REDUCING CAR-DEPENDENCE IN AR-RIYADH CITY THROUGH THE INTEGRATION OF LAND-USE PLANNING AND TRANSPORT

By

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بسم الله الرحمن الرحيم

In the name of Allah, Most Gracious, Most Merciful

5. And cattle He has created[2023]
For you (men) : from them
Ye derive warmth,
And numerous benefits,[2024]
And of their (meat) ye eat.

٥ وَٱلۡأَنۡعَٰمَ خَلَقَهَاۗ لَكُمۡ فِيهَا دِفۡءٞ
وَمَنَٰفِعُ وَمِنۡهَا تَأۡكُلُونَ

6. And ye have a sense
Of pride and beauty in them
As ye drive them home
In the evening, and as ye
Lead them forth to pasture
In the morning.[2025]

٦ وَلَكُمۡ فِيهَا جَمَالٌ حِينَ تُرِيحُونَ وَحِينَ
تَسۡرَحُونَ

7. And they carry your heavy loads
To lands that ye could not
(Otherwise) reach except with[2026]
Souls distressed : for your Lord
Is indeed Most Kind, Most Merciful

٧ وَتَحۡمِلُ أَثۡقَالَكُمۡ إِلَىٰ بَلَدٖ لَّمۡ
تَكُونُواْ بَٰلِغِيهِ إِلَّا بِشِقِّ ٱلۡأَنفُسِۚ إِنَّ
رَبَّكُمۡ لَرَءُوفٞ رَّحِيمٞ

8. And (He has created) horses,
Mules, and donkeys, for you
To ride and use for show ;[2027]
And He has created (other) things
Of which ye have no knowledge.[2028]

٨ وَٱلۡخَيۡلَ وَٱلۡبِغَالَ وَٱلۡحَمِيرَ
لِتَرۡكَبُوهَا وَزِينَةٗۚ وَيَخۡلُقُ مَا لَا تَعۡلَمُونَ

2023. Why will you go back to material things, considering that material things are made subservient to your use and enjoyment in various ways as suggested in the clauses that follow.

2024. From wool, and hair, and skins, and milk. Camel's hair makes warm robes and blankets; and certain kinds of goats yield hair which makes similar fabrics. Sheep yield wool, and Llamas alpaca for similar uses. The skins and furs of many animals yield warm raiment or make warm rugs or bedding. The females of many of these animals yield good warm milk, a nourishing and wholesome diet. Then the flesh of many of these animals is good to eat. There are other uses, which the animals serve, and which are referred to later.

2025. The good man is proud of his cattle and is good to them. As they go to, and return from, pasture, morning and evening, he has a sense of his power and wealth and their beauty and docility. Will not man turn from these material facts to the great spiritual truths and purpose behind them?

2026. The cattle and animals also carry loads, and thus make inter-communication between different lands easy. But for them there would have been many difficulties, not only physical, but psychological. Weary men carrying loads are in no mood for social and spiritual intercourse. This intercourse is made possible by the kindness and mercy of God.

2027. Horses, mules, and donkeys as well as other animals may be beasts of burden, but they may also be pedigree animals bred for beauty and for all those more refined uses, such as processions, in which grace and elegance is the predominant feature.

2028. If we examine the history of transport, there have been vast changes through the ages, from rude pack animals to fine equipages, and then through mechanical contrivances, such means of transport as elegant coaches, tramways and railways, useful motor lorries and Rolls-Royce cars, and air-ships and aeroplanes of all descriptions. At any given point of time, many of these were yet unknown to man. Nor can we suppose the limit to have been reached now or that it will ever be reached at any future time. Through the mind and ingenuity of man it is God that creates new things hitherto unknown to man.

QUR'AN, 16: 3-8 taken from Ali, A. Yusuf, THE HOLY QUR'AN. Text, translation and Commentary, 1983, p.657.

ABSTRACT

Reducing Car-dependence in Ar-Riyadh City Through the Integration of Land-use Planning and Transport

Saleh Abdulaziz Al-Fouzan

This study investigates the role which planning measures potentiality could contribute to reduce the growth of car-dependence in Ar-Riyadh city, the capital of Saudi Arabia. Complexity of modern transportation systems suggests that many factors have a significant impact on car dependence. The main focus is on land-use planning and design measures that might reduce car use and increase the choice of alternative travel modes. The study also considers other possible factors such as economic measures, management and regulation measures, and the improvement of alternative means of travel.

Based on the descriptive analysis of key trends in travel behaviour and land-use patterns of Ar-Riyadh, and on the review of the theories and models of urban structure and transportation in some major industrialised countries, the study has addressed the following key questions: (1) what are the current patterns and recent trends in travel generated by particular types of urban form and land-uses; (2) how do current planning policies and development trends influence the demand for travel; (3) what are the main lessons to be learnt form the experience of some industrialised countries regarding reducing car-dependence through planning policies; and (4) what are the likely limitations on the effectiveness of planning policies in Ar-Riyadh.

In addressing these questions this study considered the ways in which land-use planing can influence reliance on the private car by: reducing the need to travel in motorised transport; reduce growth in the length and number of motorised journeys; increasing the practicability of using non-motorised modes of travel; and encourage and increasing the choice of alternative means of travel which have less environmental impact.

The ways in which land-use planning and design measures can control dependence on the private car are considered to be through influencing: (1) the urban density, (2) urban form and the location of development, (3) the neighbourhood structure, and (4) transport infrastructure. The evidence of the study indicates that, in overall terms, the planning policies and design measures most pertinent to the objective of

reducing travel demand and encouraging use of alternative modes of travel are:

1. increasing development density (with high design standards) and population density in specific areas such as public transport corridors and major centres. This practice will influence the viability of public transport as well as walking and cycling;

2. focusing residential and facilities, with wide catchment areas attracting large numbers of people, in major public transport corridors;

3. encouraging the development of neighbourhood and district centres which offer a range of everyday community shopping, education, health etc. in addition to improving existing neighbourhood subdivision by restructuring communities to better accommodate pedestrians; and

4. limiting the development of fast-road infrastructure and encouraging the development of facilities for alternative means of travel and locating major generators of travel demand in existing centres or new centres which are highly accessible by alternative modes of travel.

In Saudi Arabia, there are no simple measures that can have direct and major effects on the car use. This is because the guiding principles in the current decision making process assume no limitation of car ownership. Given the importance of the car on Saudi Arabia, substantial limitation on its use requires fundamental measures capable of influencing people's travel demand and people's choice of mode through land-use planning. Evidence in this study suggests that in the long term, land-use planning can be use to minimise the reliance on the private car.

The data in this thesis reveals that economic measures such as road pricing, central area pricing system (area licensing), car pricing and taxation, high charges for parking meters and parking fines, increasing fuel prices, and other legislative measures, can have an important impact upon travel demand and modal choice. However, such measures are not the focus of this thesis. As mentioned, the focus of this thesis is on land-use measures that might reduce travel demand and increase the choice of alternative means of travel. However, land-use measures by themselves can only provide opportunities for reducing growth in travel demand and choice of travel modes. Therefore, they need to be supported by other measures such as economic measures, management and regulation measures, and improving alternative means of travel in order to be effective.

التقليل من الاعتماد على السيارة الخاصة في مدينة الرياض بواسطة التكامل بين تخطيط استعمالات الأراضي و تخطيط النقل والمواصلات

تناقش هذه الأطروحة موضوع الدور الذي يمكن أن تلعبه الإجراءات والمعايير التخطيطية للمساهمة في خفض النمو المتزايد في مجال استخدام السيارة الخاصة للتنقل في مدينة الرياض عاصمة المملكة العربية السعودية. إن التعقيد الحالي في تخطيط المدن ونُظم النقل الحديثة أدى إلى تأثير عوامل كثيرة في مسألة زيادة استخدام السيارة الخاصة، لذلك فإن التركيز الرئيسي في هذه الأطروحة سوف يكون على الإجراءات والمعايير التخطيطية والتصميميه التي يمكن أن تساعد في التقليل من استخدام السيارة الخاصة وفي نفس الوقت تساعد علي زيادة فُرص تواجد وسائل نقل بديله عن السيارة.
بالاعتماد على التحليلات الوصفية لظواهر سُلوكيات النقل ونمط التخطيط لمدينة الرياض كذلك بالاعتماد على دراسة النظريات وأنماط التكوين الحضري والنقل في بعض مدن البلدان الصناعية هذه الأطروحة تناقش الأسئلة التالية:

١. ما هي الأنماط الحالية والاتجاهات الحديثة للنقل الناتجة من الأنواع المختلفة للتكوينات الحضرية واستعمالات الأراضي.

٢. كيف تُؤثر سياسات التخطيط الحالية واتجاهات التنمية في زيادة الطلب على وسائل النقل.

٣. ما هي الدروس الرئيسية التي يمكن الاستفادة منها من تجارب بعض المُدن الصناعية في موضوع الإجراءات الطبقة للتقليل من استخدام السيارة الخاصة خُصوصاً بواسطة السياسات التخطيطية.

٤. ما هي المعوقات الرئيسية التي يمكن أن تمنع التأثير الإيجابي للسياسات التخطيطيـــة في مدينة الرياض.

للإجابة على هذه الأسئلة السابقة؛ اعتمدت هذه الأطروحة على الطرق التي يمكن أن تؤثر إيجابيا على استخدام السيارة الخاصة عن طريق التكامل بين تخطيط استعمالات الأراضي و تخطيط المواصلات مثل:

- تقليل الحاجة أو الضرورة لاستخدام السيارة الخاصة.
- تخفيض النمو المستمر في أعداد وأطوال الرحلات بالسيارة الخاصة.
- تشجيع و زيادة تواجد وسائل نقل بديلة عن السيارة الخاصة تكون قليلة الضرر على البيئة.

