to settlement growth but in many cases orientated that growth and determined its direction and its limitations There are many examples that can demonstrate this type of transportation impact on settlement growth, but Jedda makes the best example

The population of Jedda increased from about 30,000[5] in 1930 to 148,000 in 1962-3 and the size of the city increased from 180 hectares in 1945 to 1200 hectares in 1962/63 This remarkable growth was a result of the construction of the port of Jedda in 1948 and the construction of the Jedda - Mecca road It was also a result of the choice of Jedda as the centre of the Saudi



COMPILED FROM THE TOWN PLANNING OFFICE, JEDDA, SAUDI ARABIA.

Fig. 10.3

Arabian Airlines and the construction of the Jedda international airport The development of transport orientated the expansion of the city as much as it caused it As can be seen in Fig 10 3, the expansion of Jedda in the period 1945 - 1951 was mainly in the area between the old city and the airport, and to a less extent along the Jedda - Mecca road It may be significant to mention that the main expansion of Riyadh has also been to the area between the old city and the airport (Fig 10 1) However, the construction of the Jedda - Medina road in 1952 led to a new direction in the growth of Jedda, and in the period 1953-56 the main growth was along this new highway The shape of Jedda today is very clearly associated with the Jedda - Mecca and Jedda - Medina roads as well as with the Jedda airport The airport marks the end of the north-eastward expansion while the two highways stimulated northward and south - eastward expansion (Fig 10 3)

The growth of the town of Abqaiq in the oil area is of major interest here, for it is the only settlement for which it was possible to obtain aerial photographs showing its different stages of growth The town of Abqaiq did not exist before 1950 Abqaiq was a Tapline pumping station then was developed as a settlement after 1950

It is located in an oil field called by the same name at a site about 40 miles south of Dhahran, served by the road network, the pipeline network and the Dammam - Riyadh railway Like all the other settlements Abqaiq started as a shanty town In 1957 the town consisted of a few sandagas near the railway station as can be seen in Fig 10 4 A In the following year (1958) modern houses started to appear near the highway at Abqaiq - Dhahran - Ayn Dar junction (Fig 10 4 B) The expansion of the modern town was very fast but until 1962 it was limited to the area along the nigh-way (Fig 10 4 C) After 1962 the expansion took a southward direction and by 1967 it reached the limit marked by the oil pipeline, (Fig 10 4 D) The example of the town of Abqaiq shows how transport facilities may give settlements a certain shape by limiting the expansion in certain directions In the case of Abqaiq the asphalt road, the railway, the pipelines and the airport formed the boundaries that gave the town its present shape

In the example of Safwa, the Dhahran - Ras Tannurah road forms a boundary between the two sections of the population the Shi'a in the old town east of the road and the Sunna in the new town west of the road The

THE GROWTH OF ABQAIQ

Abqaiq, I957

Scale: I Centimetre to 200 Metres.

Fig. IO.4 (A)

THE GROWTH OF ABQAIQ

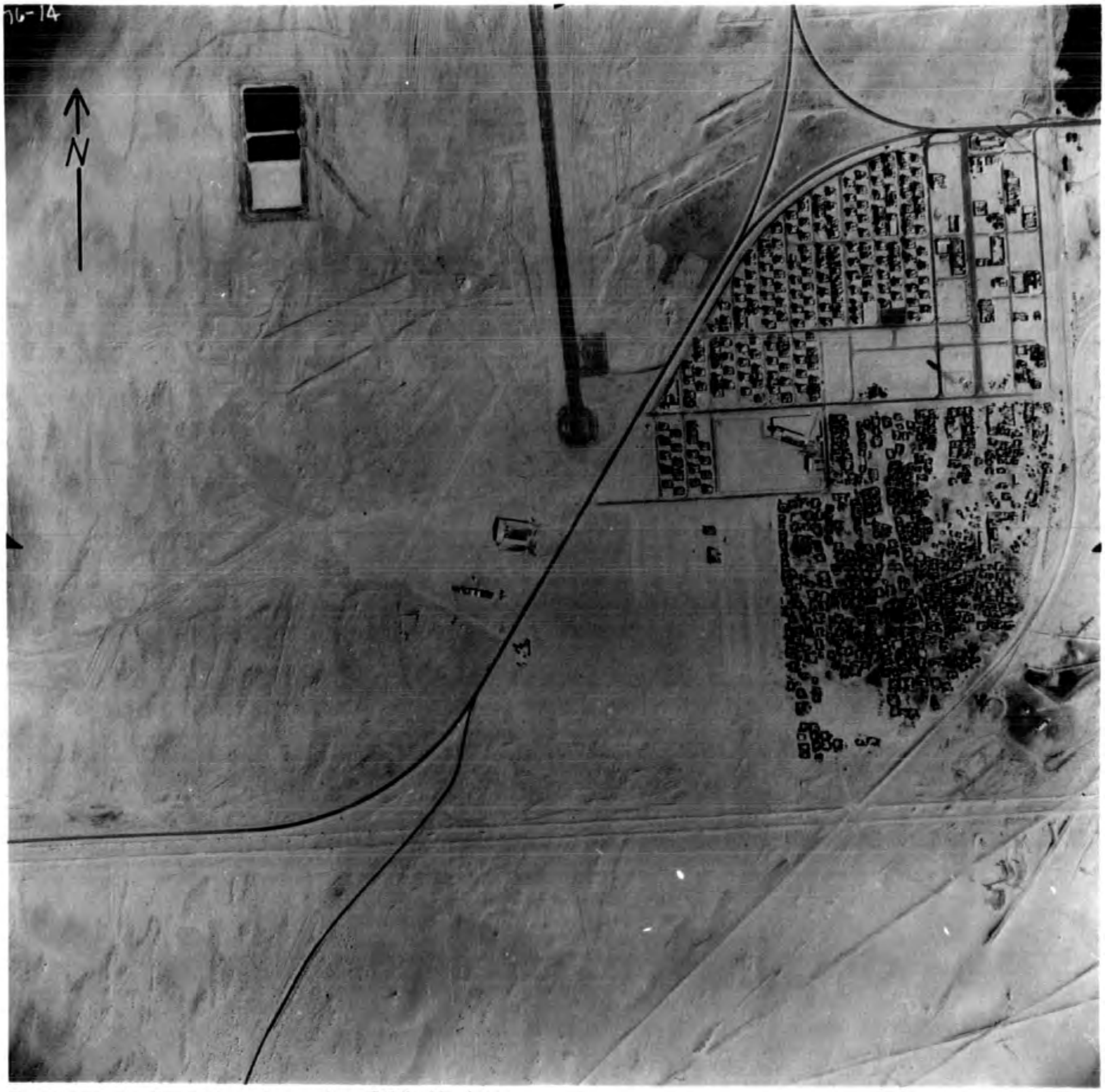
Abqaiq, 1958

Scale: I Centimetre to 200 Metres.

Fig. IO.4 (B)

THE GROWTH OF ABQAIQ

Abqaiq, 1962

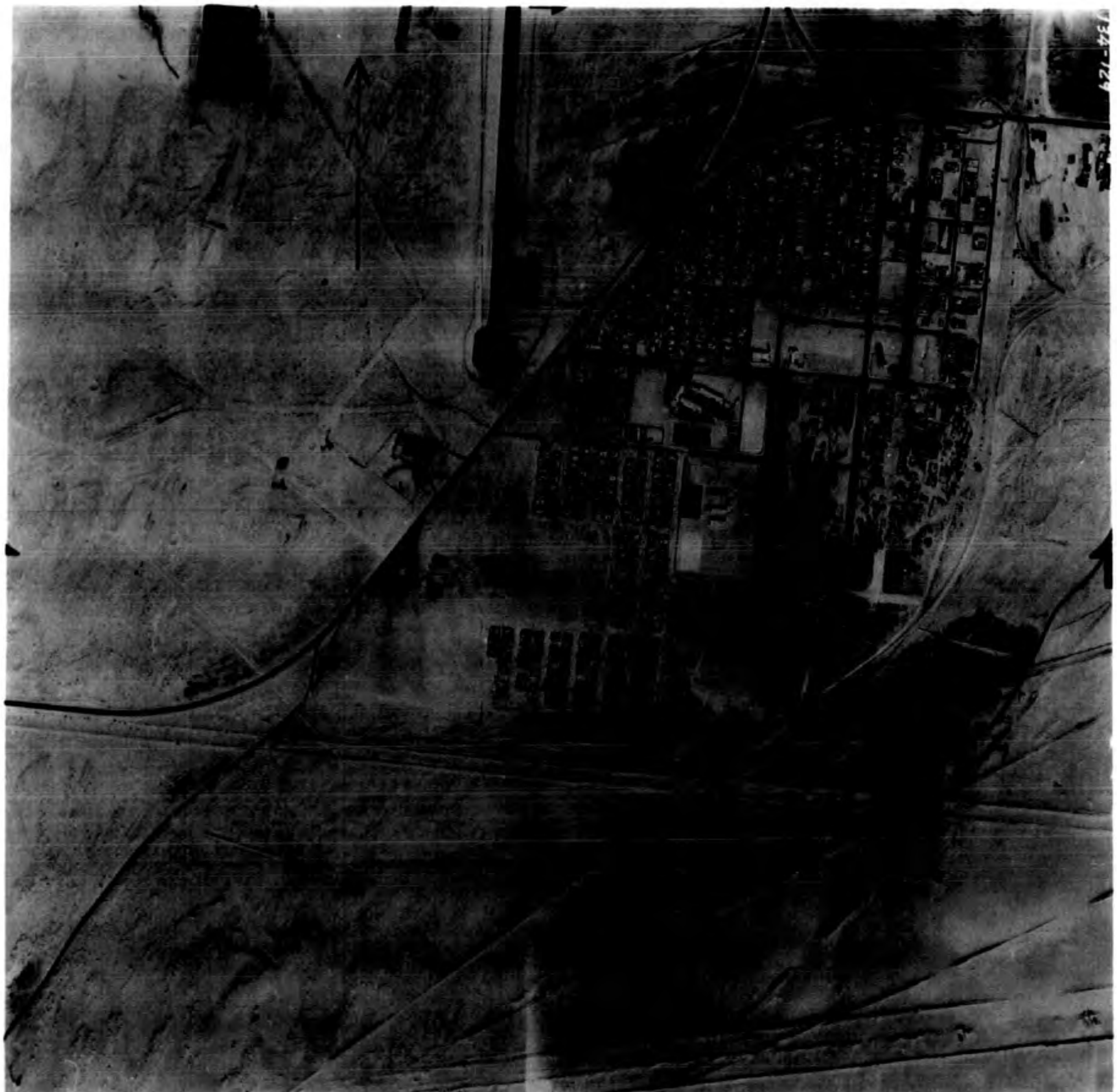


Scale: I Centimetre to 200 Metres.

Fig. 10.4 (C)

THE GROWTH OF ABQAIQ

Abqaiq, I967



Scale: I Centimetre to 200 Metres.

Fig. IO.4 (D)

road when it was built in 1950 passed to the west of Safwa which was inhabited by Shi'a. The construction of the road stimulated the growth of the town which took place along the western side of the road. This new expansion was inhabited by Sunna (Sunna and Shi'a are two major sects in Islam). The Dhahran - Ras Tannura road forms a boundary between the two sections of the population of Safwa exactly as the Tigris river does for the city of Baghdad.

One further aspect of the impact of transport development on settlements is the change of the morphology of the main old cities of Arabia due to automobilization. Probably the best example for this type of impact is Medina which for security reasons had a special morphology in the past. In some parts of the city houses were separated only by very narrow and twisty passages (Azigga) and in the rest of the city a number of houses about 10 to 20, were built in a circle or square which formed a yard with one narrow gate that could be closed at night and whenever this was necessary. These collective yards are called Ahwisha. Both the Ahwisha and Azigga were used to cope with the Bedouin attacks on the city which used to happen quite often before the formation of the Kingdom of Saudi Arabia As a result of the use of motor vehicles which spread with the absolute security under the rule of Ibn Saud the morphology of the old Azigga and Ahwisha had to be changed, and replaced by new motorable streets This change has been in fact the main aspect of the development of Medina in the present century

It is wrong to think, however, that the relationship between the development of transport and settlements is always a positive one True it is usually so, but as has already been made clear, the modern media of transport may limit settlement expansion Further, the development of transport may in fact lead to the decline of some settlements

The construction of the new port facilities in Jedda in 1948 led very quickly to the capture of traffic from Yonbu which was until that date the port for Medina dealing with considerable freight and pilgrim traffic It may be sufficient to say that it was Yonbu and not Jedda which was chosen for the meeting between King Ibn Saud and King Farouk of Egypt in 1945 After 1948 Yonbu lost all its traffic to Jedda, which became the port for Medina as well as the port for all sea pilgrims Consequently

Yonbu declined economically and in number of population

Diversion of traffic after the construction of certain asphalt roads has resulted in some settlement decline too The best example is the diversion of traffic between Mecca and Taif from the old Yamaniyyah road to the new asphalt road which was inaugurated in 1965 This traffic diversion led to the decline of the three settlements on the old Yamaniyyah road It must be mentioned that in this example the traffic diversion was total, that is to say that since the opening of the new Taif-Mecca road no motor vehicles have used the old Yamaniyvah road except when one of the Yamaniyyah towns is the origin or destination of such traffic The loss of the passing traffic by the towns of the Yamaniyyah road meant a change in the pattern and cost of transport Before 1965 all the three towns used to communicate directly with Mecca or Taif but since then the communication between Mecca and the two towns located at the eastern part of the road had to be via Taif and vice-versa for the town that is located at the western part of the road Moreover, it became impossible to travel or transport any commodity to or from the Yamaniyyah towns to either Mecca or Taif without hiring a whole pick-up at a very high price (100 SR for a trip between

Mecca and Taif on the Yamaniyyah road) Furthermore, by losing the passing traffic the Yamaniyyah towns lost the income from the facilities which they used to provide to the passing traffic It also became more costly to sell their agricultural products in the markets of Mecca and Taif Consequently the income of these towns declined and the cost of living increased (Fig 10 5)

From personal investigation by the author in May 1968 it was found that one of the Yamaniyyah towns (As-Sayl Al Kabeir) lost 27 coffee and rest houses, 70 shops, 5 petrol stations and a number of puncture shops Another town (As Sayl Al Sagheir) lost 10 coffee houses and rest houses, 20 shops, 3 puncture shops and a number of petrol stations The third town (Az Zayma) lost 2 coffee and 4 shops The number of the lost service shops is proportional to the size of each of the three towns Most of the people who were employed in these services have left these towns as well as many farmers The farmers who did not leave had to switch from cultivating grapes and tomatoes to grain cultivation Unfortunately it is impossible to measure accurately the emigration from these towns which resulted from this traffic diversion, but from various interviews

At As Sayl Al Kabeir (1968)

Fig. 10.5 One of many coffee houses that were closed in the towns of the Yamaniyyah road as a result of traffic diversion.

with well-informed people at As Sayl Al Kabeir it is believed that not less than 250 people have left the town since 1965 (The town had a total population of 2,868 in 1962-3)

Transport Development and Social Changes

The impact of the development of transport on social changes in Saudi Arabia is immensely great, ranging from the social integration between the various parts of the country to the modernization of the way of life of the Saudi society The association between transport development and the spread and performance of the social services, e g schools, hospitals, post offices etc , is very clear in Saudi Arabia Space, time and data do not allow a detailed study and thus one has to be content with the broad lines and then concentrate on one or two important aspects of this association between transport development and social changes

Broadly, with the development of transportation the space factor which isolated the communities of the various towns and regions has weakened, the geographical distance separating these communities has been diminishing and the size of the country has been shrinking Socially, the Hijaz is not any more the only developed part of

Arabia and Riyadh is no longer isolated from any outside influence With the use of air and motor transport in the 1940's, the construction of the Dammam - Riyadh railway in 1952, the construction of modern roads and the growth and spread of transportation services a considerable social integration has been achieved between the various parts of the country and particularly between the three axis regions

Air transport in particular has played a considerable role in the social integration, simply because of the vast distances involved between settlements and because of the lack of other media of modern transport in many regions in the past However, the Dammam - Riyadh railway has also played an important role in the Riyadh and the eastern region In the past few years and at present road construction is advancing very fast and thus the influence of this medium of transport on social changes is now reaching most parts of the country Pipelines effected social changes in indirect ways, first because they usually cause the appearance of parallel roads (see Chapter four), and secondly because at the pumping station, facilities like electricity and water supply are usually provided People who live in the