لذلك فإن الطرق التي اعتمدت في هذه الأطروحة للسيطرة على استخدام السيارة الخاصـــة للتنقل داخل المدن بواسطة الإجراءات التخطيطية والتصميميه هي:

١. التركيز على موضوع الكثافة السكانية و العمرانية.
٢. التركيز على نمط نمو المدينة وتخطيط استعمالات الأراضي.
٣. التركيز على تخطيط هيكل المجاورات السكنية (الأحياء السكنية).
٤. التركيز على تخطيط البنية الأساسية لشبكات المواصلات.

لقد بينت البراهين والأدلة الواردة في هذه الأطروحة أن الإجراءات التخطيطية والتصميميه وثيقة الصلة بموضع تقليل الحاجة لاستخدام السيارة الخاصة وفي نفـــس الوقـــت تشجيـــع استخدام وسائل نقل بديلة للسيارة هي:

١. التشجيع على زيادة الكثافة السكانية و العمرانية بمستوى تصميمـــي و بيئـــي عـــالي الجودة في وسط المدينة وفي مراكز المدينة الرئيسية وعلى الطرق المخدومة بـــالنقل

الجماعي. هذه الإجراءات يمكن أن تؤثر إيجابياً على زيادة استخدام النقل الجماعي للمسافات الطويلة وعلى زيادة استخدام المشي والدراجات للمسافات القصيرة.

٢. التشجيع على إنشاء المجاورات السكنية ومباني الخدمات العامة على الطرق الرئيسية المخدومة بالنقل الجماعي.

٣. التشجيع على إنشاء مراكز خدمات للأحياء السكنية كذلك مراكز خدمات للمقاطعات حتى توفر كثيراً من الضروريات اليومية (تسوق، تعليم، صحة ... الخ). كذلك ينبغي تحسين مخططات الأحياء السكنية الحالية بواسطة إعادة تنظيمها لتكون اكثر ملائمة للمشاة بدلاً من السيارات.

٤. التقليل من إنشاء الطرق السريعة وتشجيع إنشاء المرافق الضرورية التي تزيد من استخدام وسائل النقل البديلة. كذلك يجب وضع مباني الخدمات الهامة (مثل الدوائر الحكومية، الشركات، الأسواق ... الخ) التي تخدم كثير من الناس في مراكز المدينة الحالية أو في مراكز جديدة تكون في الحالتين مخدومة بوسائل نقل بديلة عن السيارة الخاصة.

لم تُهمل هذه الأطروحة الإجراءات الأخرى التي تم تطبيقها في كثيرا من مدن العالم مثل الإجراءات الاقتصادية، الإجراءات الإدارية و التنظيمية، كذلك الإجراءات التي تُحسن وسائل النقل البديلة. لقد أوضحت المعلومات المذكورة في هذه الأطروحة مثلاً أن الإجراءات الاقتصادية التي تم تطبيقها في بعض المدن الغربية كان لها دور في التخفيف من استخدام السيارة الخاصة وفي نفس الوقت كان لها دور في زيادة استخدام وسائل النقل البديلة. هذه الإجراءات الاقتصادية تشمل وضع ضرائب على استخدام بعض الطُرق، وضع ضرائب على دُخول أماكن معينة من المدينة، وضع ضرائب على تملك السيارة الخاصة، وضع ضرائب وعقوبات على استخدام مواقف السيارات، زيادة سعر وقود السيارات ...الخ.

بالرغم من أن الإجراءات الاقتصادية المذكورة ليست مجال تركيز هذا البحث لان مجـــال التركيز الرئيسي في هذه الأطروحة كما ذُكر سابقاً هو التكامل بين تخطيـــط اســتعمالات الأراضي و تخطيط المواصلات للتقليل من استخدام السيارة الخاصة وفـــي نفــس الوقــت الزيادة من فُرص تواجد وسائل نقل بديله إلا أن العقبة الرئيسية التي تواجه المسئولين عن تخطيط المدن و شبكات المواصلات حالياً أن الإجراءات التخطيطية لاستعمالات الأراضي بمفردها لا تستطيع التأثير الكامل في حل المشكلة لذلك تحتاج إلى دعم الإجراءات الأخرى مثل الإجراءات الاقتصادية، الإجراءات الإدارية و التنظيمية، كذلك الإجراءات التي تُحسن وسائل النقل البديلة.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

This study in general investigates the role which land-use planning can play potentiality in reducing car-dependence in Ar-Riyadh city, the capital of Saudi Arabia. The focus of the study is to examine the extent to which land-use planning could contribute to the reduction in the growth rate of car-dependence in order to minimise the incompatibility between the existing city structure of Ar-Riyadh and the socio-cultural conditions in Saudi Arabia. A change in land-use patterns and transport modes in a city of the size and growth pattern of Ar-Riyadh cannot easily be put into practice in short term. This research is carried out therefore as a study of car-dependence and involves the investigation of alternative growth options for Ar-Riyadh which would make a contribution to minimise the problem. No single improvement can resolve the problem, a new strategy and a comprehensive approach to the land-use and transport planning policies is required to control the growing car dependence. If Ar-Riyadh's authority does not investigate for Ar-Riyadh alternative planning strategies now to control the increasing car dependence and minimise car problems, this will be very difficult in the future.

Previous studies into the use of the car in urban areas have taken many different forms. The majority of them concentrate on the collection of volumetric data, such as trips per day and origins and destination studies, without considering the factors influencing the increasing car use. There is a close interactive relationship between the land-use and the transport. In this study the relationship between land-use and transport in Ar-Riyadh will be examined. The land-use pattern is directly related to the dominate transportation type. Understanding the relationship is a key to understanding urban transportation problems and the appropriate ways to reduce it.

1.1 The starting point of research: a paradox

Three decades ago in Saudi Arabian cities, most people lived in communities where walking was an essential part of getting to work, school, mosque or shop. Most of the communities were compact with mixed land-uses. Houses were located reasonably close to goods and services. Businesses and shops were concentrated and mixed to include a variety of activities around the central mosque. Communities were organised to support walking (especially for women and children) because residential districts were next to retail and service districts (walking distances). Streets were safe and pleasant for walking.

After the early Seventies, Saudi Arabia experienced a period of rapid urbanisation following the recent rate of economic growth. This has allowed the Saudi government to start expensive physical and institutional development on a grand scale which has led to dramatic changes in the urban structure of the Saudi Arabian cities. These changes were happening at a very fast rate in a very short time.

During this stage, Ar-Riyadh has grown far beyond the predictions of both area and population. This fast development growth creates many problems especially regarding planning and control. Rapid urban growth has led to extensive low-density developments, segregation of land-uses, dispersal and decentralisation of developments, lack of community centres in most new neighbourhoods, and transport policies which concentrate on building fast road infrastructure and neglect the pedestrians' requirements. In addition, an overall public transport facilities are very limited.

During the Sixties, which witnessed the origins of car dependence in Saudi Arabian cities, the government decided to control the fast urban growth of Ar-Riyadh. A coherent plan of the whole city was initiated at the beginning of the Sixties. The first attempt at comprehensive physical planning for Ar-Riyadh was undertaken by Doxiadis. The most important point regarding influencing car dependence in Ar-Riyadh that Doxiadis Master plan is based on a grid pattern with a high degree of access to the development areas,

favouring car traffic, combined with low density development, and a majority of individual dwellings.

This new urban development pattern in Ar-Riyadh has led to increasing distances between land-uses, increasing demands for travel, and increasing car ownership and car use. Therefore, the overall effect has been to create a very high level of car dependence. People walk less and depend more on motorised transport throughout the city, whereas the old cities used to be compact with high density and mixed land-uses.

In Saudi Arabia, car dependence not only has an environmental and economical impact, as in the industrialised countries, it also has a social dimension. The conversion of traditional cities from communities where people walked to communities' dependant on cars has created loss of convenience in carrying out daily activities especially for people who have limited access to cars such as women and those who are old; young; handicapped; and unable to drive.

Women are the poorly provided for in the new structure of Saudi Arabian cities. Travel for women (almost 50% of the population) between home and work, schools, shops, and public facilities becomes very difficult because the prevailing socio-cultural conditions in Saudi Arabia do not permit women to drive and the existing public transport, which is largely inefficient, does not provide adequate privacy for women. Families are highly dependent on adult males for transport. Therefore paradoxically whilst the current

structure of Saudi Arabian cities encourages car dependence, at the same time it denies women and children access to the facilities which they require.

A change in city form and transport infrastructure in future development is required in order to accommodate not only the needs of women, children, and people who have limited access to cars but also to reduce the car-dependence of the population as a whole which will lead to decrease the environmental impact of car traffic and reduce the economical cost of transport.

The city that resulted from Master Plans and development control was utterly dependent on the car as major modes of transport. As a result, there is a raped increase of car ownership and car use in Ar-Riyadh. Increases in car use lead to many problems in most of the world cities. As the volume of cars grows rapidly, roads become congested, road accidents increase, air pollution rates increase and insufficient parking spaces create even more problems.

The car, despite its flexibility, is not the whole answer to urban transportation needs. If dependence on the car continues to increase in Saudi Arabian cities, the result will be more car problems in the future. This will create more congestion, frustration, parking difficulties, car accidents, environmental pollution, health problems, more dispersal of urban growth, and more community disruption.

This conflict in Ar-Riyadh city points at several potential remedies such as: restructuring of the city, changing in the land-uses, and introducing alternative means of travel such as pedestrian ways for short distance and efficient public transport for long distance.

1.2 Objectives of the study

There are considerable recent social and physical changes in Saudi Arabian cities. The influence of using the car as major means of transport is enormous and there are signs that in the foreseeable future the problems of pollution and congestion, with their social and health consequences will reach the level experienced today in the American cities especially Los Angeles.

It is the main objectives of this thesis to investigate means and methods which could help minimising car dependence in the Saudi Arabian cities, specifically in Ar-Riyadh, for several major reasons:

- to reduce congestion, frustration, parking difficulties, car accidents, environmental pollution, health problems, and their effects caused by car transport and to make the city more sustainable;
- to minimise dispersal of urban growth and disruption of communities caused by car use;
- to render the structure of Ar-Riyadh city more compatible with socio-cultural contextual of Saudi Arabia;

- to achieve a more environmental and economical use of energy resources; and
- to help reducing the cost of management and maintenance of the city and its transport infrastructure.

1.3 Key questions

In meeting the above objectives the study will address the following key questions:

1. What are the current patterns and recent trends in travel generated by particular types of urban form and land-uses?
2. How do current planning policies and development trends influence the demand for travel?
3. What are the main lessons to be learned form the experience of some industrialised countries regarding the reduction of car-dependence through planning policies?
4. What are the likely limitations on the effectiveness of planning policies in Ar-Riyadh?

The use of the private car has many dimensions, for example: number of journeys; trip purpose; trip length; mode of travel; number of occupants; all of which can be affect by policies. The use of the private car is also affected by ease of public transport; population density; the mixture of land-uses; location of development; city form; neighbourhood structure; and distribution of amenities. Thus to affect a change in car use there are many areas at which planning policies can intervene. Some planning policies have been

found to be more effective than others. It is necessary first to identify factors operating in Ar-Riyadh. Some of these can, other can not easily be changed. Lessons can be learned form the experience of other world-wide cities. But cultural differences have to be taken into account. In this thesis, the historical development of Ar-Riyadh and key trends in travel behaviour and land-use patterns will be analysed, possible approaches to reduce car dependence will be presented, examples of other cities will be investigated, and areas of policies that can intervene in Ar-Riyadh will be identified.

1.4 Area of the study

The focus of this study is Ar-Riyadh city. Ar-Riyadh is selected for several reasons. First, it provides the best example of car dependence in the Kingdom of Saudi Arabia. Secondly, it is the capital and is undergoing rapid growth and change. Thirdly, it is the centre of government projects, the city experiencing plenty of change, most of all in its transportation infrastructure. fourth, from the point of view of research strategy, government agencies offer essential data for this study, especially the Ar-Riyadh Development Authority (ADA). Finally, as a resident the author has substantial knowledge of the city and has witnessed some of the recent development.

1.5 Methodology of the research

The specific methodology of the research are to:

1. examine the objectives and feasibility of previous transport and land-use planning policies in Ar-Riyadh.

2. study current land-use patterns and transport behaviour, trends, and their feasibility in Ar-Riyadh;

3. collect data on and review contemporary research concerning the relationship between development patterns, land-use and travel demand in some major industrialised countries;

4. consider the contribution which land-use planning policies and different planning measures can make to reduce travel demand and increase the modal choice; and

5. consider the impact of transport provision on community development and travel patterns.

This study has used a number of different approaches such as:

1. **Review of literature:** publications were reviewed concerned with the analysis of travel patterns (mode, purposes, etc.); development trends; and empirical and ex-post evaluations of land-use and transport studies in major Western countries. The review also included overall assessments of current trends in settlement patterns and in the location of specific travel-

generating uses, and the effectiveness of the planning system in influencing land-use and travel patterns.

2. **Case studies from the UK, USA and Europe**: three examples of experiences in different parts of the world were chosen which have , or have recently, attempted to integrate land-use planning and transport to reduce reliance on the car and increase the choice of alternative modes of travel. These are: (1) Copenhagen as a case study of a centralised city, (2) Los Angeles as a case study of a decentralised city, and (3) Planning policy in the United Kingdom

3. **Household questionnaire survey:** the work was also informed by the findings of a recent Residential Survey for Ar-Riyadh which was conducted by the Ar-Riyadh Development Authority (ADA) in 1987.

4. **Interview of specialists:** discussions were held with a range of planning and transport specialists in Los Angeles, San Francisco, Ar-Riyadh and Glasgow to establish their views concerning the relationship between land-use, transport infrastructure and travel demand.

1.6 Organisation of the thesis

This study is organised in twelve chapters:

- **Chapter Two**: describes the historical development of Ar-Riyadh;
- **Chapter Three**: presents the history of Ar-Riyadh's formal planning and the origins of car dependence
- **Chapter Four**: analyses key trends in land-use patterns of Ar-Riyadh;
- **Chapter Five**: analyses key trends in travel behaviour of Ar-Riyadh;
- **Chapter Six**: considers the impact of cars on the development of some cities in Western countries;
- **Chapter Seven**: assesses the environmental impact and economical cost of increasing car-use in major industrialised countries;
- **Chapter Eight**: considers the possible approaches to reducing car-dependence;
- **Chapter Nine**: presents the inter-relationships between land-use, transport infrastructure and travel behaviour;
- **Chapter Ten**: examines examples of attempts to integrate land-use planning and transport;
- **Chapter Eleven**: explores implications for land-use policy in Ar-Riyadh; and
- **Chapter Twelve**: presents the conclusions and recommendations for further research.

CHAPTER 2

THE HISTORICAL DEVELOPMENT OF AR-RIYADH

2. THE HISTORICAL DEVELOPMENT OF AR-RIYADH

Since the early 1970s, Saudi Arabia has witnessed a remarkable economic boom as a result of increased oil revenues. The Saudi government introduced a series of economic development plans to provide the highest achievable standards of living. Most of the infrastructure development of the country was completed during the mid-seventies and the mid-eighties. The rapid development of Saudi Arabian cities (*Jeddah, Makkah, Al-Madianah, Al-Taif, Al-Dammam, Al-Khobar, Al-Dhahran, Buraidah, Unaizah, Hail, Tabouk, Abha, etc.*) is well represented by the experience of Ar-Riyadh city. Ar-Riyadh receives a large share of development because it is the capital and the centre of political power. For example, in almost half a century, Ar-Riyadh has been transformed from a small traditional town covering less than one square kilometre and of 20,000 inhabitants[1] to a big modern city covering more than 1,500 square kilometres[2] with over 2,300,000

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[1] Doxiadis, 1970 in Daghistani, 1985, p.40.

[2] Estimated by A-Riyadh Municipality in Daghistani, 1985, p.102.

inhabitants.[3] This means fifteen-hundred fold increase in area and more than a one-hundred and fifteen fold increase in population.

In this chapter a variety of information will be provided to provide a better understanding of the city. First the general setting of Ar-Riyadh will be presented followed by a brief summary of the history of Saudi Arabia. After that, the history of Ar-Riyadh's urban development will be presented, leading to a concluding summary.

2.1 General setting

The Kingdom of Saudi Arabia comprises 2,300,000 square kilometres (900,000 square miles).[4] Figure 2-1 shows the national setting of Saudi Arabia. Ar-Riyadh is located almost at the geographical centre of Saudi Arabia at latitude 24-38 north and longitude 46-43 east. Ar-Riyadh lies about 600 meters above mean sea level, on a part of the great *Najd* (highland) plateau which slopes gently eastward. The city is located in the western part of the plateau, which is about 25 kilometres wide. Ar-Riyadh is situated on the eastern bank of the *Hanifah* valley. This valley runs in a north-west to south-east direction, and is generally considered to be the most important valley for cultivation in the region of the *Najd*.[5] *Najd* has never been easy to

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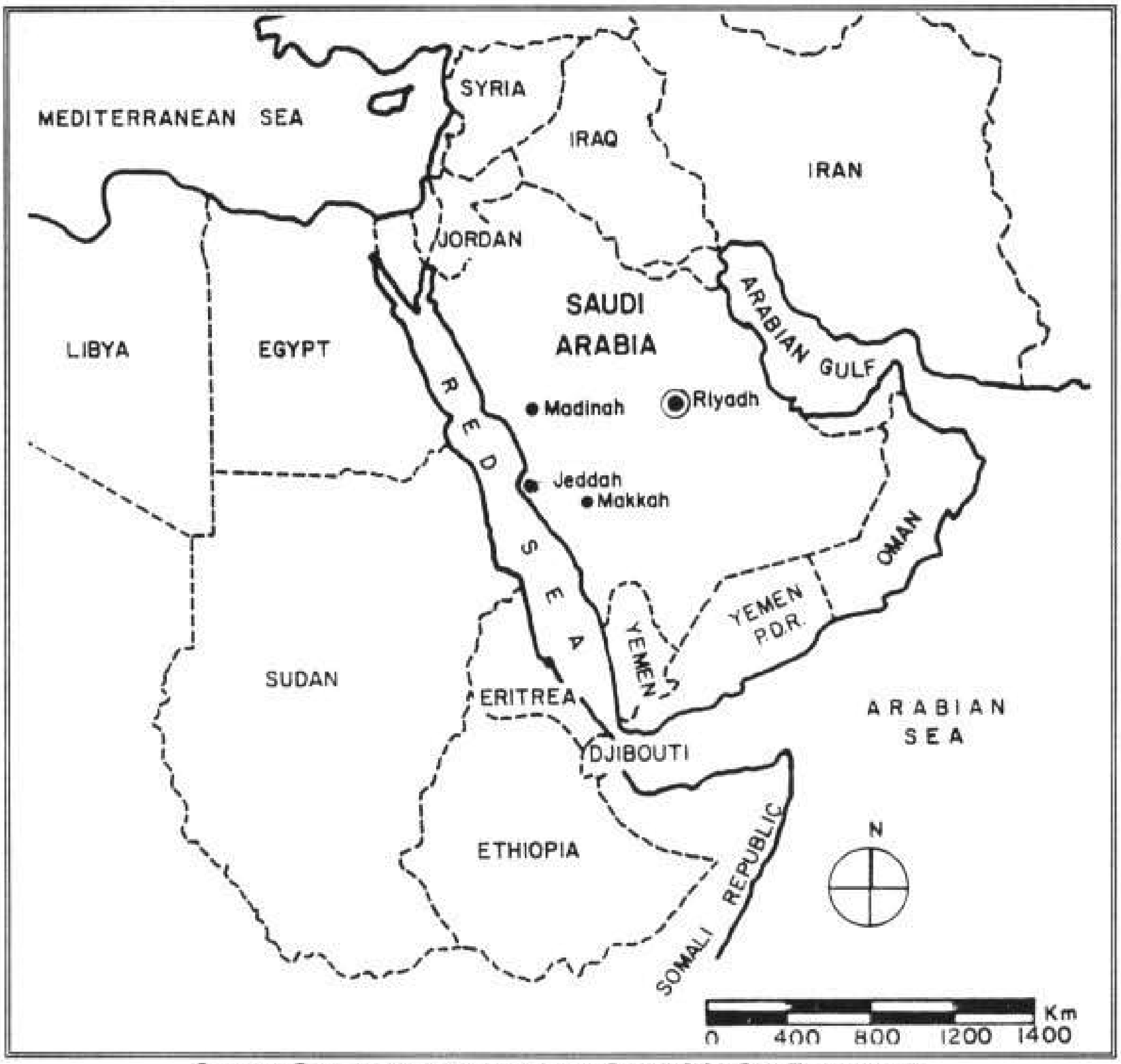
[3] Estimated by Arriyadh Development Authority, 1992, p.6.