Tapline towns, for example, enjoy more facilities than most of the other towns of similar size It is very important to mention the fact that the use of the motor car is limited to the areas reached by the asphalt road network Some of the people in isolated desert oases have not yet ridden in a motor car Traffic surveys and personal observation show very clearly that the penetration of an asphalt road to a certain area means the start of the use of motor cars in that area On the other hand, in the main cities of the east-west axis which have been linked with modern roads for some years, the motor car has played a very important social role In a country where cinemas, night clubs and bars are not allowed and do not exist, driving has already become a main recreational facility Large numbers of the people of Riyadh, Jedda and the oil area cities go for a pleasure drive with their families out of the cities especially on Thursday and Friday at about sun-set People in Jedda mainly drive to ObHur, People in the oil cities mainly drive to Half-Moon Bay and people of Riyadh drive along the Khurays road

To measure the extent of this phenomenon the author on Friday 3rd May, 1968 carried out a traffic survey in order to count the number of cars driven on the Khurays road merely for pleasure by people who live in Riyadh The count started two hours before and ended three hours after sun-set, a period of five hours During this period 5,798 cars were counted (2,220 from Riyadh to Khurays and 3,578 from Khurays to Riyadh) 1,921 cars came from the direction of Riyadh in the two hours before sun-set, and 1,850 cars were counted returning to Riyadh in the hour after sun-set The sun-set time is the most popular for pleasure driving as it is the time when the heat of the day has ended and the darkness of the night has not started There is also evidence that the number of cars driven for pleasure along the Khurays road decreases remarkably after 10 Kms from Riyadh, and that about a similar number of cars can be counted on Thursdays [6] If we assume that there is an average of three passengers in each car the number of people who enjoy this pleasure would be about 10,000 on each of these two days

It is noticeable that the Khurays road pleasure drive is helping in the social change now underway As a young citizen from Riyadh said "A year ago I did not allow my wife to be without a veil outside the house, when I bought the car I found it impractical to find my wife

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spectacular single project of this kind is that of Wadi As Sahba which aims to settle 1,000 Bedouin families in a new town halfway along the railway from Dammam to Riyadh, the project involves the cultivation of 10,000 feddan, with a total cost of 65,147,000 SR [7]

It is unfortunate that the role of transport development in the urbanization of nomads and in modernizing the livestock economy has been overlooked by the government so far The gradual and remarkable effect of the Tapline and the Tapline road on the settlement of the nomads has not yet been fully appreciated During the writer's trip to the northern region of Saudi Arabia in (March and April, 1968) it was very clear that the number of Saudi nomads was insignificant, although the northern region is usually known as the most nomadic part of the country, and my visit was in the best pastoral season After talking with the inhabitants of the Tapline towns it was clear that the nomads of the northern region have gradually been urbanized and now live in the new Tapline towns The construction of the Tapline and the Tapline road plus the drilling of some wells near the pumping stations attracted the Bedouin to erect their tents near these veiled in our pleasure drive to Khurays, after taking her unveiled to Khurays a few times I liked the idea and now I take her unveiled to the streets of Riyadh when we go shopping"

The impact of transport development on the social development of the nomads is by no means less significant than on the urban communities According to the 1962-3 population census the nomads form one-fifth of the total population (20 8 per cent) The social and political problems caused by this section of the population have been realised since the very early years of the formation of Saudi Arabia by King Ibn Saud who tried to settle a large number of them in new settlements called *Hejar* In the 1950's the government considered the problem of the nomads very seriously since it was found that this section of the population did not benefit from the social and economic development which was mainly confined to the main urban centres of the east-west axis In fact it was found that, due to the drought which prevailed in the 1950's, plus the new western tastes of the urban population, the nomadic economy had seriously declined It was for this reason that the government undertook various projects to help the Bedouin to settle and change to farming The most pumping stations during the summer and to go for pasture during the spring Gradually a number of these Bedouin built houses and became farmers or workers in shops or other services In this way four towns were developed out of four pumping stations along the Tapline The impact of the motor vehicles on the nomads and their way of life has another important aspect Bedouins now use lorries or pick-ups to carry them and their livestock from one place to another This, of course, helped their mobility which is the basic factor in nomadic life Further, with motor vehicles the Bedouins now carry many barrels of water to their camps Lorries and pick ups are very common in the desert of Saudi Arabia nowadays (Fig 10 6)

However, though the general impact of transport development on social change has been very remarkable in many positive ways, some communities have witnessed a negative social change as a result of transport development This type of negative impact is a result of traffic diversions which are created by the construction of some new roads The communities of the Yamaniyah road between Mecca and Taif have suffered much social decline after the diversion of the traffic between Mecca and Taif

Bedouins' tents near Arar, a first stage towards settlement.

Motor vehicles are used by Bedouins for the carrying of water and other requirements.

Fig. IO. 6

to the new road which was opened in 1965 A personal investigation by the author in the three towns of As Sayl Al Kabeir, As Sayl As Sagheir and Az Zayma showed that the post now comes only about twice a week instead of every day as before the traffic diversion In fact, when the town of As Sayl Al Kabeir, was visited in May 1968, it was found that the post had not arrived for two weeks The teachers in the school said that they receive the daily newspapers for one or two weeks in one post People also mentioned that their sons who study in the high schools of Taif and Mecca used to come and visit them about once a week, but now they only come about once every three or even six months The health officer of the school mentioned that whooping cough was spreading in the school but he had failed to report this to the authorities in Taif for the last fifteen days because of the unavailability of transport facilities, he added that as whooping cough is a dangerous disease and may spread in the town very quickly 'I decided to hire a pick-up to carry my official letter to the authority in Taif'

Conclusion

The hypothesis of this chapter is that the growth of settlements as well as the social change towards modernization are closely associated with the development of transport which was a basic factor in the Ideal-Typical Sequence Model[8] of transport development (see Chapter Twelve), just as the geographical mobility of people and ideas was the basic factor in the Lerner[9] model for social changes from tradition to modernization

Further, this chapter shows the various ways in which various settlements and communities respond to the development of different media of transport In Saudi Arabia the growth of settlements such as Jedda, Riyadh and Dammam as well as the creation of new settlements such as Ar'ar, Rafha, Al Qaysumah, An Nuariyah and Abqaiq on the newly built transportation lines, were the most important results of the impact of transport evolution on settlement development In some cases transport development caused the change of the morphology of settlements, as in Medina, in other cases transport development gave certain shapes to settlements such as seen in the examples of Jedda and Abqaiq, and in one case a transportation line forms a boundary between two different parts of one settlement (e g Safwa) However, certain settlements may respond in a totally negative way to the development of transport, as in the case of Yonbu, As Sayl Al Kabeir, As Sayl

As Sagheir and Az Zayma

It may be said that ports, roads, air transport, the railway and even pipelines have all had a remarkable impact on the growth of settlements though one medium may be more significant than others for the growth of a certain settlement at a particular time Airports were found to have two different kinds of impacts stimulate the growth of the area between the airport and the old city (Jedda and Riyadh) but then form the limit of the expansion in that direction (Jedda)

In a country as large as Saudi Arabia and in a society as traditional as the Saudi society, the development of transportation has been playing a remarkable role in the social integration between the people of various parts of the country, in the spread of social services and in modernizing the way of life Both air and motor transport have been of great importance in social changes Air transport has been particularly important in the social integration in the country while motor transport has been having an increasing impact on modernizing the way of life and in the settlement of nomads

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CHAPTER ELEVEN

The Cost and Pricing of Road Transport

The aim of this chapter is to investigate and analyse the structure of road transport economics both as seen by the producer and the consumer of the services The first section deals with the cost of the production of transport services in relation to the main influencing factors, whilst the second section deals with the cost of buying the transportation services - the prices - and the main influencing factors The last section investigates the profitability of road transport business

The cost of transportation is an essential factor of transport policy making Decisions on constructing new roads, priority between various alignments, regulations and integration between various media of transport can not be made efficiently without sufficient information on the constructures of the cost of transportation

Though important as such, knowledge of the cost of transport, particularly road transport, is almost totally lacking in Saudi Arabia, mainly because of the difficulty in obtaining sufficient and reliable information One of the main causes of such difficulties is the fact that the road transportation business mainly consists of sole owners who are usually illiterate and obviously do not keep any records of their income and expenses Further, the few relatively large firms who keep such records are usually reluctant to disclose their financial situation because of suspicions that this may benefit a competitor or impose unwanted government regulations

Nevertheless, the author was kindly given access to the financial records of some of the relatively large transportation firms or different types One of these firms deals only with trucking business and will be referred to as the T T F (Trucking Transportation Firm), the other deals with bus transport between Riyadh and the Gulf area and will be referred to as the B T F (Bus Transportation Firm), while the third deals with Hajj transport and will be referred to as H T F (Hajj Transportation Firm) The real names of these firms are not disclosed here Some 30 taxi drivers were also interviewed in Riyadh during the period Jan - May 1968 on matters concerning cost structures

Transportation Structures

The national transportation services in Saudi Arabia - that is the services between various parts of the country - are done by road, rail, pipeline and air, plus negligible coastal transportation services Both in freight and passenger transport, roads have the largest and the most widely distributed services

Road transport structure reflects the under-developed economic structure by being mainly of sole ownership type This is true in the case of freight transport where each truck is usually owned by its operator, as well as in passenger transport where each bus or taxi is usually owned by its driver

With the oil transported mainly by pipelines, the Hajj has remained until now the most effective factor in creating the biggest transportation firms in the whole country Yet the oil industry is the second most important factor in this respect and it is in the oil area that we find the most organized road transportation business In fact the influence of Aramco on the structure of road transport is far more than that of the government, though Aramco influence is limited to the oil area

In order to avoid immobilizing a large amount of money on transportation services, Aramco has developed through encouragement or direct organization unique taxi, bus and trucking local enterprises in the oil area where leasing, rental and contract systems were developed

Under the leasing system, a local enterpreneur purchases vehicles to the specification of Aramco which operates and maintains them Under the rental system, the local enterpreneur buys vehicles to Aramco specification but he also maintains them This requires that he has garage facilities with which he can serve the public as well as Aramco Both rental and lease agreements are most commonly for a period of three years, after which the vehicles are sold in the used car market by the enterpreneur In the contracting system, the contractor maintains his vehicles During non-company working hours these vehicles can be rented to the public on a self-drive basis In Dhahran there are 22 vehicles serving the Administration Building of ~~the Company~~ Aramco under a contracting system In Dhahran, Abqaiq and Ras Tannurah, there are contract bus services to transport employees between their work sites and local towns daily, and more distant towns at weekends The constructor supplies the buses, drivers and maintenance facilities Aramco also developed a highly organized taxi system in the three oil administration towns

Apart from the Hajj and the Aramco organized transportation firms, there was between (1961 - 4), a bus transport firm with four buses This firm ran a daily service between Riyadh and the oil area in the period

1961-4 There are also some small trucking firms in Jedda working mainly in transportation services between the port and the city

The above description illustrates the general pattern of the structure of road transport which is mainly of sole ownership type but with some relatively organized firms at both ends of the east-west axis The further we go from this axis the simpler the transport structure becomes, that is to say that the structure of road transport is closely associated with the pattern of socio-economic development

Market Structures

Roads have a monopoly in freight transport except in the eastern part of the country where they compete with the Dammam-Riyadh railway The absence of internal water or rail transport and the high prices of air transport allow such a monopoly For passenger transport, however, roads compete with air transport and in the eastern part with the railway as well

The competition between roads and other media of transport is affected by market structure as well as by the condition of roads The Riyadh - Dammam railway, for example had a monopoly of freight transport between Riyadh and the Gulf Coast but this was ended in 1961 when the Riyadh - Dammam highway was built The competition is developing in favour of roads as a result of road improvement This applies to air - road competition too, with air transport at the present time enjoying a semi-monopoly in passenger transport to and from areas which are not yet linked with modern roads However, the penetration of modern roads to such areas is usually followed by the use of motor cars, and thus air transport is being faced with increasing competition

In the road transport business itself, monopoly does not exist apart from very minor cases such as the monopoly of taxi transport in Aramco controlled residential areas by Aramco organized taxis Yet the Hajj transportation business is not purely competitive, since it is to some extent controlled by goverment legislation (Chapter Nine) In the case of the relatively organized transportation firms in the oil area they have a tendency towards oligopoly since Aramco and the Tapline are the main buyer of their services

The market structure, however, is a function of supply and demand The demand for road freight transportation is limited to the distribution of imports, particularly from the main ports to the main cities and from the main cities to the smaller settlements (Chapter Seven) Local industrial and agricultural production creates only very small road transportation demands

Consequently, the demand for freight transport is mainly limited to the east-west axis with higher demands for port-inland transport than for transport in the other direction and from the axis to the periphery regions than in the opposite direction This conclusion is based on the pattern of freight traffic which was explained above (Chapter Seven) However, since freight transport depends mainly on imports the demand for it is very much affected by the volume of imports, which is directly affected by the general economic situation in the country

Lacking mass production in either industry or agriculture, the transportation demands of farmers and average business men can usually be met with light trucks more economically than with heavy trucks It is for this reason that light trucks (pick-ups) form 17 0% of the total traffic on the highways It is also for the same reason that the sole ownership is the most common in road transportation business

Passenger demands are even more limited to the east-west axis area because of road conditions and social and economic development, as well as because of the relative integration which has already been achieved between the three axis regions In other areas the demand for passenger transport is very limited and met by trucks which carry passengers as well as freight The demand for road passenger transport is also affected by some seasonal changes The Hajj season has a peak demand particularly in the Hijaz region This is a one direction demand at the time The summer season also increases the passenger transportation demand to and from Taif which is the summer resort of Saudi Arabia

The Cost Structures

The total cost of road transport consists of fixed and variable costs Fixed costs e g licences, insurance and garaging costs, are not affected by the mileage or the extent to which vehicles are used, whilst variable costs e g fuel and maintenance costs, are closely linked with the use of vehicles Accordingly, the proportion of variable to total cost varies according to the extent to which vehicles are used In public road transport, for example, the proportion of variable to total cost is 70% while in private transport it is only 58% [1] Further, because fixed cost does not increase with use, in private motoring, where the fixed cost is relatively high, the impact of mileage on costs per unit is very significant In Britain a motor car of two years old, for example, costs 101 29 pence per mile when it runs 1,000 miles a year and only 10 47 pence when it runs 15,000 miles a year [2]

In this section the cost of the trucking, the normal bus services and the Hajj bus services are investigated as examples of various road transportation business The analyses are based on the actual financial records of the T T F , the B T F and the H T F The cost of sole owner trucks or buses can be estimated from these records

The T T F is a trucking firm in the oil area, dealing mainly with Aramco and the Tapline Company, but also with the general public About 93% of the services of this firm are bought by the Tapline and Aramco (81% and 12% respectively), the remaining 7% are bought by the general public The firm operates 13 trucks and has an American organizer and it is the only trucking enterprise in the country with financial records divided into fixed and variable costs

Table 11 1 - Average Cost per Truck per Month (The T T F)

Fixed Cost	SR		Percentage
Wages & Salaries	877		11
Insurance	58		1
Depreciation	1440		18
Administration	424		5
Total Fixed Cost	2799	35%	
Variable Cost			
Maintenance	2868		36
Tyres	1307		16
Fuel	413		5
Oil and Lubrication	62		1
Others	549		7
Total Variable Cost	5199	65%	100
Total Fixed and Variable Cost	2799		
	5199		
	7998	100%	

As shown in table 11 1, variable costs of trucks are much higher than fixed costs It may be significant to note that the proportion of variable costs of trucks to the total costs is much higher in Saudi Arabia than in Britain 65% and 34% respectively This is mainly due to the high maintenance cost in Saudi Arabia which is caused by climatic conditions, inadequate garage services, costly spare parts, careless driving and bad road conditions Maintenance costs in Saudi Arabia are as high as 36% of the total cost, compared with only 9 6% in Britain For almost the same reasons, tyres cost 16% of the total cost in Saudi Arabia compared with only 3 3% in Britain On the other hand, wages and fuel expenses are cheaper 5% and 11% in Saudi Arabia, compared with 10 2% and 27 8% in Britain,[3] as might be expected in an oil producing underdeveloped country