[4] Transworld Arabian Library, 1983, p.14.

[5] Daghistani, 1985, p.22f.

reach from outside. The mountain barrier of *Hijaz* towers above the land to the west, and on the other three sides lies wilderness of sand.[6] As a result, traditionally Ar-Riyadh is relatively isolated from the other major cities.

Figure 2-1: National setting and the location of Ar-Riyadh



Source: Sert Jackson International/SAUDCONSULT, 1980, p7.

[6] Transworld Arabian Library, 1983, p.42.

2.2 A brief history of Saudi Arabia

During the last three centuries, there have been three Saudi states ruling the area. A brief history of the first, second and present Saudi states will be summarised in the following sections.

2.2.1 The first Saudi state

During the late 17th, 18th, and early 19th centuries, the first Saudi state extended over most of the *Arabian Peninsula*. The capital was *Ad-Dariyah* a few miles north of Ar-Riyadh. In actuality, Ar-Riyadh was incorporated into the first Saudi state in 1773.[7] In the early 19th century, the Ottoman sultan became alarmed at the growth of the Saudi state, and ordered his viceroy in Egypt, Mohammed Ali, to send his army into Arabia to capture the Holy Cities (*Makkah* and *Al-Madianah*) and destroy the new state. *Ad-Dariyah* was captured and destroyed in 1818.[8]

2.2.2 The second Saudi state

In 1823, Turki bin Abdullah Al Saud seized Ar-Riyadh from Mohammed Ali's forces. He entered *Ad-Dariyah* without a fight and moved immediately against Ar-Riyadh which he secured as well. He was the first to

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[7] Daghistani, 1985, p.42.

[8] Daghistani, 1985, p.42.

make Ar-Riyadh his capital. Turki rebuilt the walls of Ar-Riyadh, constructed a fortified palace in the city centre, and built a great mosque. Due to the city's expansion in the 1950's, unfortunately, none of these survived.

Under Turki's son; Feisal (grand father of King Abdulaziz, the founder of the present Saudi state), the rule of Al Saud was again extended over much of central and eastern *Arabia Peninsula*. After the death of Feisal, Ar-Riyadh was ruled by Abdullah. In the last quarter of the 19th century, the second Saudi state was dislodged from Ar-Riyadh by the Muhammad Ibn Rashidi rulers of *Ha'il* (city north of Saudi Arabia).

2.2.3 The present Saudi state

In 1902, Abdulaziz Al Saud with a small group of relatives and friends recaptured Ar-Riyadh and re-established the Saudi dynasty. This victory was the first step towards the founding of the modern Saudi state, which has since transformed most of the *Arabian Peninsula* from poverty and disorder to stability, wealth and prosperity.

2.3 The history of Ar-Riyadh's urban development

The rapid economic growth and the consequent increase in population had a clear impact on Ar-Riyadh's urban growth, land-use locations and transportation pattern. In the following sections, Ar-Riyadh's history of urban development will be presented in four stages: (1) urban development before 1900; (2) urban development between 1900 and 1950; (3) urban

development between 1950 and 1970; and (4) urban development after 1970.

2.3.1 The first stage: Ar-Riyadh's urban development before 1900

The earliest written historical references to the general area where Ar-Riyadh was later established are dated 715 BC, and refer to the existence of a town named *Hajr*.[9] In 1050 AD, references to *Hajr* were made again by a Persian traveller, Nassir Khesro, who mentions the existence of a well-fortified city surrounded by walls, with a mosque and a big market. From the 14th century onward, there are frequent references to communities in the same area, and specially *Ad-Dariyah*, which for a certain period was more significant than Ar-Riyadh.[10]

Among the earliest available sketches of Ar-Riyadh is one made by a European traveller called William Palgrave in 1863 as seen in Figure 2-2. According to Palgrave, Ar-Riyadh was a small town, square in plan and crossed by two main streets running both north-south and east-west dividing the town into four distinctive parts.[11] Palgrave's sketch shows of the following structures located in the centre: 1. The Great Square and Market Place; 2.

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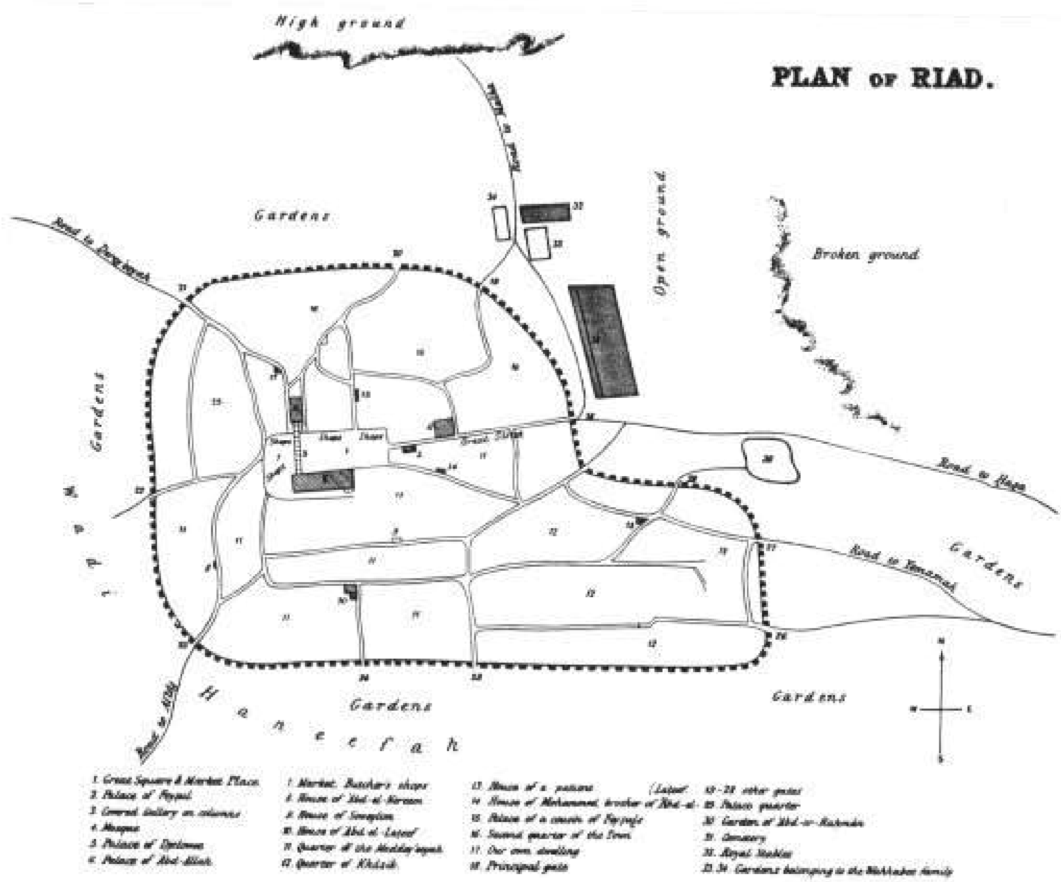
[9] Doxiadis Associates, 1970 in Daghistani, 1985, p.41f.

[10] Doxiadis Associates, 1970 in Daghistani, 1985, p.42.

[11] Palgrave, W. G., Personal Narrative of a Year's Journey Through Central and Eastern Arabia, 1862-1863, 1868, in Daghistani, 1985, p.46.

Palace of Feysul Place; 3. Covered Gallery on columns Place; 4. Mosque Place; 5. Palace of Djelowee Place; 6. Palace of Abd-Allah (Abdullah) Place; 7. Market and butcher's shops Place; 8. House of Abd-el-Kereem (Abdalkereem) (located towards south-west of the centre); 9. House of Soweylim (located towards south of the centre); 10. House of Abd-el-lateef (Abdallateef) (located towards south of the centre); 11. Quarter of the *Meddeyjeeyah* (located towards south and south-west of the centre); 12. Quarter of *Khazik* (located towards south-east of the centre); 13. House of patient (located towards south-east of the centre); 14. House of Mohammed (brother of Abd-el-lateef) (located in the centre); 15. Palace of a cousin of Feysuls (located towards north of the centre); 16. Second quarter of town (located towards north of the centre); 17. Our (Palgrave) own dwelling (located towards north of the centre); 18. Principal gate (located towards east of the centre); 19 to 28 other gates; 29. Palace quarter (located towards east and north-east of the centre); and 30. Garden of Abd-er-Rahman (Abdulrahman) (located towards east of the centre outside city's wall). In addition, the following structures are located towards north-east outside city's wall: 31. Cemetery; 32. Royal Stables; 33. and 34. Gardens belonging to the *Wahhabee* family.

Figure 2-2: Palgrave's sketch of Ar-Riyadh in 1863



Source: Daghistani, A., 1985, p.46.

2.3.2 The second stage: Ar-Riyadh's urban development 1900-1950

Before 1900, as seen in the previous Section 2.3.1, Ar-Riyadh underwent various stages of expansion and decline following the political and economic statues of the various dynasties which dominated it. After the recapturing of Ar-Riyadh in 1902 by the Saudi dynasty, King Abdulaziz immediately rebuilt the walls of the city. A detailed description of the urban growth of Ar-Riyadh in that period was provided by John Philby who was a member of the British mission to the Saudi state in 1918. He drew a plan for the city that gives a clear idea about its structure at that time. Figure 2-3 shows Philby's Plan of Ar-Riyadh. He described Ar-Riyadh at that time as the following:

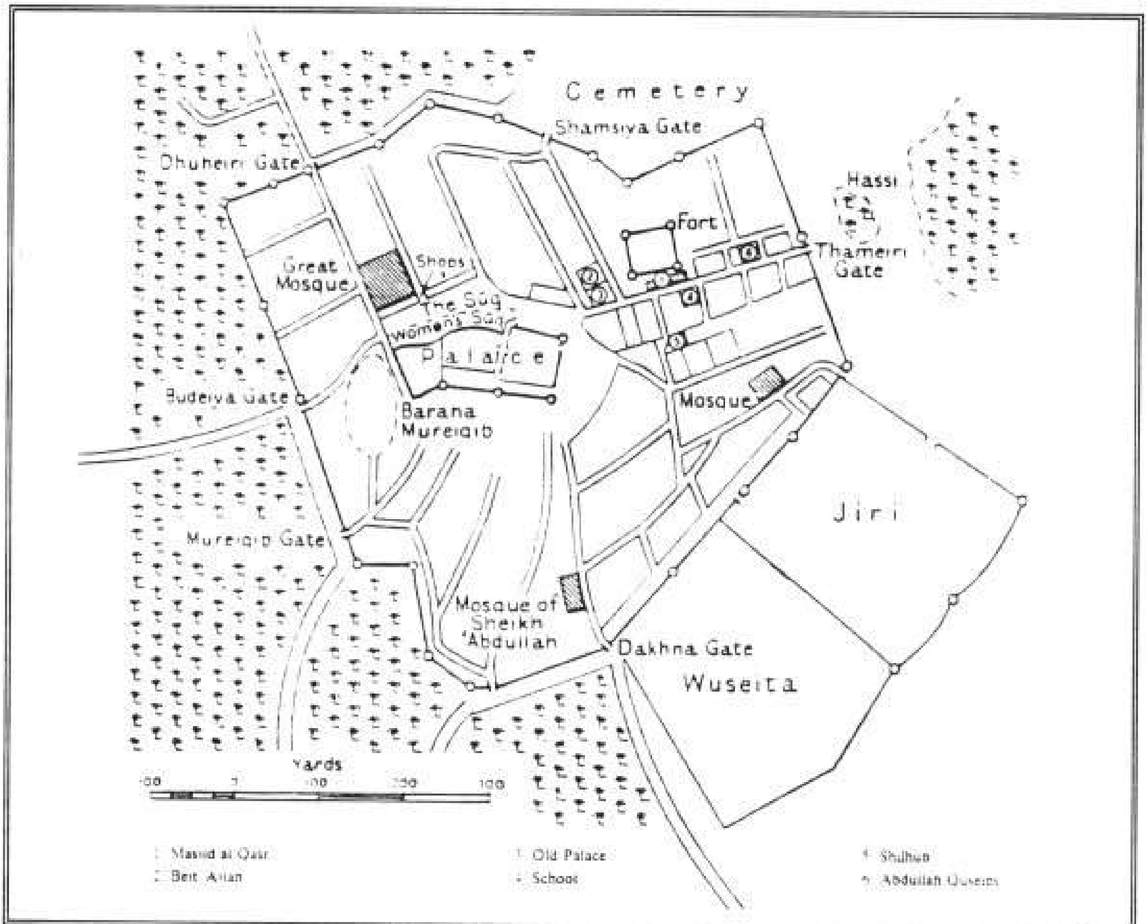
> "Riyadh is completely encircled by a thick wall of coarse sun-mud bricks, about twenty-five feet in height and surrounded by a fringe of plain sharks teeth design; at frequent intervals its continuity is interrupted by imposing bastions and less pretentious guard-turrets, circular for the most part and slightly tapering towards the top, but some few square or rectangular, varying from thirty to forty feet in height and generally projecting slightly outwards form the wall line for greater facility of defence"[12]

Philby's plan shows that the city was encircled by fortification walls and surrounded by palm trees. The outside wall was fitted with almost nine major gates (Dhuheiri Gate, Budeiya Gate, Mureiqib Gate, gate near mosque

[12] Philby, 1922, in Daghistani, 1985, p.58.

of Sheikh Abdullah, Dakhna Gate, two gates near Jiri, Thameiri Gate, and Shamsiya Gate). In the middle of the city, the plan shows a major palace, the *Suq* (market) and women's *Suq* (women's market). The plan also shows some major mosques, a school, palaces and the main fort. The scale of the city is waking distance (less than 900 by 900 yards).

Figure 2-3: Philby's Plan of Ar-Riyadh, 1918



Source: Daghistani, 1985, p.58.

At the beginning of this century, pedestrian and animals were used for transport in Ar-Riyadh. In the 1920s and possibly earlier, cars were introduced into Saudi Arabia.[13] By the beginning of the 1930's, Ar-Riyadh's physical transformation had begun as a result of the development of tracks for car traffic and later the development of an airport. In the 1920s, the city had a radio station which was part of a network connecting major Saudi cities. These developments helped break the traditional isolation of the city.

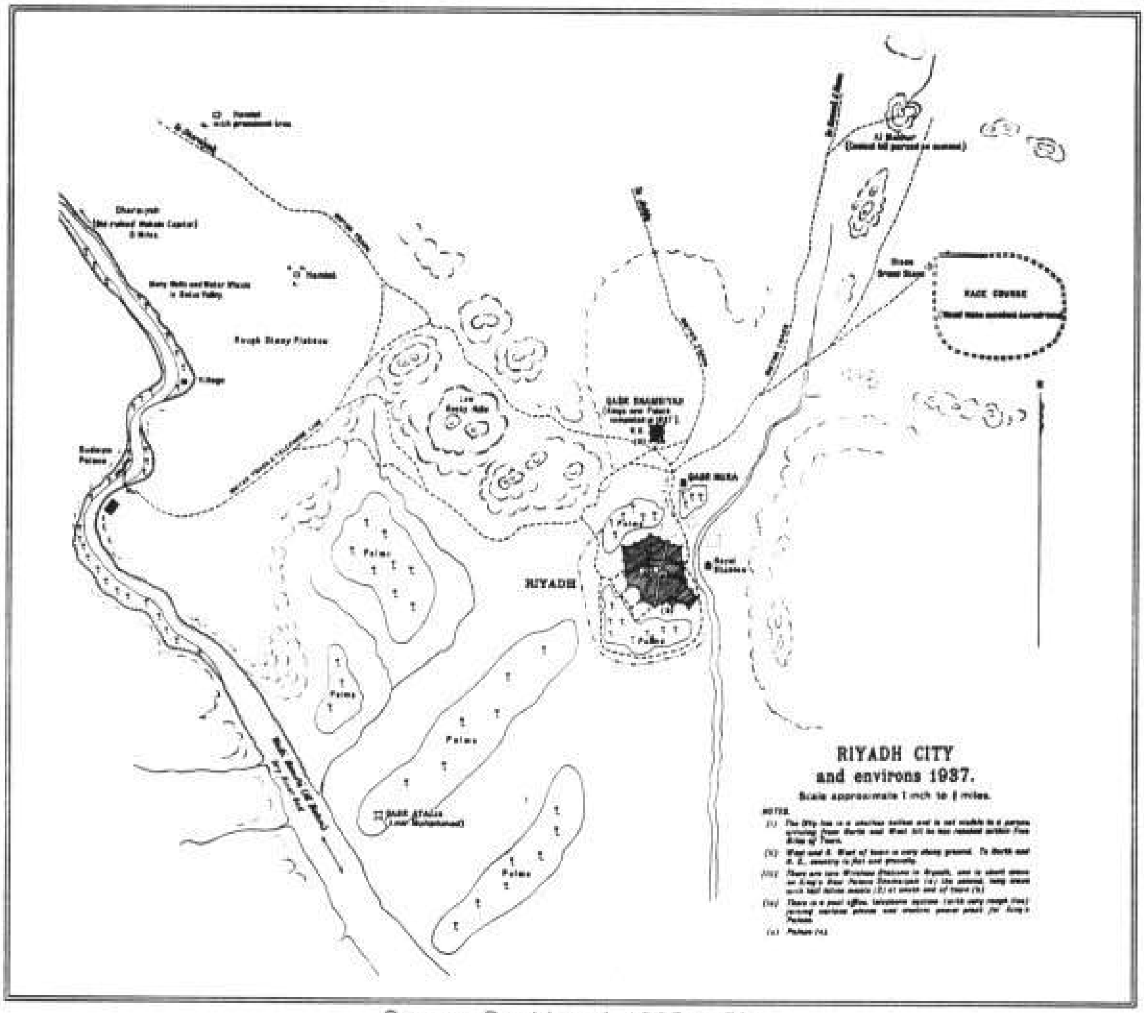
Figure 2-4 shows Dickson's Plan for Ar-Riyadh and environs in 1937. The plan shows *Wadi Hanifah* (Hanifah Valley) and physical transformations outside the fortified walls of Ar-Riyadh such as the palaces *Qasr Shamsiyah* (King's new Palace completed in 1937), *Qasr Nura*, *Budaiya* Palace, and *Qasr Ataja*. In Dickson's Plan for Ar-Riyadh it is evident that introduction of cars allows physical transformations outside the fortified walls of Ar-Riyadh. Motor tracks to the new palaces and surrounding areas are clear in the Dickson's Plan which indicates that cars were used at that time. According to Dickson notes in the plan:

> "(i) The city lies in a shallow hollow and is not visible to a person arriving form North and West till he reached within five miles of town.
>
> (ii) West and N. West of town is very stony ground. To North and N. E. country is flat and gravely.
>
> (iii) There are two Wireless Stations in Riyadh, one is short wave on King's New Palace Shamsiyah (a) the second, long wave with tall lattice masts at south end of town (b).

[13]Nawwab, Ismail et al., 1981, p.160.

(iv) There is a post office, telephone system (with very rough line) joining various palaces and electric power plant for King's Palace."[14]

Figure 2-4: Dickson's Plan for Ar-Riyadh, 1937



Source: Daghistani, 1985, p.59.