It is extremely significant to refer to the fact that the T T F keep records for the ton/km done by each of their trucks, in a country where road transport business is still at its early stages of development These records enabled us to work out the average ton/km cost which is the total expenses of a truck divided by the ton/km done by the same truck On average, it was found that this equals

0 308 SR per ton/km for a certain period Further, as the ton/Km done by various trucks varied from 6,054 ton/Km to 153,205 ton/Km a month it was possible to work out the cost per ton/Km in relation to the extent to which the truck is used, or in another way to find the average cost of the ton/km in relation to the utilization of the truck (Fig 11 1)

The cost of sole owner trucks should, however, be somewhat lower than the cost of the T T F, because there is no significant economy of scale in road transport,[4] especially when the total number of the trucks run by the T T F is only 13 Further, the sole owner operator saves the administration and building costs and spends less on maintenance, which accounts for 35% of the total cost in the T T F The reduction in maintenance cost is due to the fact that an owner operator takes more care of his truck than a hired driver, and a sole owner operator usually does most of the repairs and maintenance jobs himself which makes it less costly

It must be expected that the bus service cost would be somewhat different from the trucking cost The records of the B T F are used here to show how different the costs of these two road transportation services are, The B T F was a small firm which ran only four buses This firm

COST OF TRANSPORT IN RELATION TO OUTPUT – TTF 1966

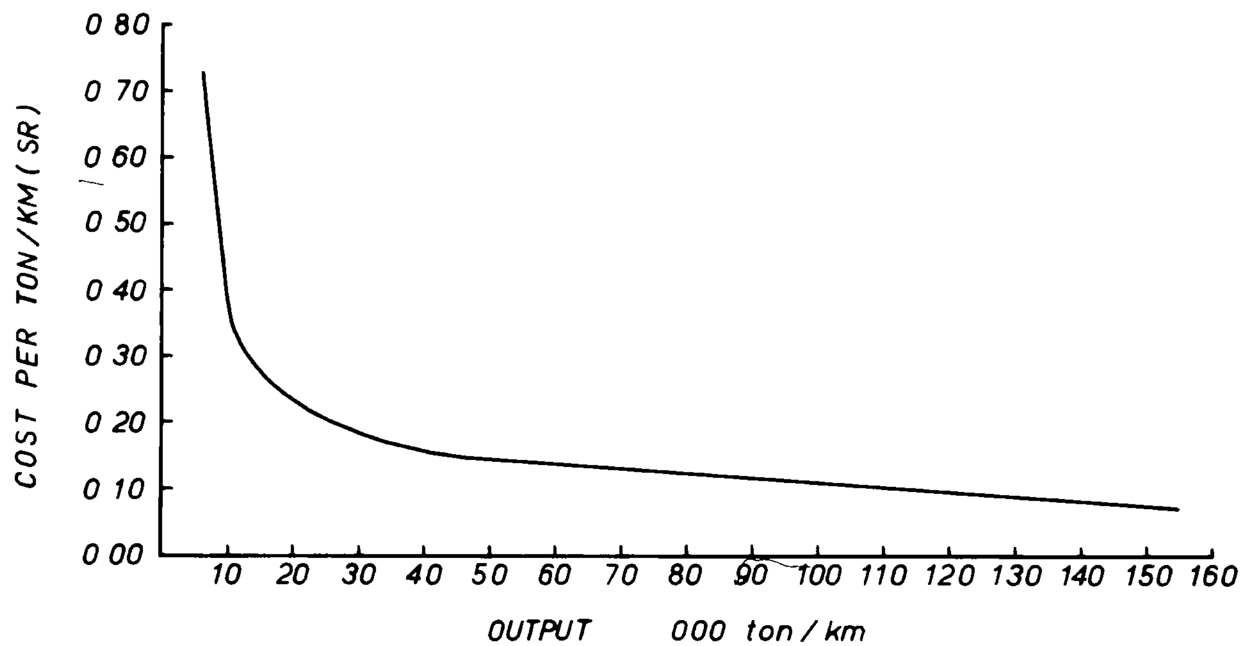


Fig II I

ran a daily service between Riyadh and Dammam in the period 1961-64 with one bus travelling from each direction every day To run this business the firm had an office in Riyadh and another one at Al-Khobar, an engineer, an assistant engineer, a servant and a small garage

The cost structure of the B T F , which is shown in table 11 2, is based on records which do not regard fixed or variable cost but only contain lists of expenditure against income, and thus at the end of the month the balance of direct expenditure and income is calculated Though this is an admirably straightforward way of doing business, the recorded cost is less than the actual cost as depreciation and capital immobilization costs are not included Such records thus tend to make the profit appear more than the real profit, and the loss less than the real loss In table 11 2 the depreciation cost and the capital immobilization costs were estimated and added to the fixed costs

Table 11 2 shows that the variable cost of bus services is less than fixed cost, yet the proportion of variable cost in Saudi Arabia is higher than that in Britain 43% as compared with 38%[5] Again this is caused by the high maintenance cost in Saudi Arabia, 26%

Table 11 2 - Average Cost per Bus per Month (B T F)

Fixed Cost	SR		Percentage
Wages and Salaries	1375		39
Office Rent	262		7
Depreciation	141		4
Capital Immobilization	229		6
Total Fixed Cost	2007	57%	
Variable Cost			
Fuel	421		12
Maintenance (including tyres)	913		26
Other Costs	196		6
Total Variable Cost	1530	43%	100
Total Fixed and Variable Cost	2007		
	1530		
	3537		

in comparison to 9 9% in Britain Against this, one would expect the fuel and wages cost to be lower in Saudi Arabia than in Britain In fact, this is true in the case of wages, which account for 39% in Saudi Arabia against 49% in Britain but not in the case of fuel which accounts for a similar proportion in the two countries (12%) [5] This similarity in the cost of fuel could have resulted from the dishonesty of drivers who, very commonly in Saudi Arabia, increase their income by taking more fuel than they need for their vehicles

Unfortunately the records of the B T F do not permit any conclusions on the average cost per passenger/km However, knowing the average number of passengers carried by the B T F (1,196 per month) and the distance between Riyadh and Dammam (467 Kms), the cost should be around 0 0253 SR per passenger/km (11 815 SR per passenger/trip)

It is of great interest to compare the cost of a normal bus service (the B T F) and a Hajj bus service (H T F), as the latter is only provided during the Hajj season whilst the former is provided during the whole year Table 11 3 shows the cost structures for a Hajj transportation firm

Table 11 3 - The Cost Structure of a Hajj Transportation Firm 1967-8 (H T F)

Fixed Cost		SR			Percentage
Depreciation					
	Vehicles	320812			
	Buildings	37237			
	Garages	9842			
	Furniture	2970			
			370,861		17
Licenses, Tax and charities			435,566		19
Wages & Salaries			618,993		28
Capital Immobilization			240,000		11
Total Fixed Cost			1,665,420	74%	
Variable Cost					
Maintenance and Tires			266,218		12
Fuel			116,264		5
Others			193,655		8
			576,137	26%	100

By comparing table 11 2 with table 11 3 the effect of the extent to which vehicles are used on the proportion of variable to total cost becomes very clear In the B T F which uses its vehicles all the year fixed costs account for 57% of the total cost, while in the H T F where vehicles are used only during the Hajj season fixed cost is as high as 74% of the total cost However, as the H T F buses are less used than the B T F, fuel and maintenance costs are only 5% and 12% compared with 12% and 26% in the B T F Salaries and wages are also less in the H T F 28% compared with 39% However, as the H T F has huge buildings and garages the depreciation cost is as high as 17% against only 4% in the B T F The Hajj transportation firm also pays high taxes (licences and income tax) which amounts to 19% of its cost while the B T F does not pay the cost of this item at all This results from the fact that the H T F is under government supervision, while the B T F is not

Now that the cost structures of three different road transportation firms have been analysed it must be mentioned that there are some general mistakes in the way transportation costs are being calculated in Saudi Arabia by transport enterprisers It was clear from the field investigation and from the figures collected that even in the case of big firms such as the H T F, vehicles are not insured As transportation business is liable to risks of accidents, financial records which do not include insurance cost or risk cost would lead to false results It was also clear from field investigation that the cost of capital immobilization is always neglected in the financial records even of big firms such as the H T F These shortcomings obviously lead to inaccurate and misleading cost/benefit balance

The Pricing of Road Transport

Apart from the Hajj Transport the road transportation market is purely competitive Hence, the price of a certain unit of transport should be equal to the cost of its production plus a reasonable profit If this simple fact is neglected by a transport enterpreneur he should be in one of two positions a) unable to sell his product because his prices are too high, or b) his income will run short of his expenditure as a result of charging too low prices and thus he would be forced out of business

In this section the actual and not the theoretical prices of road transport services are analysed in relation to the main influencing factors This analysis is based on figures obtained from various parts of Saudi Arabia in the period January - May 1968

Many factors were assumed to have some degree of influence on prices, among them is obviously the market structure In the above discussion, it was explained that the demand for road transport, particularly freight transport, is not equal in various parts of the country or in all directions of traffic In passenger transport the demand is also affected by seasonal factors particularly the Hajj

The prices of transport, however, are not only a function of demand but of supply as well Prices are particularly affected by the transport structure itself such as competition from other media of transport or from other firms in the same medium Also reliability, safety, good organization and comfort are all important factors in the pricing of transportation services

Above all these factors (market structures, supply and demand, transport structure) is the cost factor The cost factor varies, as was found above, according to many factors such as mileage, the size of the firm, and road conditions, all these factors, thus, should indirectly affect the prices

The prices of transport are also affected by the nature of the cargo with regard to its size, value and liability to damage or danger Discrimination in the prices according to these factors is very common in the transportation business

RATES CHARGED BY TTF IN RELATION TO TYPES OF COMMODITY, ROAD CONDITION AND DISTANCE 1966

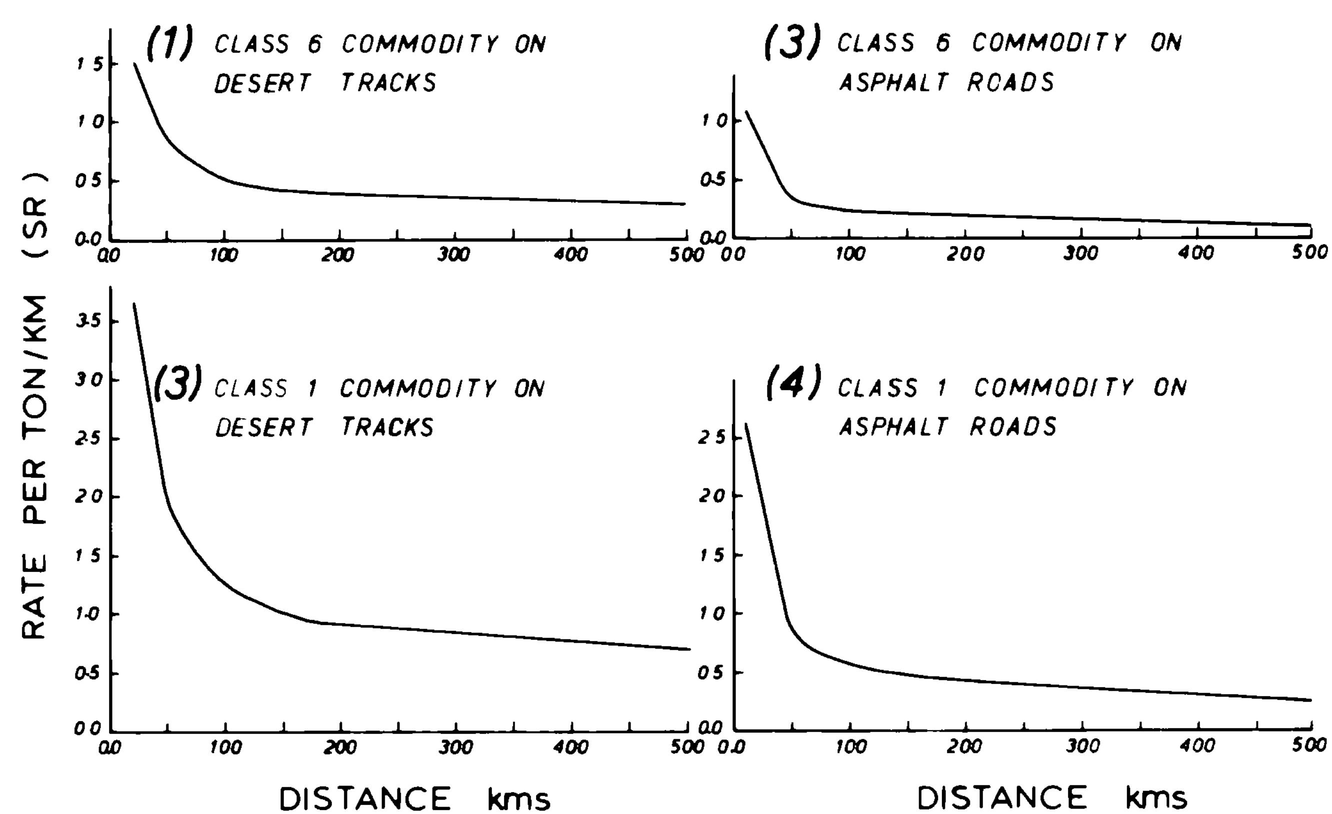


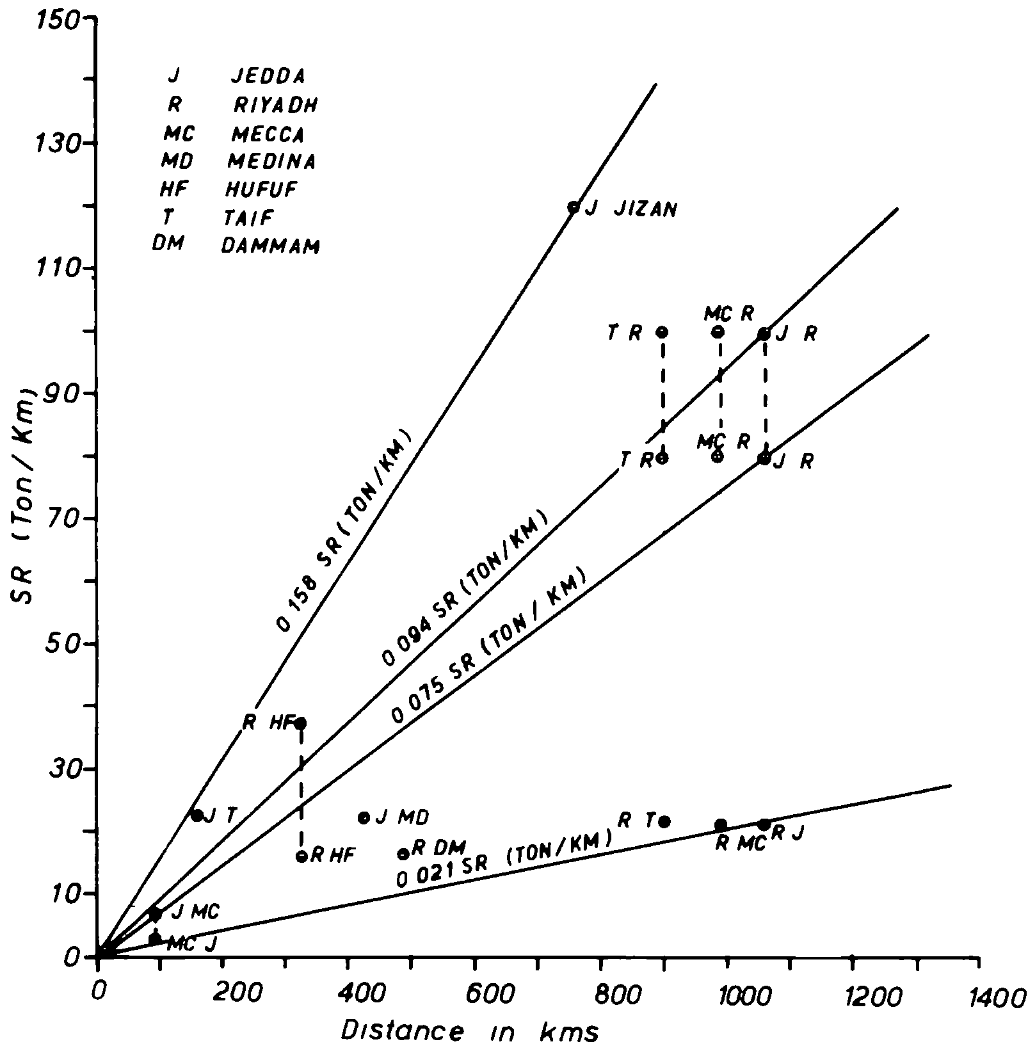
Fig. II 2

In this section the figures obtained are analysed to show how far the above assumed factors do actually affect the prices of road transportation services in Saudi Arabia Freight and passenger road transport are dealt with separately

Figures 11 2 and 11 3 summarize the factors that actually affect the prices of road freight transport in the country Figure 11 2 shows the prices charged by the highly organized and relatively large firm the T T F , whilst figure 11 3 is for the prices charged by the sole owner truck operators who are dominant in the freight transport industry in Saudi Arabia

The first fact which figures 11 2 and 11 3 reveal is that the T T F prices are far higher than the prices charged by the sole owner truck operators The difference between these two types of the trucking business is as high as 0 30 per ton/km over a distance of 100 Kms This difference results from variations in the cost factor which is higher in big firms for reasons explained above On the other hand, the higher price is paid willingly by some consumers for the safety and reliability factors which the T T F has and the sole owners lack This is very important for shippers like Aramco and the Tapline who buy about 93% of the T T F services

RATES CHARGED BY SOLE OWNER TRUCK OPERATORS IN RELATION TO ROAD CONDITION DIRECTION OF TRAFFIC AND DISTANCE 1968



DIFFERENCE IN TON RATE BETWEEN ONE DIRECTION & THE OTHER ON THE SAME ROAD

– – – – DIFFERENCE IN TON RATE BETWEEN TRAFFIC ON ASPHALT ROADS & TRAFFIC ON DESERT TRACKS

In general, there is no discrimination in the road freight transport prices in Saudi Arabia The T T F , however, is the only enterpreneur who applies such discrimination between various commodities As shown by comparing A against B and C against D in Figure 11 2, the difference in the prices may be as high as 1 5 SR per ton/km between two classes of commodities

A comparison between Figure 11 2 and 11 1 shows that as the cost per unit of freight transport decreases with the increase of distance, so do the prices The rate per ton/kms differs from 2 600 SR per ton/km over 10 Km distance to only 0 280 SR per ton/km over 500 Km distance The relationship between prices and distance is far clearer in the T T F rates than in the prices charged by the sole owner operators as can be seen by comparing Figure 11 2 with Figure 11 3

Since the movement of freight is not equal in both directions of the main highways (Chapter Seven) and since this results in unequal transportation demands, as shown above, the prices also differ according to the direction factor Figure 11 3 shows how the difference in the prices according to direction may be as high as 0 54 SR per ton/km, which is very significant as it means that the transportation rate from say Riyadh to Jedda is only 28% of the rate from Jedda to Riyadh

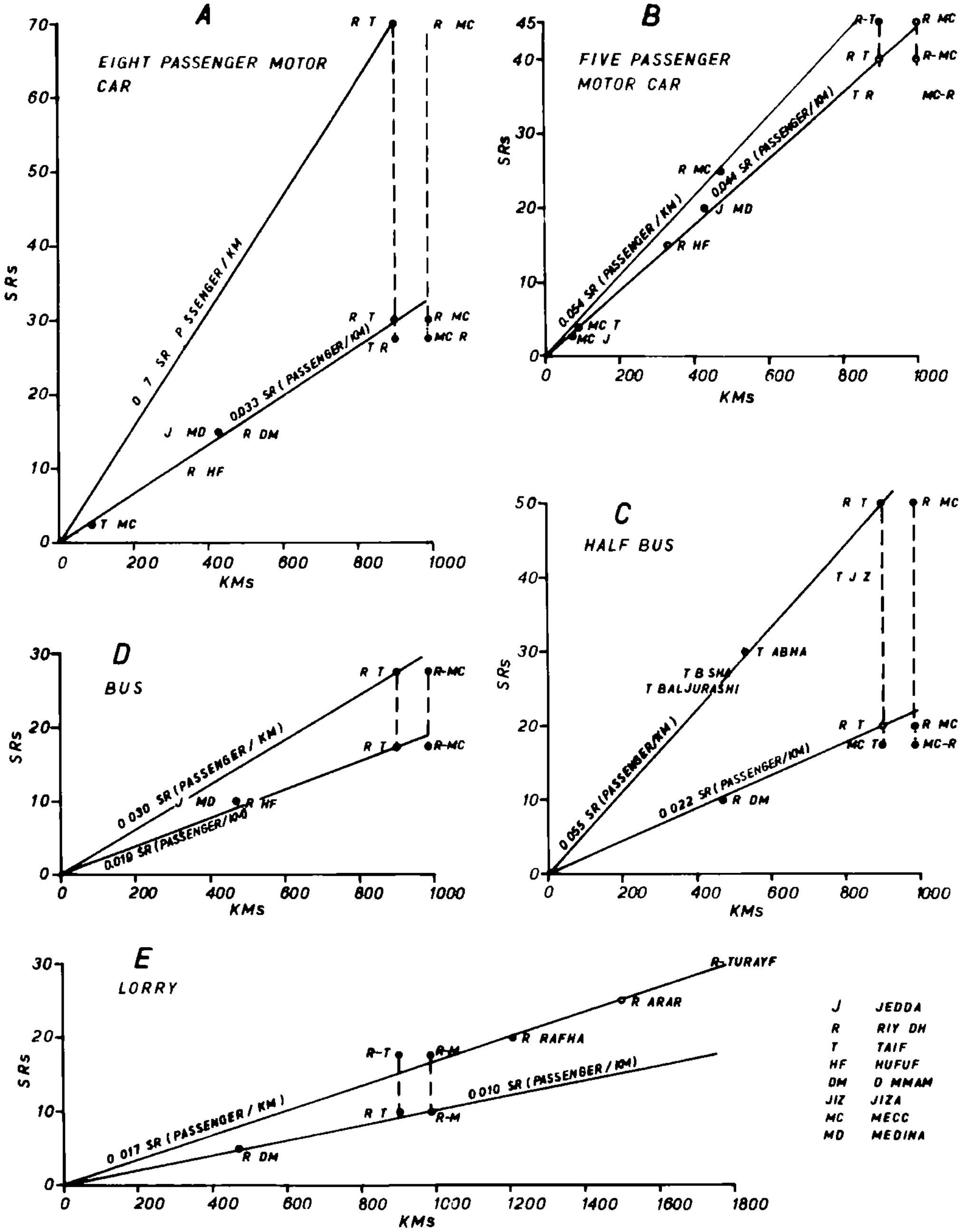
Figures 11 2 and 11 3 also show how the condition of roads is a very important factor in road freight transport prices Obviously the prices of transport on desert tracks are higher than on asphalt roads Such a difference is as high as 1 5 SR per ton/km over a distance of 20 Kms for class I commodities as shown by comparing B and D in Fig 11 2 Furthermore, the prices on asphalt roads or desert tracks vary according to the possible driving speed of the various roads For asphalt roads the Jedda - Taif road has the highest price per ton/km as shown in Fig 11 3 because of its low design speed For desert tracks the Jedda - Jizan road has the highest prices since it runs via a very difficult mountainous area

In deciding the prices of passenger transport, comfort and time are more important factors than in freight transport On the other hand, unlike in freight transport distance does not seem to have any regular effect on the prices per passenger / km, as can be seen from Fig 11 3

Because of this comfort and speed factor the prices vary from 0 010 SR per passenger/km in a truck to 0 056 SR per passenger/km in a five passenger motor car Between these two extremes there are the eight passenger motor cars, the half-bus and the lorries, all carry passengers at respectively lower prices (See Fig 11 4) The effect of comfort on the prices of road passenger transport can best be illustrated by the difference in the prices of different seats in the half-bus which varies in the case of the Taif-Riyadh trip from 30 SR per passenger in the front seats to only 15 SR per passenger in the back seats

The other important factor in the prices of passenger road transport is road conditions Actually road transport in a five passenger motor car does not exist on desert tracks at all, because of the high cost involved A few eight passenger motor cars sometimes operate on such desert tracks but at a very high price which is about 0 077 SR per passenger/km compared with only 0 033 SR per passenger/km over a similar distance on an asphalt road Prices are reduced by a similar proportion from desert tracks to asphalt roads in all types of vehicles as can be seen in Fig 11 4 The prices of passenger transport also vary between one asphalt road and another when the design speed differs between them Accordingly the prices per passenger/km on the Mecca - Taif road are higher than on any other

RATES OF PASSENGER TRANSPORT IN RELATION TO TYPE OF VEHICLE DIRECTION OF TRAFFIC ROAD CONDITION AND DISTANCE



DIFFERENCE PASSENGER RATES BETWEEN ONE D RECTION AND THE OTHER ON T E S ME ROAD

— — — D FFERE CE N PASSE GER R TES BETWEE TR FF C O SP LT RO DS ND DESERT TRACKS

ASA

Fig II 1

asphalt road in the country

Seasonal changes in the demand for passenger transport also affect the prices The Hajj is the most important in this respect particularly in the Hijaz region but also in the rest of the country (Chapters Eight and Nine) In the Hajj season of 1968 the taxi rate in Riyadh, which is about 1,000 kms away from the holy cities, increased from 0 25 to 0 5 SR because most of the taxis went to work in the Hijaz where the demand and thus the prices were much higher than in Riyadh Due to the same factor, the prices of passenger transport to and from Taif increase during the summer, the rate per passenger from Taif to Riyadh in a five passenger motor car is 40 SR in the summer compared with 35 SR in the winter

The above prices are not affected by any government intervention or control except for the Hajj transport Yet the Town Boards in most of the main cities do sometimes make sure that passengers are not charged more than the normal market prices as fixed by the majority of transport operators Traffic Police also ensure that vehicles stand in various places in queues which ensures that vehicles which come first to the station are loaded before any other vehicles The police usually also ensure that the number of the passengers carried by each vehicle is not more than its normal capacity

The Profitability of Road Transportation Business

In an underdeveloped country like Saudi Arabia where the sole ownership is the main aspect of the structure of transport, and where most of the road transport operators are illiterate, a purely competitive market may lead to market prices lower than the actual cost of production This is an argument which the people responsible for the Riyadh-Dammam railway, the Hajj transportation companies and the T T F believe in During interviews they all suggested that the sole owner operators usually lose and are forced out of business because the prices they charge for their services are too low One of the consultant firms supported this argument and suggested government intervention[6] Vehicle dealers also confirm this, because, they say, the sole owner operators very often fail to keep up their payments of hire purchase This argument, however, has not yet been proved by concrete evidence, because of the lack of financial records In the field investigation, therefore, it was of special interest to gather information which might answer this serious question is the road transport business in Saudi Arabia running on sound economic basis?

Information on this point was collected from the above three mentioned transportation firms the T T F , B T F , and the H T F Also about 30 taxi drivers were interviewed in Riyadh and asked particularly about their average monthly income

In the case of the three mentioned firms it was found that in general capital immobilization cost and insurance cost are not included in the accounts accounted (apart from in the T T F), so income and expenditure are not totally accurate In the case of the sole owner operators there are neither balance sheets nor financial records The rule is that the owner is making a profit if he can continue running his vehicle and meet his own or his family expenses

Yet with all these shortcomings the information obtained on the balance sheets of the three transportation firms and the financial situation of the taxi drivers in Riyadh are highly significant as far as the profitability of the road transportation business is concerned

The analysis of the T T F balance sheet shows that in the period of four months (January - April, 1966) there was a deficit of 12 52 SR per month per vehicle out of the 13 trucks eight made a profit between about 730 to 4,450 SR per month the other five made a loss of between 600 and 13,350 SR per month Thus even this firm, whose prices are much higher than the prices charged by the sole owner operator, is losing

In the case of the H T F the sheet balance for a period of thirteen years 1955-67 shows a profit of 1,383,504 SR in the whole period or an average of 106,423 SR a year However, when the cost of capital immobilization was considered, (at 5% per annum) this firm was found to have lost 18,705 SR during the 1955-67 period or on average of 1,439 SR a year (See Chapter Nine)

The only transportation firm which was found making a profit was the B T F In the period studied (six months in 1964) the firm made a profit of 10,144 SR , that is 1,691 per month On average, each of the firms four buses made a profit of 423 SR per month

The interviews with the taxi drivers in Riyadh revealed that on average they make 1,226 SR a month excluding the expense of running the car Most of the interviewed drivers said that they pay 500 SR monthly to the car dealer according to the hire purchase contract, and with the remainder they keep their family Thus if all goes well he is no doubt making some profit The problem comes if the taxi driver gets involved in an accident as then he would be out of business It is for this reason that only two of the thirty drivers interviewed had spent more than five years in the service On average they spent only 3 6 years and only eleven of them had spent more than the average length of time It has also been clear from those interviews that to get the average income of 1,226 SR a month, it is necessary to drive one's car oneself A hired driver is less productive, less reliable and often dishonest and careless This condition is reflected by the fact that 29 of the drivers interviewed were owners of their vehicles

Conclusion

It can be concluded that in general the relatively big and organized road transport business is not a profitable enterprise from the financial point of view, with its present cost and price structures The T T F is losing in spite of the relatively high prices it charges and so are the Hajj transportation firms The sole owner truck operators may, with some luck make a profit since his cost is lower and since he carries passengers on the top of his cargo Generally, the taxi business and also the bus services are profitable though the profit is remarkably small in the case of the bus transport and risky in the case of the taxi business

Most road transport enterprises are misled by their way of calculating the cost of producing the services Even big firms like the H T F and the B T F neglect the insurance cost, the capital immobilization cost and the opportunity cost

The insurance cost is particularly important in the transport business, especially in taxi transport because of the risk involved Vehicles are normally not covered by any kind of insurance in Saudi Arabia Among the 30 taxi drivers interviewed, only one was insured In this case a serious road accident would put the transport enterpreneur out of business, and probably in prison too As most of the taxi drivers buy their cars on hire purchase they find themselves unable to pay the car dealers after a serious road accident In fact, it is because of this reason and the high rate of accidents in Saudi Arabia that many vehicle dealers mentioned that they lose a large amount of money every year and that the courts are full of cases of drivers who are unable to pay for vehicles they bought on hire purchase

In such cases, the introduction of compulsory insurance would take the road transport business a large step forward The people concerned should be educated about the value of insurance and also about the structure of the cost and prices of transport This would help the transport business far more the intervention in the prices by government legislation