[14] Dickson, 1937 in Daghistani, 1985, p.59.

2.3.3 The third stage: Ar-Riyadh urban development (1950-1970)

In the 1950's the rate of physical change in Ar-Riyadh was increasing. The city walls were demolished. Peace and stability, combined with increasing wealth from oil production generated significant growth. According to Daghistani, modern facilities of all kinds came to the city during this period: electricity replaced kerosene lamps; asphalt roads were laid; telephone networks and motorised water pumps were installed; schools and colleges were established and hospitals and ministerial buildings followed; newspapers appeared and then television was introduced.[15]

By the 1950s, a network of roads connected Ar-Riyadh with the eastern and western regions and in 1951 the railway linking Ar-Riyadh with the city of Ad-Dammam was opened. This was followed by the opening of the Ar-Riyadh Airport (now replaced by a new airport called the King Khaled International Airport, located about 35 Km. north of the city centre).

Figure 2-5 shows Baker's plan of Ar-Riyadh in 1953. The plan is almost like Dickson's plan of Ar-Riyadh in 1937 except for the following additions: an Airport towards the north of the original city, the Crown Prince's Palace towards the north-west, and some new communities around the original city. Moreover, the plan shows an area towards north-west called

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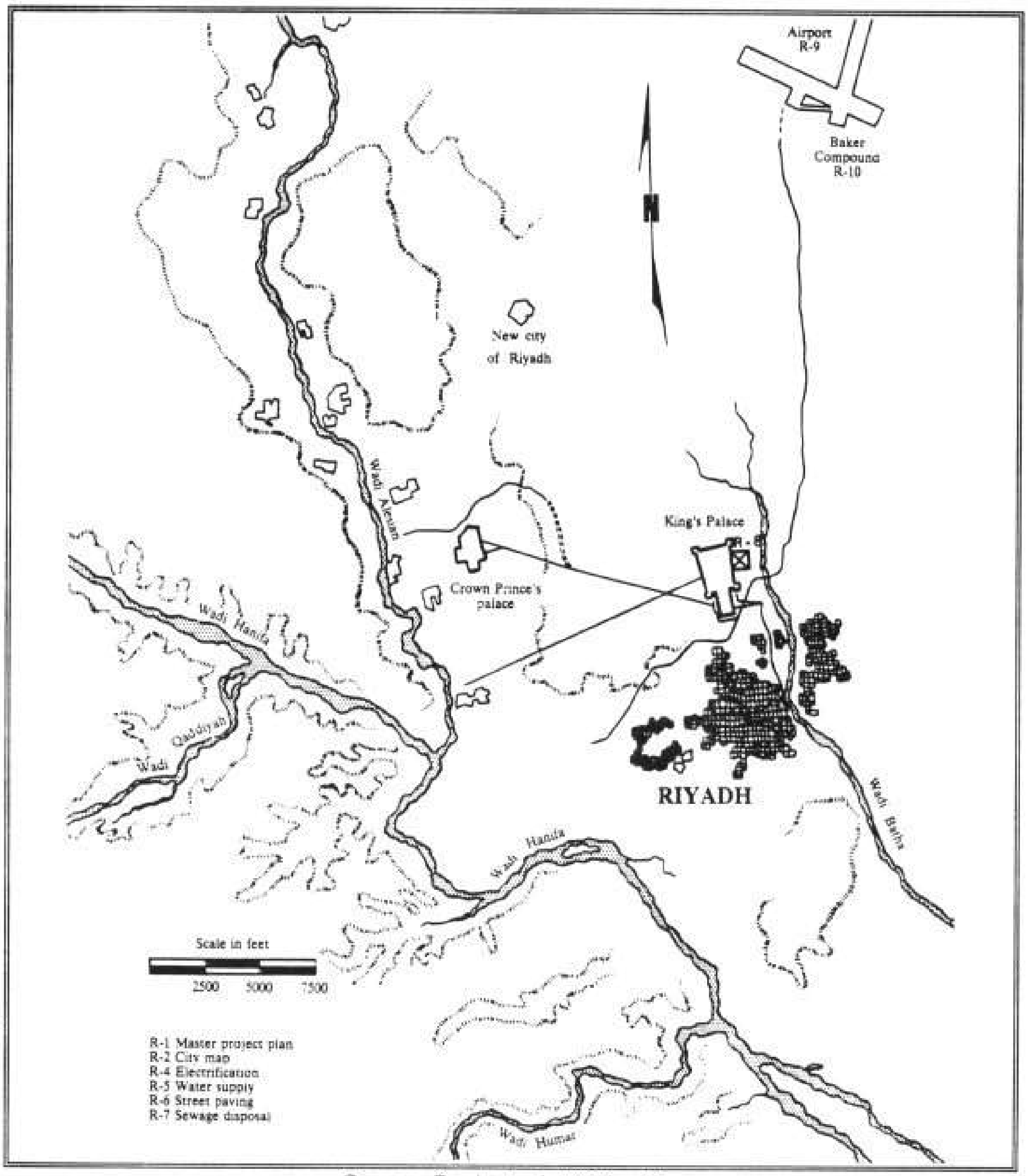
[15] Daghistani, 1985, p.77.

new city of Riyadh (*Nasiriyyah* quarter) and some communities developed around *Wadi Alesian* (Hanifah Valley).

Figure 2-5: Baker's plan of Ar-Riyadh, 1953



Source: Daghistani, 1985, p.71.

In 1953, the government decided to transfer all its major ministries from the city of Jeddeh to Ar-Riyadh. Major governmental buildings were constructed in the north part of the city on both sides of *King Abdulaziz Street* (Airport Road) to accommodate that movement. The Ministry of Finance initiated a City Planning operation in the new quarter *Al-Malaz*, north of the city, to accommodate its employees. The planning concept of this quarter consists of wide streets and low densities, in contrast to the traditional space pattern of the Ar-Riyadh ancient quarters. In the fifties, *Al-Malaz* became a pattern for urban design which guided the physical organisation of Ar-Riyadh's new quarters. Figure 2-6 shows part of Al-Malaz housing project in Ar-Riyadh and Figure 2-7 shows traditional pattern of urban development in Ar-Riyadh.

According to the Arabic Institution for Urban Development, this development encouraged the creation of the first middle and upper-income suburban development in the northern part of the city (*Al-Malaz* and *Al-Muraba*), followed by the establishment of the *Al-Badiah* suburban development to the west of the city. These suburbs were arranged with a minimum plot size of 500 square metres and a minimum street width of 15 metres. In these new suburbs, modern concrete and red brick were used in the construction of all houses, replacing the traditional mud buildings.[16]

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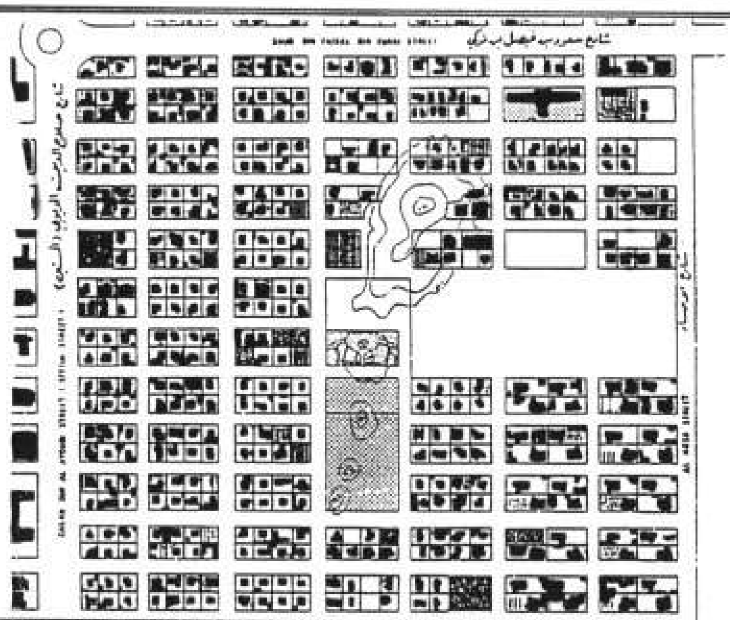
[16] The Arabic Institution for Urban Development, 1983, in Telmesani, 1989, p.72f.

Figure 2-6: Part of Al-Malaz housing project in Ar-Riyadh



Source: after SCET, Riyadh: Action Mater Plan, Technical Report No. 3, 1977, p.88.

Figure 2-7: Traditional pattern of urban development

Source: Daghistani, 1985, p.129.

Figure 2-8 shows Ar-Riyadh nodes of growth in 1950s. These nodes are: (1) an Airport towards north and the ministries developed around the Airport Road; (2) *Al-Malaz* quarter and the Railway Station towards north-east; (3) *Al-Nasiriyyah* quarter towards north-west; (4) Al-Shumaysi quarter and Al-Badi'a quarter towards the east; and (5) *Manfuha* community towards the south. Moreover, the plan shows a major network of roads connecting Ar-Riyadh with the Eastern Regions; *Ad-Dariyah* (the capital of the first Saudi State) located a few miles north-west of Ar-Riyadh; Al-Qasim Regions (north-west); Makkah city (south-west); and Al-Kharj town (south-east). According to Al Sheikh, roads were built to connect Ar-Riyadh with the rest of the country. Prior to 1955 there were no asphalt roads between Ar-Riyadh and any other city. The first project was the 53 mile Ar-Riyadh-Al-Kharj road which was completed in 1955.[17]