References

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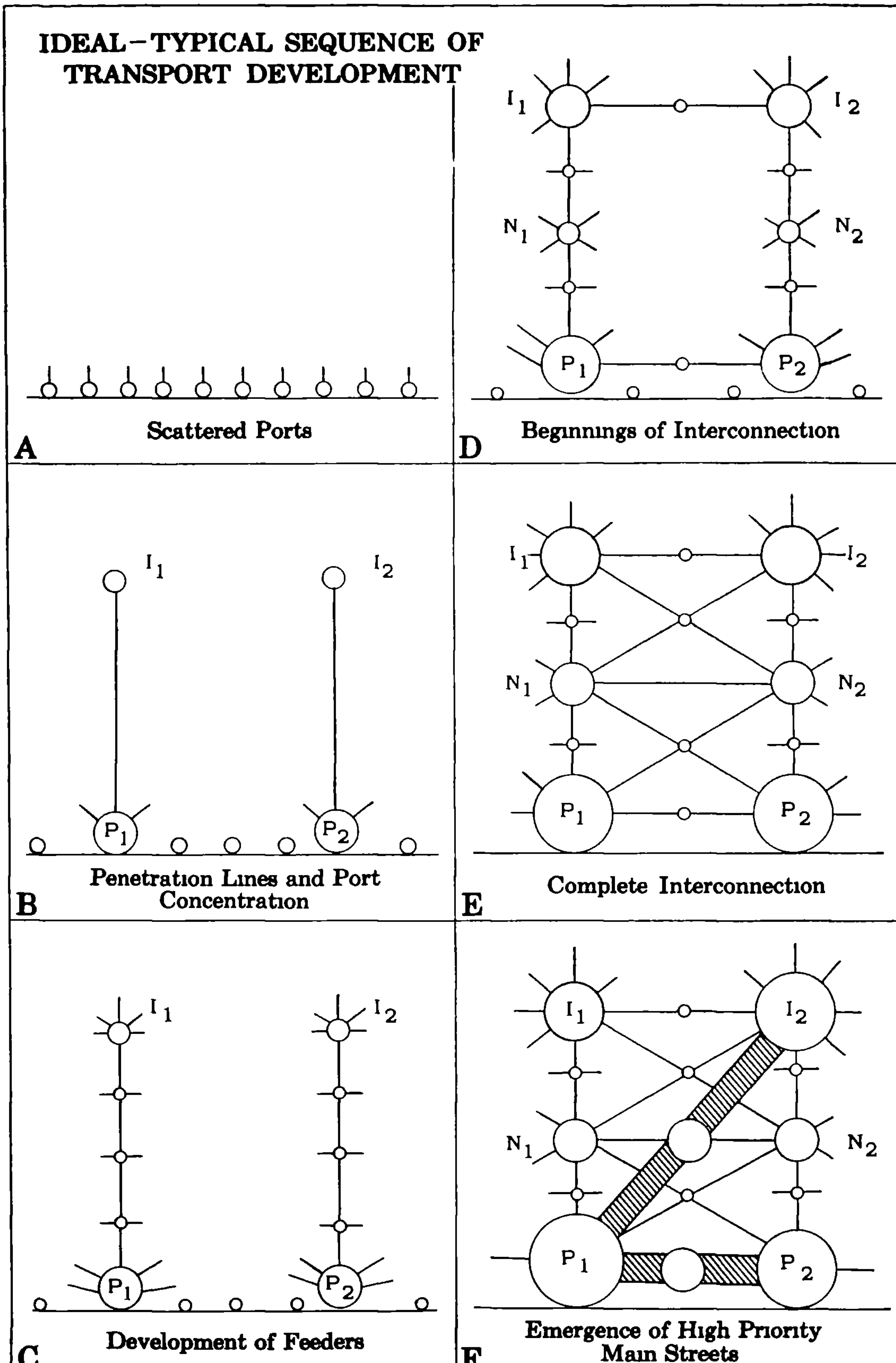
CHAPTER TWELVE

The Ideal-Typical Sequence Model its Applicability to the Development of Transport in Saudi Arabia, the Sudan and other Middle Eastern Countries

Many years ago von Thunen[1] showed that transport geography was a promising subject for models and statistical analysis More recently the use of the gravity model in traffic studies has made the prediction of traffic between two points possible [2] Further, research has already started with great success on the exploitation of geometric analysis in network studies [3] Transport geography, thus, has already gone a considerable way in the application and development of numerical, theoretical and model techniques

One of the models which was developed by transport geographers is the Ideal-Typical Sequence Model (Fig 12 1) which generalizes the process of transport development in underdeveloped countries [4] This model which was produced by Taaffe, Morrill and Gould has a special significance for us because it deals with transport development in the underdeveloped countries while most of the other models, such as the one produced by Haggett,[5] were based on studies made on developed countries

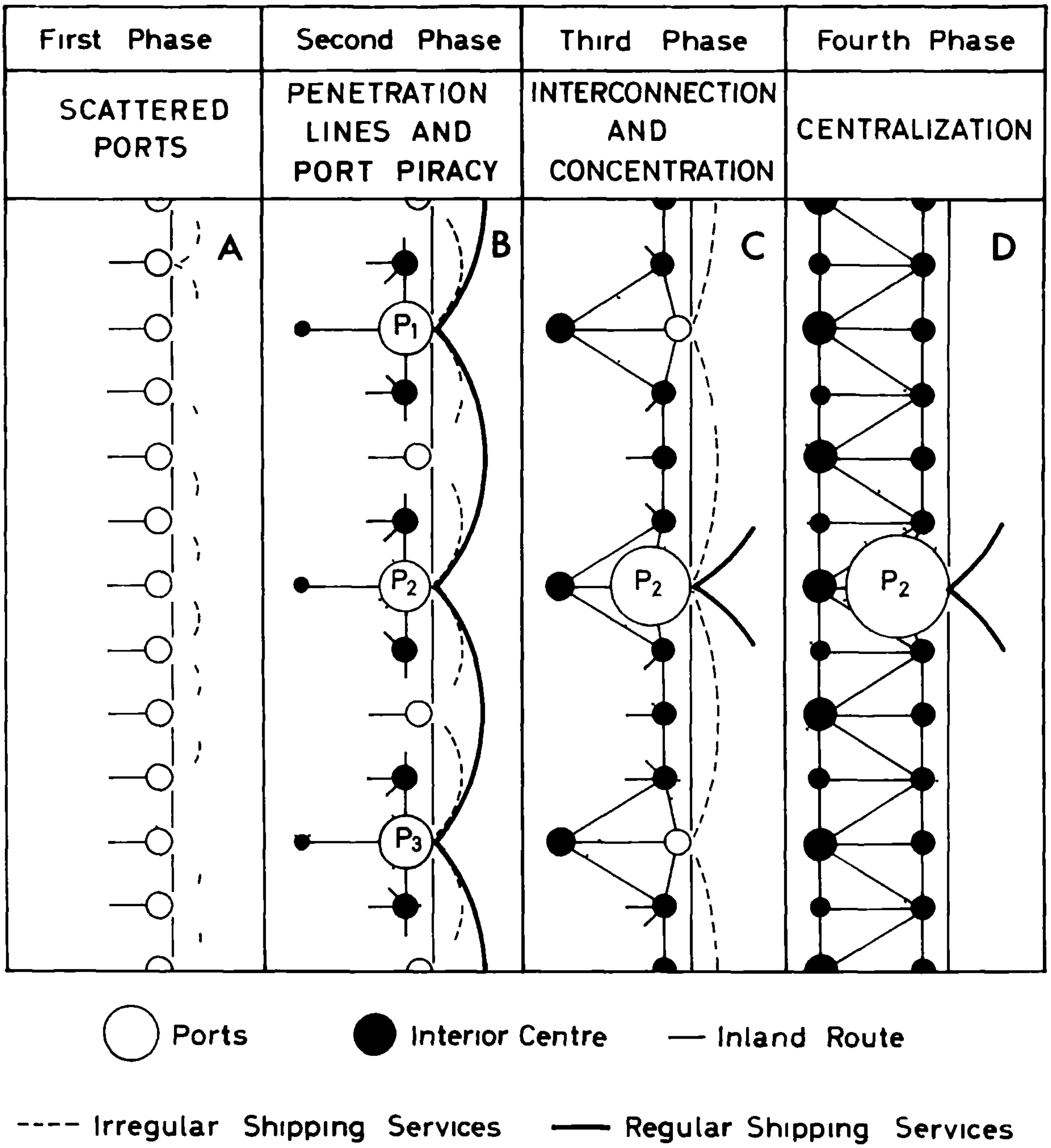
The Ideal-Typical Sequence Model was based on the



After Taaffe, E J et al

Fig 12 1

conclusion that the expansion of a transport network is from its beginning a continuous process of spatial diffusion and at the same time an irregular or sporadic process influenced by many specific economic, social, or political forces[6] The model shows four sequences of development (see Fig 12 1) Phase one (A) is characterized by a scatter of small ports on the coast-line with little lateral inter-connection and with an extremely limited hinterland for each port Phase two (B & C) is characterized by the penetration of transportation lines from the ports towards each other and inland Hinterland transport costs are reduced for certain ports and thus the market expands at certain ports and certain inland centres, which, in turn, leads to port concentration and the focus of feeder routes on the major ports and inland centres Phase Three (D & E) is characterized by the interconnection between the various centres and nodes on the penetration routes Phase four (D) is characterized by the emergence of high-priority (main-streets) as a result of the growth of some inland centres and some ports at faster rates than the other centres Three principles are behind this model (a) the principle of penetration lines, (b) the principle of inter-connection between these penetration lines and



Idealized Type Sequence of Port Development

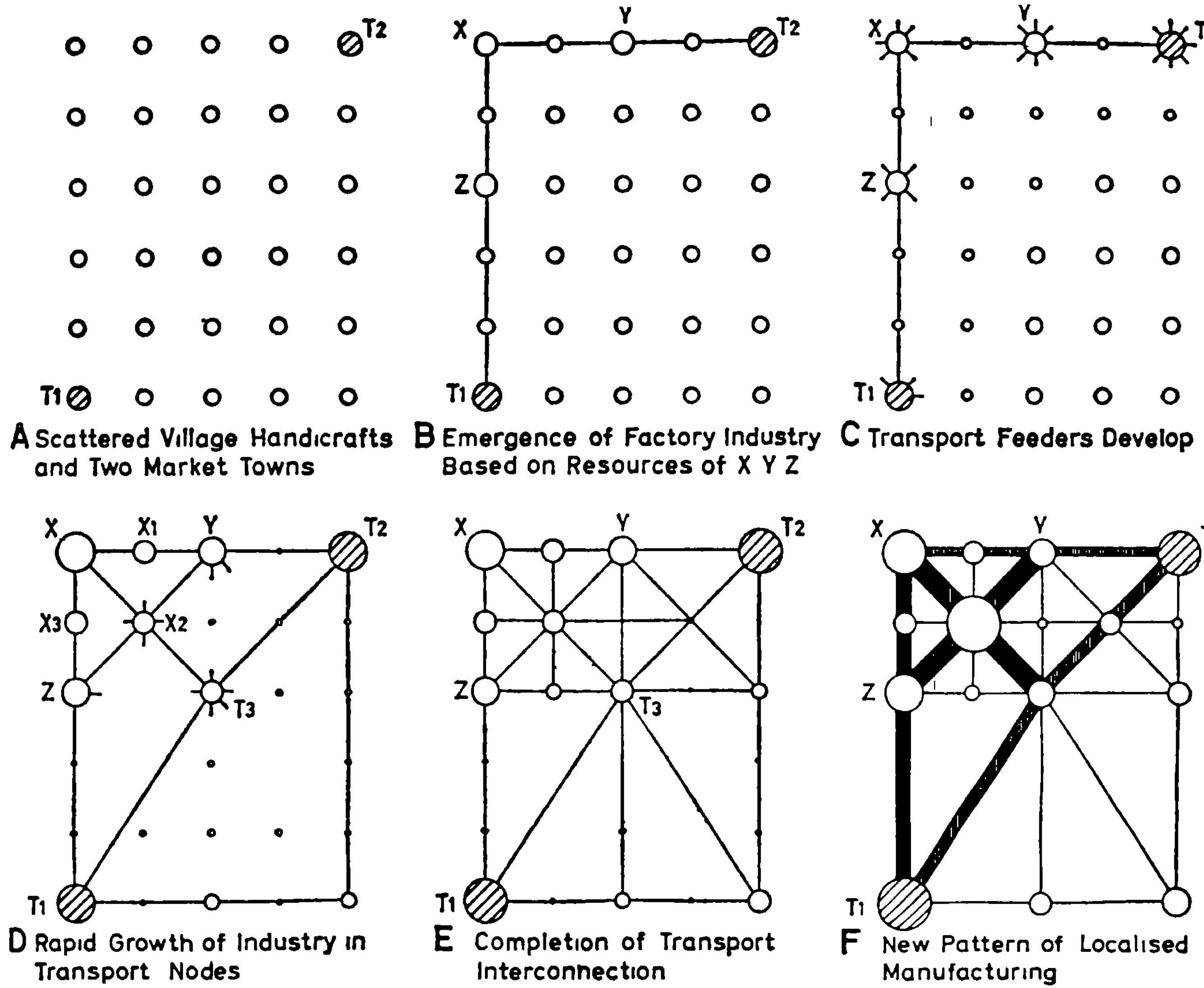
After Rimmer, P. J.

Fig. [illegible]

(c) the principle of continuous process

Three studies have so far been produced in connection with the sequence model Rimmer[7] in 1967 applied the Sequence Model to the changing status of New Zealand Seaports (Fig 12 2) and Sesay in his unpublished Ph D thesis (1967) also applied the model to the development of transportation in Sierra Leone[8] Further Ian Hamilton[9] in 1967 produced a sequence model for the emergence of the modern spatial pattern of industry Hamilton's model was based on the Ideal-Typical Sequence Model of transportation development, as can be seen in Fig 12 3 No study, however, has yet tried to answer the two excellent questions raised by Haggett[10] about the sequence model how far is the model applicable outside West Africa in particular and colonial areas in general, and how far is the division into separate stages justified? In this chapter an attempt is made to test the applicability of the model to the development of transport in Saudi Arabia and to some extent in some other Middle Eastern Countries This application is based on the detailed study in Chapter Two and Chapter Four of this thesis

Before applying the model, two questions should be



The emergence of a modern industrial location pattern raised about the generalization of this model First, is the model for the transport development in underdeveloped countries or underdeveloped areas? The use of the word area seems to be preferable in most cases for then we can apply the model to more than one area of a single country, especaılly when the country under study has more than one coastline However, the word country may be preferable in some cases since political boundaries may have a strong impact on the shape of the transportation network, as was shown by Wolfe [11] The second question is how can one apply the model to every underdeveloped country? How, for example, can it be applied to a land-locked country like Afghanistan? Further, even if the country is not land-locked, its geographical characteristics may differ to a great extent from those of Ghana and Nigeria The answer to this last question will be made clear by applying the model to Saudi Arabia, the Sudan and some other Middle Eastern countries

The Case of Saudi Arabia

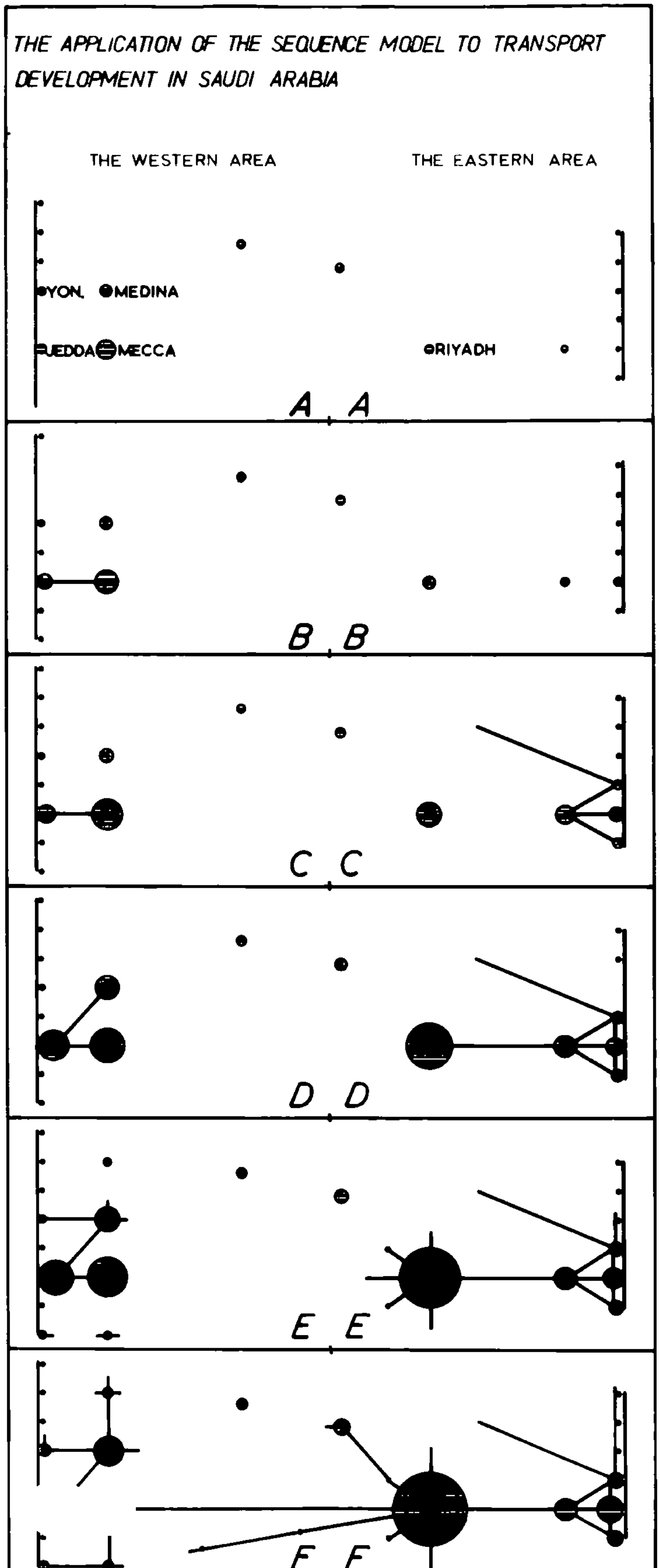
Saudi Arabia differs from the underdeveloped countries of West Africa on which the model was based in a number of ways 1 Saudi Arabia has not been colonized, at least not by the type of colonialism in West Africa and most other underdeveloped countries This point is relevant because most underdeveloped countries have had railways in the nineteenth and early twentieth centuries built by the colonizing powers and have colonial-type economies which are extremely orientated towards Europe 2 Being a desert country, Saudi Arabia has no agricultural products to export It also has not been a producer of minerals in large quantities, except oil, whose transport depends on pipelines more than on roads or railways Saudi Arabia thus did not build its roads or railways to support export as was the case in most of the underdeveloped countries 3 Arabia had well developed ancient caravan networks The routes across Arabia were international ways before Islam and increased in number and importance after the appearance of Islam 4 Saudi Arabia was very poor until the second World War, but since then its wealth has increased at an unusually rapid rate It was for this reason that Saudi Arabia, which had missed the age of railway construction, came with great enthusiasm to the age of road construction 5 The most important cities of Saudi Arabia (and most other Middle Eastern Countries) are situated inland and not on the sea coast as in West African countries Owing to these differences the east-west axis pattern of development, and not the sequence model, has been the typical sequence for transport development in Saudi Arabia The east-west axis pattern was described in chapter three and was applied in almost every other chapter of this thesis Yet the sequence model is also applicable to transport development in Saudi Arabia

Application of the Sequence Model

To create the most suitable conditions for the application of the sequence model, a) Saudi Arabia is divided into two parts, the western part with its coastline on the Red Sea and the eastern part with its coastline on the Gulf, b) the horizontal distance (east - west) is multiplied by four and c) the location of the ports and cities is altered to some extent to form a regular shape The development of the modern roads and railways was considered, but the Hijaz railway was neglected because it did not last very long The application of the model is shown in Fig 12 4

The Western Area

A Here we find a scatter of small ports, but two of them (Jedda and Yonbu) are already developed more than the others Links between these two ports and their


THE APPLICATION OF THE SEQUENCE MODEL TO TRANSPORT DEVELOPMENT IN SAUDI ARABIA
THE WESTERN AREA
THE EASTERN AREA
YON.
MEDINA
JEDDA
MECCA
RIYADH
A A
B B
C C
D D
E E
F F
AS

F [illegible]

major hinterland centres (Mecca and Medina) already exist, but with a primitive method of transport

B & C The development of modern transportation started with a road (1938) which linked the major inland city (Mecca) with its port (Jedda) The construction of this road reduced transportation cost to and from Jedda, and with the construction of Jedda port (1947) traffic was diverted from Yonbu to Jedda Yombu thus declined to become a minor port while Jedda expanded (see chapters three and ten)

D Consequently, the second penetration line was built (1952) between Jedda and Medina and not between Yonbu and Medina Yonbu declined even more, its population started to go to Jedda and Medina and many houses and stores were left empty and unused

E The Government tried to rescue the declining town of Yonbu by the construction of the Yonbu-Medina road (1956) This helped Yonbu to a very small extent, as Jedda had already developed as the major port for the whole area The traffic in Jedda port kept increasing to a level above the capacity of the port and thus small ports were constructed in Yonbu and Jizan

F This was followed by more penetration lines from both Mecca and Medina to the north, east and south and thus a certain level of connectivity was achieved

The Eastern Area

A & B In this area we also find scattered ports on the coastline with Hufuf and Riyadh as the two main inland centres None of the sea ports was more than a little fishing village and Hufuf was a large oasis surrounded by the hot, arid and saline desert

C The modern development of transport in the area came only after the discovery of oil In the early 1950's many short asphalt roads were rapidly constructed between certain ports and the inland oil centres (see Chapter Three)

D In 1952 a railway was constructed between the Dammam port on the Gulf coast and Riyadh which is located over 400 Kms inland

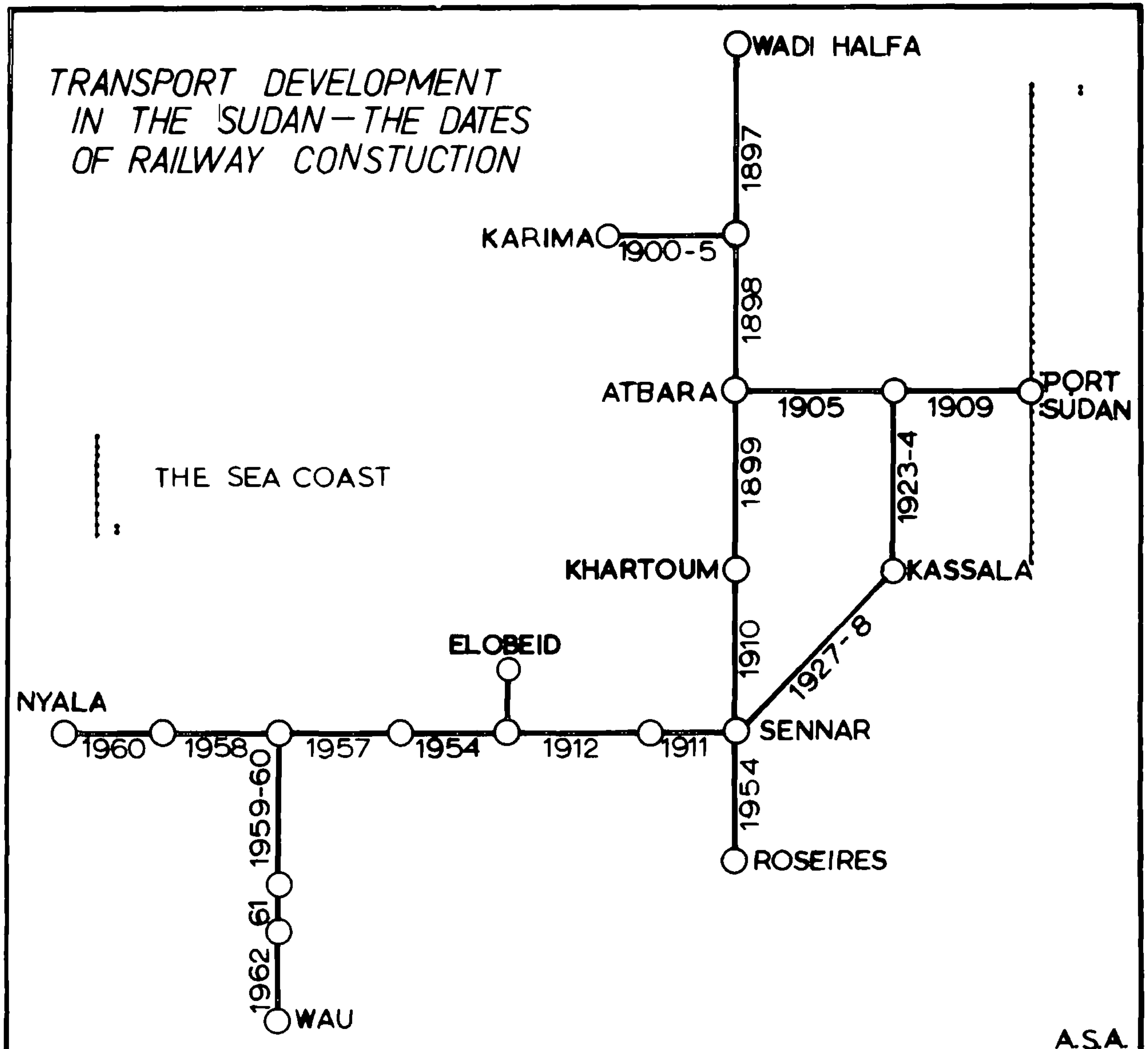
E Riyadh responded very quickly to the construction of the railway and to the efforts of King Ibn Saud to build and modernize his capital (see Chapter Ten) Some feeder roads were focused on Riyadh linking it with Al Kharj and Ad Diriyah (see Chapter Three)

F The continuous expansion of both the eastern and the western areas led to the linkage of the road networks of the two areas In 1965 the two coastlines of Saudi Arabia were linked by a modern road which extends from Jedda to Dammam

The above summary of the development of transportation in Saudi Arabia and its illustration in Fig 12 4 suggests that the sequence model is, to a large extent, applicable to Saudi Arabia This does not mean, however, that it is the best way of showing the pattern of transport development in this country, nor does it mean that all the details of the model are applicable The direction of the first penetration line for example seems to have come from Mecca to Jedda rather than from Jedda to Mecca, as the model suggests This point about the direction of the penetration lines can be elaborated by applying the model to the transport development of the Sudan

The Case of the Sudan

The Sudan has some particular geographical and historical conditions Life in the Sudan, like in Egypt, is closely linked with the Nile valley where most of the population and social and economic activities are concentrated The seacoast, on the other hand, is not only isolated from the Nile Valley by scarcely populated area but also by mountain ranges extending from north to south


TRANSPORT DEVELOPMENT IN THE SUDAN – THE DATES OF RAILWAY CONSTUCTION
WADI HALFA
1897
KARIMA
1900-5
1898
ATBARA
1905
1909
PORT SUDAN
THE SEA COAST
1899
1923-4
KHARTOUM
KASSALA
1910
1927-8
ELOBEID
NYALA
1960
1958
1957
1954
1912
1911
SENNAR
1954
ROSEIRES
1959-60
61
1962
WAU
A.S.A.

Further, the coastal part of the Sudan was under the administration of the Hijaz (in Arabia) for sometime during the Turkish rule while the Nile Valley was under the rule of Egypt.

Owing to these geographical and historical conditions, the first railway to be built in the Sudan was not built between the seacoast and the Nile Valley but between Wadi Halfa and Saras (1875) and then extended to Kerma (1897) along the Nile Valley. The largest part of this line was built by the Anglo-Egyptian army in the course of the compaigns against the Sudanese Mahdiya. The real start of the present railway network, however, came about with the construction of the Wadi Halfa - Abu Hamid line in 1897 and its extension to Khartoum in 1899. More railways were built afterwards towards the east, south and west[12] (Fig. 12.5)

Like in Ghana and Nigeria, the early construction railways in the Sudan were built to serve the colonial political, military and economic aims. Yet the sequence model is not applicable to transport development in the Sudan since the early railway lines did not penetrate from the seacoast inland but along the Nile Valley and then towards the seacoast. However, the three principles of penetration, interconnection and continuous process are applicable

The Direction of the Penetration Lines A Suggested Modification

The above attempt to apply the sequence model to the development of transportation in the Sudan suggests that the model in the form produced by Taaffe, Morrill and Gould has no general application to all under-developed countries The three main principles of penetration lines, interconnection between those penetration lines and the principle of continuous process all, however, are valid for the Middle Eastern countries, with some reservation about the principle of continuous process, which does not apply to Arabia if the Hijaz railway and the historical caravan route networks are considered As will be seen below (Chapter Thirteen), the development of transport in Arabia is of a cyclical nature and not a continuous process The development within each cycle is, however, of a continuous pattern

The main weakness in the model thus is not in its principles but in the direction of the penetration lines The model suggests that these lines come from the sea coast and penetrate inland, but the case of the Sudan suggests the opposite Consequently, if we can modify this point then the model could be of more general application To make this modification we need to discover the main factor (the law) which governs the direction of the penetration lines

The investigation of transport development in the Middle East and the available literature on West Africa and other underdeveloped countries suggest that the direction of the early penetration lines in each underdeveloped country was governed by the direction from which the outside colonial (or interested) power came For most of the countries in the American continents, Australia, New Zealand and Africa the colonial power came from the sea direction Consequently, certain centres on the coastlines were developed as main cities and later as national capitals Thus, the penetration lines started from these relatively developed centres towards the backward interior either for military, political or economic reasons For the Sudan the outside interested (colonial) powers were Egypt and Great Britain, which was politically dominant in Egypt The early penetration lines in the Sudan came from the north towards the south and later towards the seacoast and other directions (Fig 12 5) In Arabia, the first penetration line (The Hijaz Railway) came from the direction of Turkey which was the influencing outside power In Iraq, the first penetration line (Baghdad - Berlin) did not come from the Gulf but from the northwest direction because Germany was the main interested outside power In view of the above observations, it may be postulated that in probably all underdeveloped countries the early transportation lines came from the direction from which the outside influencing, interested or colonial power came It follows that in most, but not all, underdeveloped countries the early penetration lines came from the seacoast inland

Some Other Suggested Modifications

The number of penetration lines and the number of points they start from also need some modification It is not necessary that two lines should come from two points to link them with another two points, they may come from one point and link it with another two points, as was the case in the western part of Saudi Arabia When the penetration lines come from the coast the number of ports which develop penetration lines seems to be affected by the length of the coastline as well as by other factors In the Sudan there was only one penetration line parallel to the Nile and from this line all the other penetration lines originated In Egypt the first penetration line came from the Mediterranean coast while the second came from the Red Sea coast It should be remembered also that the motives behind the construction of the penetration lines may differ from one underdeveloped country to another It has already been explained that the motives behind the construction of the early penetration lines in Saudi Arabia were totally different from those in Ghana, Nigeria and the Sudan It may be added that the motive behind the construction of the first two penetration lines (railways) in Egypt was to link the Red Sea with the Mediterranean and ease the transport between England and India (See Chapter Two)

The Four Stages and the Measurement of Network Development

It is very difficult to determine how far the division into four phases is justified Certainly a division is essential since the model deals with the process of development, but are four stages applicable and how long should they take? For both the eastern and western areas of Saudi Arabia the four stages sequence is, to a large extent, applicable It can be said that the transportation network of Saudi Arabia is at some stage of the third phase, that is the phase of interconnection

However, in Saudi Arabia the development from the first to the third stage has taken a very short period in comparison with Ghana or Nigeria The weakness of measuring the transport development by the use of this model lies in the fact that the route network in a certain area may reach the fourth phase while in the rest of the country it is in the stage of penetration It follows that the model is not an accurate method of measuring the development of transport specially in large countries

Measuring the level of transport development is, however, a very difficult matter even with the use of the Beta Index[13] or other new methods The problem arises from the fact that such indices measure the level of connectivity between a certain number of vertices already linked to the network Thus, settlements which are not linked to the network cannot affect the calculation of the index It follows that a large country with a number of towns in a small area connected with a good transport network would have a high index, in spite of the fact that the route network is only limited to a very small area

Conclusion

The above application of the Ideal Typical Sequence

Model of transport development has shown that, broadly, the model is applicable to the transport development in Saudi Arabia but not in the Sudan The three principles of penetration, interconnection and continuous process are, however, applicable even to the Sudan Consequently, with the suggested modifications concerning the direction, numbers of the penetration lines and the motives behind the construction of those lines, the model should become of general application to all countries irrespective of their geographical characteristics

References and Notes

1 J H von Thünen, Der isolierte Staat in Beziehung auf land-Wirtschaft und Nationalökonomie, Rostock, 1826 Quoted in Chisholm, M , Rural Settlement and Land Use, 1966

2 The gravity model has been used in a number of transport geography papers including Helvig, M , Chicago's External Truck Movements Special Interactions between the Chicago Area and its Hinterland, Research Paper 90, Department of Geography, Chicago University, 1964

3 Haggett, P , "Network Models in Geography," in Chorley, R J & Haggett, P , Models in Geography, 1967, Chapter Fifteen, pp 609-664

4 Taaffe, E J , Morrill, R L , Gould, P R , 'Transport Expansion in Underdeveloped Countries A Comparative Analysis', The Geographical Review, Vol 53 October 1963, pp 503-529

5 Haggett, P , op cit pp 609-664

6 Taaffe et al , op cit, 503

CHAPTER THIRTEEN

Problems and Prospects

Transport development is one of the main problems facing the socio-economic growth of Saudi Arabia, as in most other underdeveloped countries In most of these countries transport is also underdeveloped and adequate resources (financial as well as technical) to improve the situation are lacking, and planning and policy making are hindered not only by the limitation in technical ability but also by the unavailability of adequate and reliable data This chapter deals with the main problems of transport planning in Saudi Arabia and attempts to draw the broad lines of what may be called a general strategy for transport development