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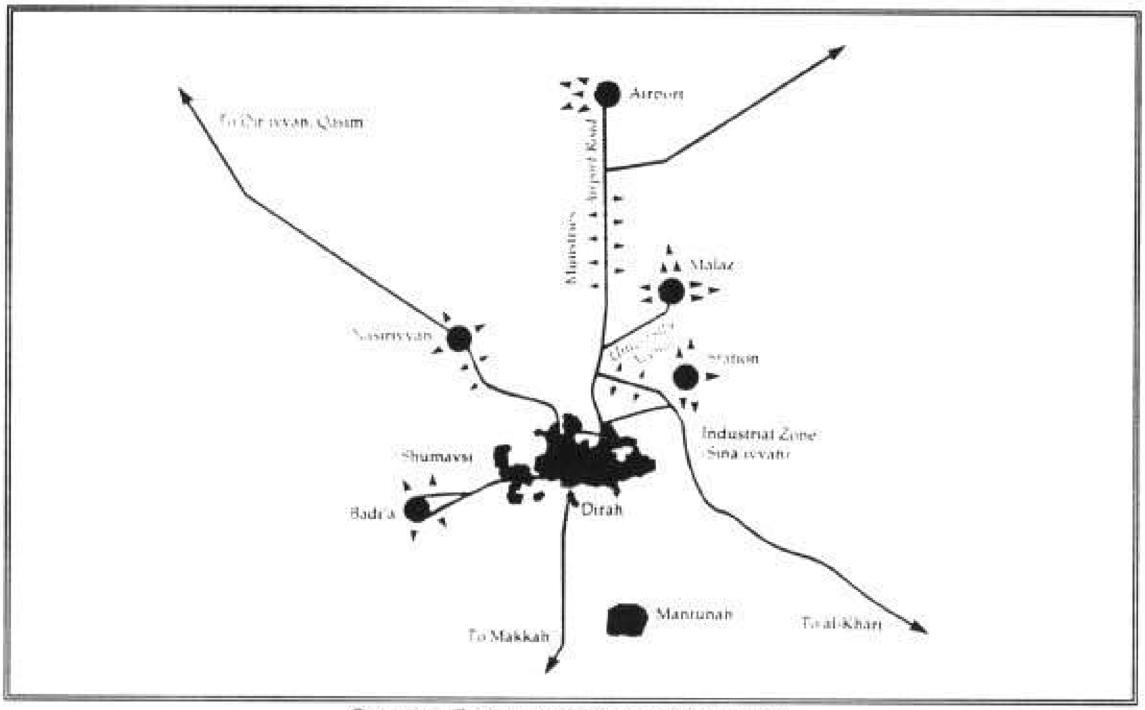
[17] Al Sheikh, A., 1981, p.29.

Figure 2-8: Ar-Riyadh nodes of growth in 1950s



Source: Facey, William, 1992, p.322.

2.3.4 The last stage: Ar-Riyadh's urban development after 1970

The rapid increase in oil revenues in the seventies has allowed the Saudi government to start expensive physical and institutional development, a large part of which went to the capital city of Ar-Riyadh. The rate of urban growth in Ar-Riyadh during the seventies and the eighties can rarely have been exceeded by any of the world's cities. In the eighties, Ar-Riyadh has

grown far beyond the predictions of the first Master Plan[18] in both area, population, and car traffic. In the following sections, urban growth, population growth, and car traffic growth will be summarised.

(a) Urban growth

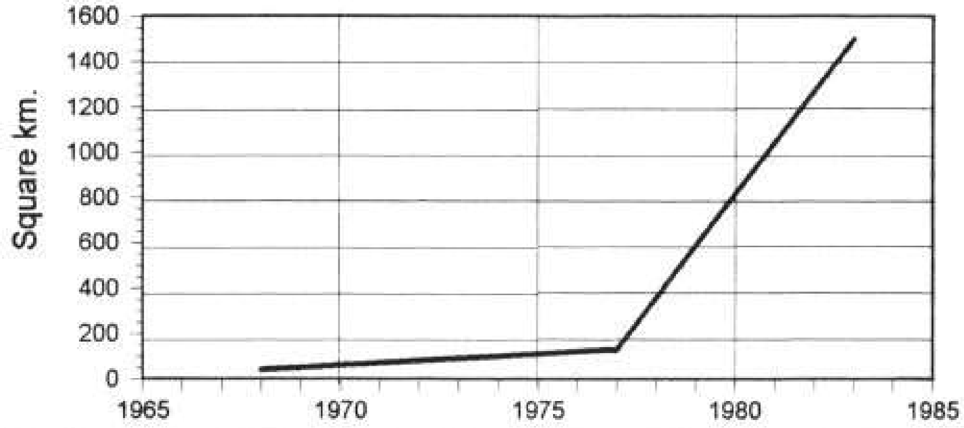
The area of Ar-Riyadh increased far beyond any prediction. In 1968 the developed area of Ar-Riyadh encompassed only 40 square kilometres, and in 1977 the built-up area of Ar-Riyadh extended to 130 square kilometres (73 square kilometres of the old city centre plus 57 square kilometres developed as suburban areas).[19] In 1983, the city area reached 1,500 square kilometres.[20] As shown in Figure 2-9, between 1968 and 1977 the urban area of Ar-Riyadh increased over 3 times in size and between 1977 and 1983 the urban area of Ar-Riyadh increased over ten times in size with low density development. Moreover, Figure 2-10 summarises the stages of growth of Ar-Riyadh from the 1930 until 1988. The plan shows that city growth was limited until 1970 and increased dramatically after the seventies.

[18] The first Master Plan of Doxiadis Associates will be discussed later in Chapter 3.

[19] SCET International/SEDES, in Arriyadh Development Authority (ADA), 1987, p. 53.

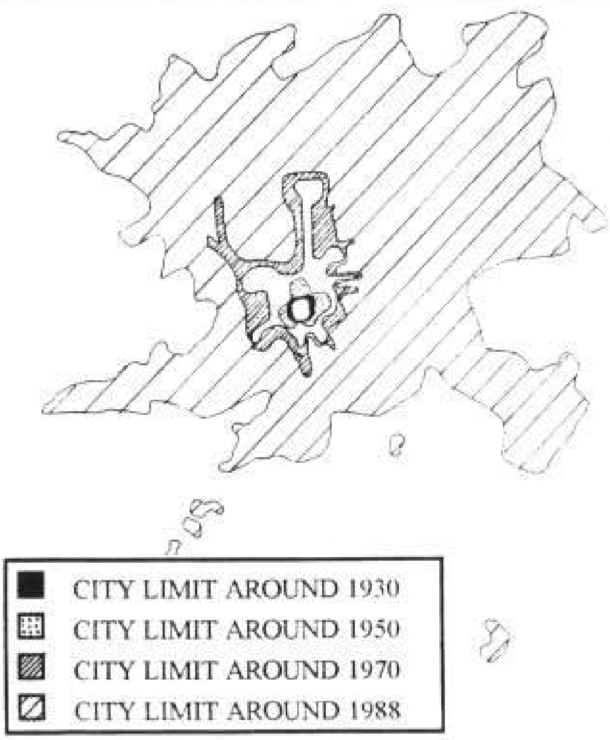
[20] Estimated by A-Riyadh Municipality, in Daghistani, 1985, p.101f.

Figure 2-9: Urban growth of Ar-Riyadh



Source: Graph developed by author based on SCET International/SEDES, in Arriyadh Development Authority (ADA), 1987, p.53 and Daghistani, 1985, p.101f.

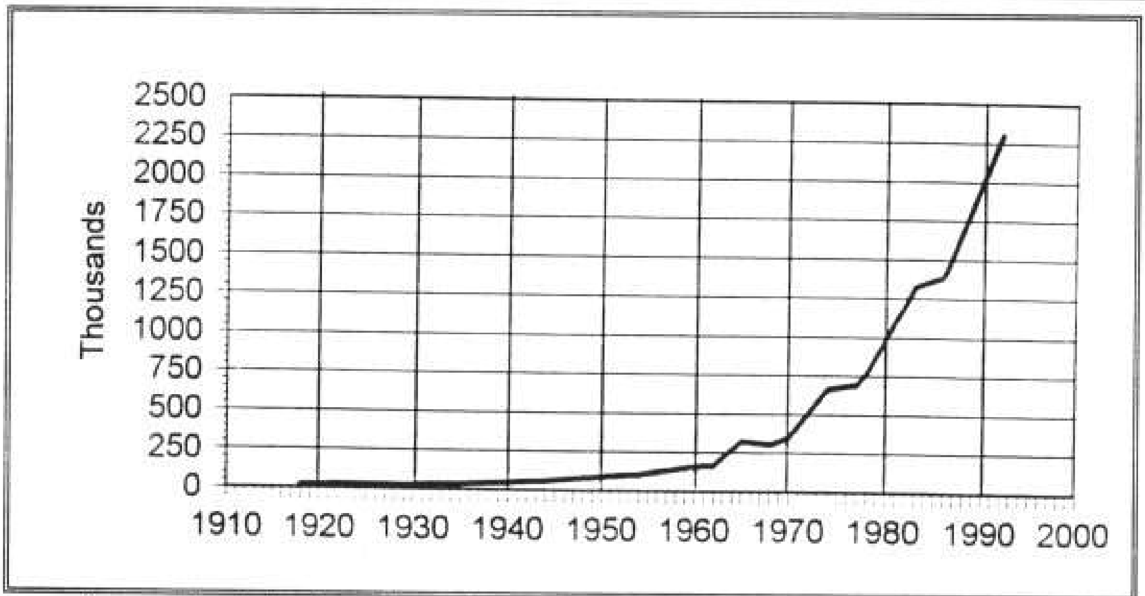
Figure 2-10: Ar-Riyadh's stages of growth



(b) Population growth

Since 1968, the population of Ar-Riyadh has been consistently increasing at a remarkable rate exceeded 9 percent. Ar-Riyadh experienced a doubling in population in less than a decade, from about 300,000 to over 600,000 between 1968 and 1977 and form 600,000 to almost 1,500,000 inhabitants by the year 1983.[21] Figure 2-11 summarises the population growth of Ar-Riyadh between 1918 and 1992.

Figure 2-11: Population growth of Ar-Riyadh (1918-1992)



Source: Graph developed by author based on Daghistani, 1985, p.78 and Arriyadh Development Authority, 1992, p.6.