The Main Goal

The history of transport in Arabia (Chapter Two) suggests that transport development is a phenomenon of a cyclical nature Three cycles have been identified in the history of transport in Arabia the pre-Islamic, the Islamic and the present day cycle Each of these cycles was found to be a product of an unexpected miracle factor the international transit trade produced the first cycle, the rise of Islam produced the second and the discovery of oil produced the third cycle The end of each cycle is usually brought about by the decline of the producing factor, and the route network and traffic usually differ from one cycle to another To a lesser degree the route network and the pattern of traffic differ within the same cycle according to their stage of development or decline Transport development, thus, is a continuous process within each cycle but not throughout history (see Chapters Two and Twelve)

At the moment the present cycle is in a process of development which is closely associated with the oil revenues Fig 13 1 is a summary of a number of previous graphs exhibiting the association of the development of roads, road traffic, motor vehicles, port activities and air traffic with the oil revenues and the general economic growth as represented by the government expenditure

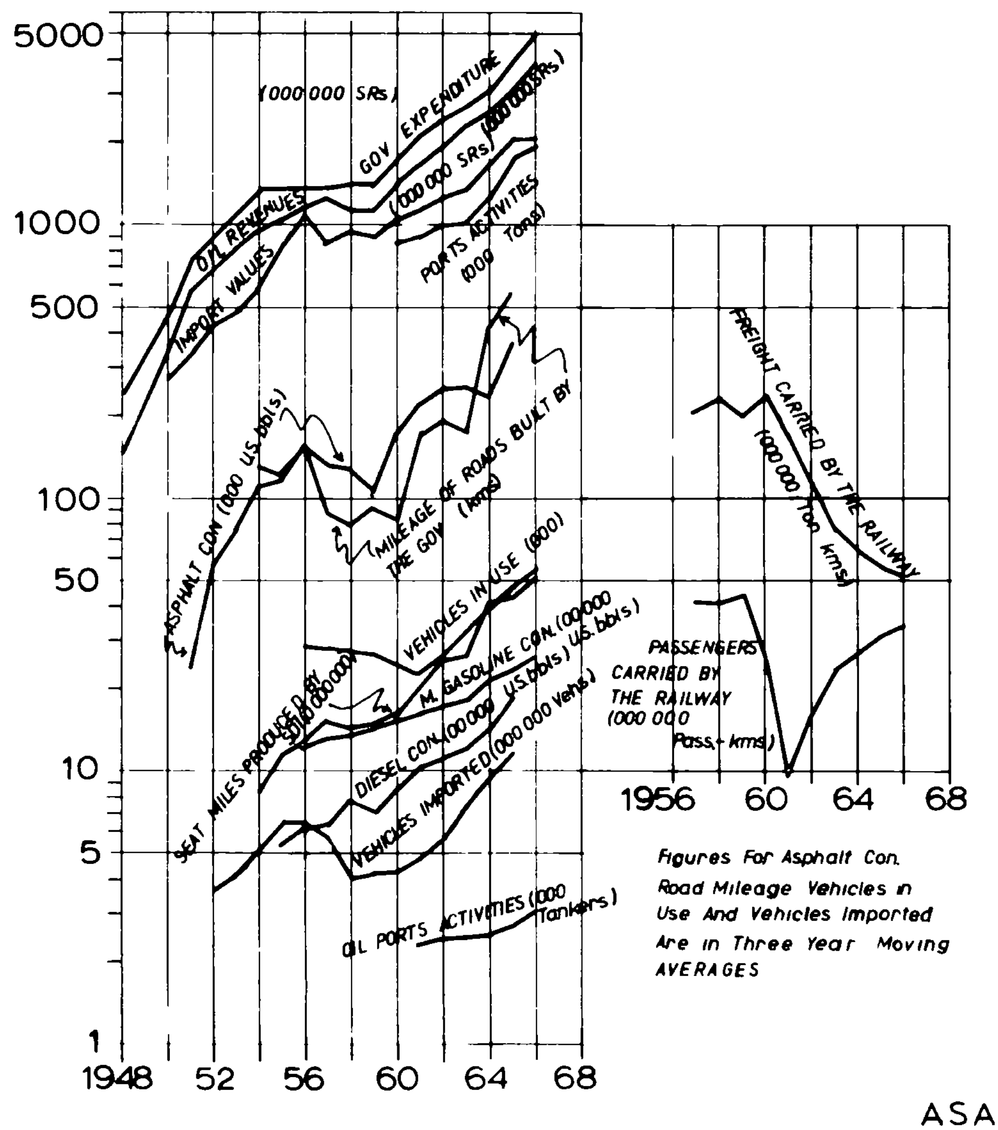
If transport development is of cyclical nature, and if the present cycle is the product of the oil discovery and if the present growth of transport is closely associated with the oil revenues, then this cycle should come to a close when the oil production starts declining and the oil fields dry up Knowing that in Bahrain oil resources are in sight of exhaustion,[1] one cannot be very optimistic about the future of oil production in Saudi Arabia In any case even optimists estimate that the oil reserves will run out in about 80 years with the present rate of production

In view of this situation Saudi Arabia should do its best to build, as quickly as possible, a modern economy which is less dependent on the export of crude oil If this can be done with the help of the present oil income, careful planning and exploitation of present technology, then the present growth in transport and in other fields could be changed from one of a cyclical nature to one of a continuous process This should be the main goal which the country should try to achieve to build a country with a modern economy which is less dependent on the export of crude oil

Transport development should be planned with this main goal in mind Transport improvement should be looked at not as an aim by itself but as a means to achieve the main goal In sum if transport development in the past was a response to the economic opportunities which were created by the oil industry (see Chapters Two, Three and Eight), present and future transport improvements should aim to create and stimulate new social and economic activities

<u>The Problem of Resource Allocation</u>

THE GROWTH OF VARIOUS MODES OF TRANSPORT COMPARED WITH OIL REVENUES AND THE GENERAL ECONOMIC GROWTH



Obviously to achieve the main goal, the available resources, finance as well as labour and technical ability, should be employed in the most promising development projects Transport is only one of many projects competing for the available resources, and thus we are faced with the problem of resource allocation The question is how much should the country spend on transport development?

The problem of resource allocation is, however, a problem of measuring the profitability of the various projects In transport projects it is extremely difficult to measure the social, political and some other benefits in a numerical and comparable way, yet careful and detailed evaluations are usually attempted In Saudi Arabia the benefit / cost ratio of the road planned since 1963 varied from 4 to 14[2] over a period of 40 years The calculation of the ratio was based on the estimation that the new roads would reduce transportation cost by about 40 to 60 percent and that traffic would increase by about 10 to 20 percent per annum Only the direct economic benefits which are derived from the reduction in the cost of transport was considered in the above mentioned benefit / cost ratio The effect of the new roads on attitudes[3] and on economic growth was not considered

Scale: I Centimetre to I Kilometre

NEW AGRICULTURAL DEVELOPMENT STIMULATED BY THE RIYADH - TAIF ROAD (About the KM 25 to the KM 50 from Riyadh).

Fig. I3.2

It should, however, be admitted that because most of Saudi Arabia is a sparsely populated desert, the impact of new roads on the areas they are built across is usually limited Yet, where underground water was found, agriculture has developed alongside the new roads Figs 13 2 and 13 3 show some of the newly developed farms along the Riyadh - Marat road The products of these new farms which appeared in the Muzahmiya plain are sold in the markets of Riyadh which is less than 100 Kms away

Table 13 1 Government Expenditure on Transport 1960-66 (000,000 SR)

Year	Total Gov Expen	Expend on Transport	%	Expenditure on Transport and Communications	%
1960	1786 0	167 3	9 4	209 9	11 8
1961	2166 0	312 3	14 4	358 8	16 6
1962	2452 2	324 0	13 2	379 0	15 5
1963	2686 0	336 3	12 5	414 7	15 4
1964	3112,0	591 9	19 0	714 4	23 0
1965	3961 0	586 9	14 8	665 9	16 8
1966	5025 0	827 4	16 5	906 0	18 0

Source Central Department of Statistics, Statistical Yearbook 1967 p 181 and p 311

In the period 1960-66 the government has been spending from 12 to 23 per cent of its expenditure on transport and communications On transport alone, it has

At the Muzahmiya plain (I968)

From the Muzahmiya plain going to Riyadh (I968)

Fig. I3.3 An example of the newly developed farms along some of the new roads.

been spending from 9 to 19 percent of the total expenditure (table 13 1) These proportions are similar to the transport investment in the United States in the period 1920-1940,[4] and the present situation in most under-developed countries [5] In view of this, it can be said that Saudi Arabia is spending a reasonable proportion of its budget on transport development

The Choice of Mode

This is not a serious problem for transport development in Saudi Arabia In the absence of internal waterways and because of the high speciality of pipelines Saudi Arabia has to choose only between roads, railways and air transport

The choice between railways and roads depends on the amount and type of traffic as well as the distances involved Broadly, with long distance and heavy bulky traffic, railways become preferable In Saudi Arabia distances are great but traffic is light The present freight traffic between any two points cannot guarantee the 1,000 ton per mile per day which is considered to be the minimum traffic required for railways [6] Further, the history of transport in developed as well as under-developed countries indicates that road traffic has been increasing with a higher rate than rail-traffic In fact railway traffic has been in many cases decreasing as a result of road competition Furthermore, Saudi Arabia's own experience has shown that the railway is fighting a losing battle with road competition Fig 13 1 shows that the total movement of goods by the various sections of the Riyadh - Dammam railway has been decreasing while road and air traffic have been growing

In view of these evidences and the generally recognized flexibility and the wide coverage of road transport, it can safely be said that roads are more suitable than railways for Saudi Arabia It follows that the reconstruction of the Hijaz railway cannot be justifiable on economic grounds The decision to reconstruct the Hijaz railway must have been based either on sentimental grounds or on overestimation of the Hajj traffic, which is limited to a very short time and which cannot support the running of this very long railway It may be very sad to cancel this project but, economically, the project should be cancelled and the money which has been spent on it should be considered as sunk capital

The transportation needs of Saudi Arabia can best be met by co-ordinated road and air transport These in fact are the two methods which have been developing in the past few years, as can be seen from table 13 2, which shows that the proportion of the money spent on the railway has been declining, the proportion spent on air transport has been maintained whilst the proportion spent on roads has been increasing It should be stressed, however, that air transport has a particular advantage—because of the large distances in Saudi Arabia (see Chapter Eight), and that with the present trend in aircraft industry, air transport may very soon prove to be suitable for carrying a large proportion of the light freight traffic in the country

Coastal transport is almost totally unutilized in spite of the two long coastlines This form of transport is limited to the transportation of about 3,770,000 U S BBLS a year (1966) of petrol from Ras Tannurah on the Gulf to Jedda on the Red Sea coast, together with about 30,000 tons a year (1967) of freight (mainly imported goods) from Jedda to Jizan It is recommended that a feasability study should be conducted to look into the possibility of modernizing and exploiting this cheap form of transport

<u>The Problem of Priority</u>

It is very often difficult to decide which road, port, or airport should be built first The problem arises because in most cases the available resources at a certain time do not allow the construction of all the transport

Table 13 2 Expenditures on Various Transportation Modes 1958-66 (000,000 SR)

Year	Air	Railway	Ports and Roads[b]	Total[a]
1958	35 0	40 4	21 7	97 1
1959	39 0	34 7	4 3	78 0
1960	55 1	33 7	66 2	155 0
1961	157 9	44 3	106 8	309 0
1962	131 0	37 4	152 3	320 7
1963	146 7	36 4	149 0	332 1
1964	178 4	38 0	370 4	586 8
1965	193 7	31 8	359 1	584 6
1966	302 0	49 1	474 1	825 2
	Percentage	Percentage	Percentage	Percentage
1958	36 0	41 6	22 4	100
1959	50 0	44 5	5 5	100
1960	35 5	21 7	42 8	100
1961	51 1	14 3	34 6	100
1962	40 8	11 7	47 5	100
1963	44 2	11 0	44 8	100
1964	30 4	6 8	62 8	100
1965	33 1	5 4	61 5	100
1966	36 6	5 8	57 6	100

Source Based on Central Department of Statistics, Saudi Arabia, Statistical Yearbooks of 1965 and 1967, various tables in the Transportation and Finance Sections

a Administrative expenditure for the running of the Ministry of Transport and Communications is excluded This was 12,300,000 SR in 1960 and gradually decreased to 2,200,000 SR in 1966

b It has not been possible to separate these two forms of transport but it should be noticed that ports account for a very small proportion facilities at the same time As broad strategy, this problem may be solved on two main principles First, transportation services which are urgently needed for the success or the opening of a certain economic project should be given priority in order to be built at the right time Also transportation projects which are quickly needed for military, strategic or political reasons should be given priority Second, in the absence of economic projects or clear strategic or political needs and when the purpose of transportation development is mainly to stimulate the general social and economic growth, priority decision should be made according to the pattern of the distribution of population and the main settlements as well as on the economic activities and the prospects of development in the various regions

The analysis of the association between road mileage (including roads under construction) and the population factor proved a significant positive relationship between the two (see Chapter Three) Moreover, if we compare Fig 1 3, which shows the distribution of settlements, and Fig 3 2, which shows the present road network, we find a close association between the road network and the distribution of the settlements which have 2,000 or more inhabitants In fact, it can be said that with the completion of the roads under construction or design at present, all the main towns in the country will be linked by the modern road network Priority thus should be given to completing the present road construction programme In the meantime a feeder road programme should be undertaken to link the few towns with more than 2,000 inhabitants which are not going to be linked to the modern roadnetwork as now planned Among these towns are As Sail Al Kabeir and Ranya (near Taif) as well as a number of towns around Rafha and in the regions of Jizan, Hail and Gassim, The main aim of the feeder road programme, however, should be to link the towns with populations between 1,000 and 2,000 to the main road network Special consideration should be given to the feeder roads in the southwest where the density of population and the amount of rainfall are high and where the prospects of development, mainly agricultural, are also higher than in any other part of the country The feeder roads would spread road services and would also work as tributaries feeding the main roads with more traffic and thus ensuring better benefits from the main roads

As for air transport, priority decisions should be based on the town-size which is the most important single factor in air traffic generation (see Chapter Eight) As broad strategy, each town with 2,000 inhabitants or more should be served by the air route network unless it is located within the influence of the traffic shadow factor Priority should be given to bigger and more isolated towns In view of this principle, the construction of suitable airports and the opening of air services to eight more towns are recommended to raise the total number of airports in the country to 33 These towns are Layla, Al Ula, Umlujj, Duba, Al Lith, Tayma, Turabah, and Khurmah Each of these towns has 2,000 inhabitants or more, is not served by the present air network and is either located more than 200 Kms away from the nearest airport or is not served yet by the modern road network The location of these towns can be seen in Fig 1 2

The Problem of Finance

In most underdeveloped countries finance is the most serious problem in transport development The problem has been partly solved by borrowing mainly from the United States and the international agencies for transport development By 1963 underdeveloped countries borrowed about $7 2 billion from those two sources [7] In Saudi Arabia the availability of money has not, however, been a serious problem because of the rising oil revenues In fact, the available figures for spent and unspent budget suggest that, owing to planning errors, the government has not been able to spend one half of the money allocated for development projects (see table 13 3)

However, until 1963 the income to the government from the various transportation forms has never been objectively calculated or even estimated, and transport used to be directly financed by the Ministry of Finance In 1963, however, the first step towards modernizing the way of financing transport was taken by transferring the Saudi Airlines into a corporation with an independent budget, and in 1967 the Riyadh-Dammam railway was also transferred into a corporation It is suggested that the roads and ports authorities should also collect their own revenues and make their own budgets The four forms of transport (rail, road, ports and air) should have coordinated plans but each should try to finance itself from its own income Money for development projects can be borrowed from the government

In table 13 4 an attempt is made to estimate the revenues of the various transportation sectors in the period 1958-1966 It may be noticed that the income

Table 13 3 Spent and Unspent Amounts of the Government Budget 1958/59 - 1963-64

All Categories	Budget	Spent	Unspent	Unspent %
1958/59	1416	1260	156	11 0
1959/60	1838	1518	220	12 0
1960/61	2068	1846	222	10 7
1961/62	2451	2160	291	11 9
1962/63	2560	2223	337	13 2
1963/64	2924	2344	580	19 8

Projects	Budget	Spent	Unspent	Unspent %
1958/59	101	69	32	31 7
1959/60	123	75	48	39 0
1960/61	220	179	41	18 6
1961/62	400	258	142	35 5
1962/63	634	436	218	33 3
1963/64	788	345	443	56 2

(25) Central Planning Organization, Saudi Arabia, An Economic Report, 1965, p 106

of SDI and the roads and ports has been steadily increasing while that of the railway has been decreasing because of road competition The income of SDI comes mainly from the fares, airport fees make only 2,500,000 SR (1966) The income of roads comes from various sources but mainly from road tax which makes about 29,000,000 SR (1966), and customs duties on imported vehicles, which make about 23,000,000 SR (1966) Tax on petrol and the income from number plates of vehicles accounted for 23,000,000 SR and 10,000,000 SR respectively,(1966) It was not possible, however, to conclude in our estimations the income from the customs duties on imported spare parts or the income from the fees of driving licences or any other unmentioned sources of income

Table 13 5 shows the government subsidies to each form of transport As can be seen, the government subsidy amounted to over 611,900,000 SR in 1966, 64% of which went to roads and ports and the rest to SDI For the lack of data it was impossible to estimate the subsidy to the railway for 1966 but in 1965 it was 17,800,000 SR or about 4% of the total government subsidies to transport The large amounts of subsidies to roads and ports were caused by the ambitious road construction projects which are in progress at present The huge subsidy to SDI is, however,

Table 13 4 The Revenues of Various Transportation Forms 1958-66 (000,000 SR)

Year	SDI[a]	The Railway[b]	Ports & Roads[c]	Total
1958	24 5	25 0	14 5	64 0
1959	23 5	28 5	25 6	77 6
1960	23 6	32 9	28 6	85 1
1961	31 0	36 2	42 1	109 3
1962	31 2	24 4	43 2	98 8
1963	39 0	16 0	71 5	126 5
1964	45 7	14 0	81 6	141 3
1965	38 8	14 0	89 3	142 1
1966	63 2	n a	101 0	?

Source Based on various tables in Central Department of Statistics, Saudi Arabia, Statistical Yearbook 1965,66 and 67

a Airports' fees are included

b Figures for 1966 are not available The income from the port of Dammam is included

c Customs Duties on imported motor vehicles are included only for 1963,'64,'65 and '66 Driving licence fees are excluded

Table 13 5 Government Subsidy to Various Transportation Forms 1958-66 (000,000 SR)

Year	SDI [a]	The Railway [b]	Ports & Roads	Total
1958	10 5	15 4	7 2	33 1
1959	15 5	6 2	21 3(surplus)	0 4
1960	31 5	0 8	38 6	70 9
1961	126 9	8 1	64 7	199 7
1962	99 8	13 0	109 1	221 9
1963	107 7	20 4	77 5	205 6
1964	132 7	24 0	288 8	445 5
1965	154 9	17 8	269 8	442 5
1966	238 8	n a	373 1	?

<u>Source</u> Based on various tables in Central Department of Statistics, Saudi Arabia, Statistical Yearbook, 1965,66, and 67

a Civil Aviation Department is included

b Figures for 1966 are not available

unjustifiable since SDI should, in view of the favourable conditions for air transport in the country and in view of the monopoly the SDI has in the domestic market, be able to operate on better financial grounds

However, if the Road Department is to be run on its own financial resources then its income should be increased from the present level This will partly happen naturally with the increase in the income from the petrol taxation and customs duties on imported vehicles and spare parts as a result of the present trend of traffic increase Road tax is, however, not expected to increase proportionally, since this is not paid by the road users but by all government employees in the form of 2% of their monthly salaries It is recommended that motorists should be asked to pay for the use of roads in the form of an annual vehicle licence Such a licence system should make an annual income of about 6,000,000 SR on the basis of 100 SR per vehicle per annum This figure is based on the estimated number of vehicles in use in 1966 and should increase proportionally to the increase in the vehicle stock Tax on petrol may also be increased from the present level of 0 273 SR per gallons if this is found to be necessary

In order to raise the income of the Road Department, it is also recommended that the customs duties on motor cars of value exceeding 18,000 SR (about £1,800) should be raised from the present 45% to 100% and for those of value exceeding 30,000 SR to 200% Duties on cars of value of 18,000 SR and below may, however, remain at the present level which is 30% and 20% for saloon and estate cars respectively It is also recommended that duties on the spare parts of the more expensive cars should be higher than those on the spare parts of less expensive cars At present customs duties on all spare parts is 5% The fees on the number plates should also be classified according to the price of the vehicle and not according to its capacity as it is the case at present (The present number plate fees are 400 SR for vehicles of less than one ton capacity, 500 SR for vehicles of between one and two tons capacity, and then 100 SR for each ton) The proposed increases are not expected to have any impact on the total number of vehicles in the country but would only reduce the proportion of the very luxurious cars (e g the Cadillacs) which are unsuitable for any underdeveloped country

Reducing the Cost of Transport

The ultimate direct aim of all transportation projects is the reduction of transportation costs This could be achieved by better utilization of the already existing facilities and not only by constructing new, expensive projects For example, the improvement of the standard of driving, the fixing of clear and adequate road signs and the improvement of the traffic police should result in a reduction in road accidents and thus in a reduction in the cost of transport Also, the use of the most suitable type of vehicles should result in lowering the cost of transport (see Chapter Nine) In air transport the improvement in management should lead to a reduction in the cost of transport It is, therefore, suggested that a programme aiming to improve the utilization of the already existing transportation facilities should start as soon as possible

Epilogue

It is hoped that this study will be only a start of more objective research, aiming to increase our knowledge about the structure of transport and the factors behind that structure This is needed if we are to promote our thinking and ideas and to improve our judgement and policy making It is also hoped that at least some of the people involved in transport planning will find some of the suggestions made in this study acceptable and practically workable and that they will find the detailed surveys and analysis of value in forming their own judgements on various aspects of transport improvements

References & Notes

1 W B Fisher, 'Geographical Contributions to Development Surveys' Advancement of Science, December, 1968 pp 158-170 (Presidential Address delivered to Section E of the Dundee Meeting of The British Association on August 22, 1968)

2 Various foreign consultants have done such studies for certain roads, among these is Sauti, S P A in its feasability report on Road 61 Mecca - Ad Darb, 1967 pp 231-245

3 The impact of transport on attitudes is similar to the impact of education, health services etc For more details see Wilson, G W Bergmann, B R , Hirsch, L V , Klein, M S , The Impact of Highway Investment on Development, 1966, pp 195-199

4 Owen, W , Strategy for Mobility, 1964, table 2 1, p 30

5 Ibid, table 3 1, p 45

6 Ibid, p 96

7 Ibid, p 170

APPENDIX A

Motor Vehicle Imports - Exponentically Weighted Moving Averages and Trend of Growth, 1950-66

Year	Actual Data	Exponentially Weighted Moving Average	
1950	3393		3714 66
1951	3535	3714 66+0 8 (3535-3714 66)	3570 93
1952	4216	3570 93+0 8 (4216-3570 93)	4086 99
1953	4939	4086 99+0 8 (4939-4086 99)	4768 60
1954	6939	4768 60+0 8 (6939-4768 60)	6504 92
1955	8125	6504 92+0 8 (8125-6504 92)	7800 98
1956	4953	7800 98+0 8 (4953-7800 98)	5522 60
1957	4475	5522 60+0 8 (4475-5522 60)	4684 52
1958	2983	4684 52+0 8 (2983-4684 52)	3323 30
1959	5514	3323 30+0 8 (5514-3323 30)	5075 86
1960	4172	5075 86+0 8 (4172-5075 86)	4352 77
1961	5028	4352 77+0 8 (5028-4352 77)	4892 95
1962	7987	4892 95+0 8 (7987-4892 95)	7368 19
1963	10396	7368 19+0 8 (10396-7368 19)	9790 44
1964	11678	9790 44+0 8 (11678-9790 44)	11300 49
1965	13695	11300 49+0 8 (13695-11300 49)	13216 10
1966	12451	13216 10+0 8 (12451-13216 10)	12604 02

Trend of growth per annum=

$$\frac{\text{The last six years/6 - the first six years/6}}{6} = 836$$

Motor Vehicle Imports - Forecast, 1966-80

Year	Exp Moving Average 1966	Trend of Growth	Forecast
1967	12,604	836	13,440
1968			14,276
1969			15,112
1970			15,948
1971			16,784
1972			17,620
1973			18,456
1974			19,292
1975			20,128
1976			20,964
1977			21,200
1978			22,633
1979			23,472
1980			24,308

Passenger Car Imports - Exponentially Weighted Moving Averages, and Trend of Growth, 1950-66

Year	Actual Data	Exponentially Weighted Moving Average	
1950	1574		1651 00
1951	1736	1651 00+0 8 (1736-1651 00)	1719 00
1952	1643	1719 00+0 8 (1643-1719 00)	1658 00
1953	2972	1658 20+0 8 (2972-1658 20)	2709 24
1954	2066	2709 24+0 8 (2066-2709 24)	2194 65
1955	3375	2194 65+0 8 (3375-2194 65)	3138 93
1956	2774	3138 93+0 8 (2774-3138 93)	2846 99
1957	2625	2846 99+0 8 (2625-2846 99)	2669 40
1958	1772	2669 40+0 8 (1772-2669 40)	1951 48
1959	3404	1951 48+0 8 (3404-1951 48)	3113 50
1960	2766	3113 50+0 8 (2766-3113 50)	2835 50
1961	2937	2835 50+0 8 (2937-2835 50)	2916 70
1962	4571	2916 70+0 8 (4571-2916 70)	4240 14
1963	5295	4240 14+0 8 (5295-4240 14)	5084 03
1964	6666	5084 03+0 8 (6666-5084-03)	6349 61
1965	8237	6349 61+0 8 (8237-6349 61)	7859 52
1966	7285	7859 52+0 8 (7285-7859 52)	7399 90

Trend of growth per annum =

$$\frac{\text{The last six years/6 - the first six years/6}}{6} = 599$$

Passenger Car Imports - Forecast 1966-80

Year	Exp Moving Average 1966	Trend of Growth	Forecast
1967	7400	599	7,999
1968			8,598
1969			9,197
1970			9,796
1971			10,395
1972			10,994
1973			11,593
1974			12,192
1975			12,791
1976			13,390
1977			13,989
1978			14,588
1979			15,187
1980			15,786

Truck Imports - Exponentially Weighted moving averages and Trend of Growth, 1950-66

Year	Actual Data	Exponentially Weighted Moving Average	
1950	1534		1819 66
1951	1691	1819 66+0 8 (1691-1819 66)	1716 73
1952	2234	1716 73+0 8 (2234-1716 73)	2130 55
1953	1942	2130 55+0 8 (1942-2130 55)	1979 71
1954	4126	1979 71+0 8 (4126-1979 71)	3696 74
1955	4365	3696-74+0 8 (4365-3696 74)	4231 35
1956	2084	4231 34+0 8 (2084-4231 35)	2513 47
1957	1768	2513 47+0 8 (1768-2513 47)	1917 09
1958	992	1917 09+0 8 (992-1917 09)	1177 09
1959	1955	1177 09+0 8 (1955-1177 09)	1799 42
1960	1253	1799 42+0 8 (1253-1799 42)	1362 28
1961	1713	1362 28+0 8 (1713-1362 28)	1642 86
1962	3032	1642 86+0 8 (3023-1642 86)	2746 97
1963	4728	2746 97+0 8 (4728-2746 97)	4331 79
1964	4774	4331 79+0 8 (4774-4331 79)	4685 56
1965	5070	4685 56+0 8 (5070-4685 56)	4993 11
1966	4786	4993 11+0 8 (4786-4993 11)	4827 42

Trend of growth per annum =

$$\frac{\text{The last six years/6 - the first six years/6}}{6} = 228$$

Truck Imports, Forecast 1966-80

Year	Exp Moving Average 1966	Trend of Growth	Forecast
1967	4827	228	5,055
1968			5,283
1969			5,511
1970			5,739
1971			5,967
1972			6,195
1973			6,423
1974			6,651
1975			6,879
1976			7,107
1977			7,335
1978			7,563
1979			7,791
1980			8,019

Bus Imports - Exponentially Weighted Moving Averages and Trend of Growth, 1950-66

Year	Actual Data	Exponentially Weighted Moving Average	
1950	285		244 00
1951	108	244 00+0 8 (108-244 00)	135 20
1952	339	135 20+0 8 (339-135 20)	298 24
1953	25	298 24+0 8 (25-298 24)	79 65
1954	747	79 65+0 8 (747-79 65)	613 53
1955	385	613 53+0 8 (385-613 53)	430 71
1956	95	430 71+0 8 (95-430 71)	162 14
1957	82	162 14+0 8 (82-162 14)	151 74
1958	219	151 74+0 8 (219-151 74)	205 55
1959	155	205 55+0 8 (155-205 55)	165 11
1960	153	165 11+0 8 (153-165 11)	155 42
1961	378	155 42+0 8 (378-155 42)	333 48
1962	393	333 48+0 8 (393-333 48)	381 10
1963	373	381 10+0 8 (373-381 10)	374 60
1964	288	374 60+0 8 (288-374 60)	305 32
1965	388	305 32+0 8 (388-305 32)	371 46
1966	380	371 46+0 8 (380-371 46)	378 29

Trend of growth per annum =

$$\frac{\text{The last six years/6 - the first six years/6}}{6} = 9$$

Bus Imports - Forecast, 1966-80

Year	Exp Moving Average 1966	Trend of Growth	Forecast
1967	378	9	387
1968			396
1969			405
1970			414
1971			423
1972			432
1973			441
1974			450
1975			459
1976			468
1977			477
1978			486
1979			495
1980			504

APPENDIX B

The Growth of Air Traffic as shown by the Seat-Miles produced by the SDI 1954-1966 Exponentially Weighted Moving Averages and Trend of Growth

Year	Actual Seat-Miles Produced (000,000)	Exponentially Weighted Moving Average	
1954	861		110 9
1955	116 7	110 9+0 8 (116 7-110 9)	115 5
1956	129 8	115 5+0 8 (129 8-115 5)	126 9
1957	154 3	126 9+0 8 (154 3-126 9)	148 8
1958	144 5	148 8+0 8 (144 5-148 8)	145 4
1959	149 6	145 4+0 8 (149 6-145 4)	148 8
1960	164 2	148 8+0 8 (164 2-148 8)	161 1
1961	162 9	161 1+0 8 (162 9-161 1)	162 5
1962	257 1	162 5+0 8 (257 1-162 5)	238 2
1963	269 4	238 2+0 8 (269 4-238 2)	263 2
1964	421 6	263 2+0 8 (421 6-263 2)	389 9
1965	440 9	389 9+0 8 (440 9-389 9)	430 7
1966	514 7	430 7+0 8 (514 7-430 7)	497 9

$$\text{The General Trend of Growth} = \frac{\text{the last six years/6} - \text{the first six year/6}}{6} = 35\ 71$$

$$\text{The 1954-1961 Trend of Growth} = \frac{\text{the second 4 years/4} - \text{the first 4 years/4}}{4} = 8\ 37$$

$$\text{The 1961-1966 Trend of Growth} = \frac{\text{the last 3 years/3} - \text{the years 1961,62,63/3}}{3} = 76\ 42$$

The Growth of Air Traffic - Forecast 1966-1985 (Seat-Miles)

Year	Exp 1966, Moving Average (000,000)	General Trend of Growth (000,000)	Forecast (000,000)	1954-61 Trend of Growth	Forecast (000,000)	1961-66 Trend of Growth	Forecast (000,000)
1967	497 9	35 71	533 61	8 37	506 27	76 42	574 32
1968			569 32		514 64		650 74
1969			605 03		523 01		727 16
1970			640 74		531 38		803 58
1971			676 45		539 75		880 00
1972			712 16		548 12		956 42
1973			747 87		556 49		1,032 84
1974			783 58		564 86		1,109 26
1975			819 29		573 23		1,185 68
1976			955 00		581 60		1,262 10
1977			890 71		589 97		1,338 52
1978			926 42		598 34		1,414 94
1979			962 13		606 71		1,491 36
1980			997 84		615 08		1,567 78
1981			1,033 55		623 45		1,644 20
1982			1,069 26		631 82		1,720 62
1983			1,104 97		640 19		1,797 04
1984			1,140 68		648 56		1,873 46
1985			1,176 39		656 93		1,949 88

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