[21] Daghistani, 1985, p.89

The reason behind this sudden increase in the rate of population growth, as mentioned before, is employment opportunities. A large number of experts and workers were brought from all over the world to help in the country's development process. According to Daghistani, for several years during the last decade Ar-Riyadh was called the largest development site in the world. By the year 1981, over two billion Saudi Riyals (almost £ 358,000,000) worth of infrastructure projects alone were underway.[22] Such a level of development naturally attracted a large number of individuals and companies seeking employment from both inside and outside Saudi Arabia. By the year 1977 the total foreign population in Ar-Riyadh reached 144,900, constituting 21% of the total population.[23] This number was increased by an addition of 420,000 foreign immigrants between 1977-1983, producing a total of 42% of the population of the city. This ratio, however, declined to 39% by the year 1986, and even less by 1988, due to completion of most of the infrastructure projects.[24] Employment opportunities within the capital also caused many Saudi citizens in other regions of Saudi Arabia to migrate to Ar-Riyadh. For example, the number of Saudi immigrants to the city of Ar-Riyadh was estimated to be 15,000 persons a year in 1986.[25]

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[22] Daghistani, 1985, p.77.

[23] Estimate on the basis of data from ADA, 1987, in Telmesani, 1989, p.66.

[24] Telmesani, 1989, p.66.

[25] Arriyadh Development Authority (ADA), 1987, p.136.

In 1992, the Arriyadh Development Authority (ADA) estimated Ar-Riyadh's population at approximately 2,300,000.[26] Table 2-1 summarises the various population estimates for Ar-Riyadh from 1862 until 1992.

Table 2-1: The various estimates of population growth for Ar-Riyadh

Year	Population	Annual Growth	Sources
1862	7,500	- -	W. G. Palgrave
1918	19,000	1.6	H. St. John Philby
1930	27,000	3.2	William Rugh
1935	36,000	5.9	Town Planning Office Building
1940	47,000	5.5	Survey (T.P.O.)
1944	61,000	5.4	Twitchell Report on (T.P.O.)
1949	83,000	6.4	(T.P.O.)
1954	106,000	5.0	(T.P.O.)
1960	160,000	8,6	(T.P.O.) Adjusted by Doxiadis
1962	169,000	- -	(T.P.O.)
1965	321,000	7.6	Mohamad Ridha Al-Jassim
1968	300,000	9.1	Doxiadis Household's Survey
1970	350,000	- -	Dr. Al Sharif, doctoral thesis
1974	662,000	- -	Population Census of 1974
1977	690,000	9.7	RAMP Socio-economic Survey
1978	760,000	9.7	Forecast from 1977 data
1981	1,100,000	9.7	Municipality Estimate
1982	1,206,700	9.7	Daghistani forecast from 1977-81 data
1983	1,323,750	9.7	Daghistani forecast from 1977-82 data
1983	1,500,000	- -	Municipality estimate
1986	1,389,174	1.6	Arriyadh Development Authority estimate
1992	2,300,000	9.6	

Source: After Daghistani, 1985, p.78 and Arriyadh Development Authority, 1992, p.6.

[26] Arriyadh Development Authority (ADA), 1992, p.6.

(c) Car traffic growth

The growth of car traffic within Ar-Riyadh city is directly related to the increase in population, motorization and mobility.[27] By comparing the survey conducted by Doxiadis in 1968, and the ADA survey of 1987, the increase within these various parameters can be estimated for Ar-Riyadh as seen in Table 2-2. The figures indicate that between 1968 and 1987, growth was extremely rapid; the population increased 4.5 times, the number of cars increased 30 times and the number of daily person trips increased 2.14 times.

Table 2-2: Comparison of population, motorization and mobility

	Doxiadis Survey[28] 1968	ADA Survey 1987	Increase Factor 1968 / 1987
Population	280,000	1,263,530	4.5
Number of cars per 100 Inhabitants	9.6	20	2.1
Daily person trip rates	1.0	2.14	2.14
Number of cars	(8261)[29]	250,600	30

Source: Author based on SCET International data, 1979, p.17 and 184.

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[27] SCET International/SEDES, 1979, p.17.

[28] SCET International/SEDES, 1979, p.17 and 184.

[29] Number of cars in 1970.

In conclusion, Ar-Riyadh passed through different periods of development during this century. When Al Sheikh examined the internal structure of the Middle Eastern cities he identified three major periods of developments similar those of Ar-Riyadh. These periods are as the following:

> "...[1] prior to the contact with the West, [2] the impact of the West, and [3] the contemporary pattern. During the first period, Muslim cities were compact, small, divided into quarters and surrounded by walls. The second period (and as a result of the contact with the Western culture) saw the creation of a new city side by side the old existing city. The segregation of the old city's population along the lines of occupation and origin persisted. Through colonial imposition several developments took place: creation of new transportation and communication systems including newly paved streets, old city walls were demolished, new commercial establishments were created, and so forth. Contemporary Middle Eastern cities owe their internal structure to the events and processes of these two period as well as to what has taken place since the political independence of Middle Eastern countries"[30]

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[30] Al Sheikh, A., 1981, p.44.

2.4 Summary

In this chapter, a brief general setting of Ar-Riyadh is presented followed by a brief history of Saudi Arabia. The urban development of Ar-Riyadh is explored by identifying four particular stages. In the third stage, the Ministry of Finance initiated a City Planning operation in the new quarter *Al-Malaz*, north of the city, to accommodate its employees. The planning concept of this quarter consists of wide streets and low densities, in contrast to the traditional space pattern of the Ar-Riyadh ancient quarters. In the fifties, *Al-Malaz* became a pattern for urban design which guided the physical organisation of Ar-Riyadh's new quarters.

The last stage which started at the beginning of the Seventies is considered to be the most influential stage, associated with the rapid increase in oil revenues. This has allowed the Saudi government to start expensive physical and institutional development on a grand scale. During this stage, Ar-Riyadh has grown far beyond the predictions of both area and population. This fast development growth creates many problems especially regarding planning and control. In the next chapter, history of Ar-Riyadh's formal planning and the origins of car dependence will be investigated.

CHAPTER 3

HISTORY OF AR-RIYADH'S FORMAL PLANNING AND THE ORIGINS OF CAR DEPENDENCE

3. HISTORY OF AR-RIYADH'S FORMAL PLANNING AND THE ORIGINS OF CAR DEPENDENCE

In the previous chapter, the historical development of Ar-Riyadh was summarised. In this chapter a variety of information regarding Ar-Riyadh's formal planning will be provided. Introduction to the development of Saudi Arabian cities will be presented followed by a brief account of the formal planning before the Sixties. Then formal planning of Ar-Riyadh after the Sixties will be studied which witnessed the origins of car dependence in Saudi Arabian cities. This will include: the Doxiadis Master Plan, the SCET International Revised Master Plan, and the work of the High Commission for the Development of Ar-Riyadh. Finally a concluding summary will be presented. Most data for this chapter were predominantly obtained from two sources (Daghistani, 1985, and Chaline & Fares, 1986) because no other sources were available.

3.1 Introduction

The Saudi Arabian cities have increased rapidly in population and area in recent years. Since the early 1970's, Saudi Arabia has been experiencing a period of rapid urbanisation following the recent rate of

economic growth. The changes have happened, and are still happening, at a very fast rate in very short time. By 1987, about 73% of the country's population were living in urban areas compared to 10% in 1947.[1] This means; in only 40 years, urbanisation in Saudi Arabia jumped from 10 percent to 73 percent.

The impact of recent growth is indeed enormous, creating an entirely new living environment. The physical as well as the social structures of the Saudi cities have undergone dramatic change. There are many reasons for this: the rapid growth in urban population (natural growth due to fertility, and growth due to rural migration and international immigration); the rise in income level; the introduction of modern technology especially the technological changes in urban transportation; the increasing car ownership and uses; the introduction of foreigner consultants; the exposure to different cultures and new-fashioned ways of life; and the major improvement in living standards. This has created a period of difficult transaction between tradition and modernity.

The rapid growth phenomena associated with the Saudi urbanisation have the effect of speeding up developments and transport infrastructure. The internal old structures of most of the Saudi Arabian cities have been greatly changed. New residential, commercial and industrial districts,

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[1] Brown, L. Carl, 1987, p.28.

motorways, streets, and bridges have been built from scratch to accommodate more people and more cars. The traditional irregular narrow and twisted streets have been replaced by new motor-ways and bridges to accommodate the increasing car traffic. Most centres of the Saudi Arabian cities experienced almost all these recent changes. Many traditional communities and houses have been destroyed to make room for new streets, parking spaces and other transportation facilities. Low density residential subdivisions have spread out to farther distances from the old city centre.

3.2 Formal planning before the Sixties

According to Al-Hathloul and Ur-Rahmaan, the first forms of city planning in Saudi Arabia emerged during the Thirties, with two models. The first model is the Royal Decree in 1937, establishing a planning system concerned with the municipal responsibilities for the management of urban space. In the second model of 1938, a new type of urban structure was introduced by ARAMCO (the American Oil Company), in *Ad-Dhahran* city (in eastern Saudi Arabia), completely breaking away from the traditional irregular city layout and introducing the grid pattern of modern American

style. It was accompanied by a new type of dwelling: the free-standing villa in comparison to the traditional compact houses. [2]

Ar-Riyadh's first extension beyond its fortified walls took place during the Thirties, and the walls were demolished in 1949. According to The Arabic Institution for Urban Development, during this period, the city witnessed the first relatively organised planning, in which an area to the south of the city was subdivided into small land lots of 8 by 8 metres which were given to the new settlers from rural areas. This area is currently called as *Manfuha*, the old city.[3]

3.3 Formal planning of Ar-Riyadh after the Sixties

Throughout history the structure and physical form of most of the World's cities have not remained static, but have changed continually. During the last half century, adoption of the car for urban transportation strongly influenced the structure and physical form of most of the world's cities. The car has become a requirement to modernity especially in car oriented societies.

The origins of car dependence in Saudi Arabian cities started during the Sixties. As a result, a coherent plan of the whole city of Ar-Riyadh was

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[2] Al-Hathloul and Ur-Rahmaan, 1985, in Chaline, C. and Fares, A., 1986, p.203.

[3] The Arabic Institution for Urban Development, 1983, in Telmesani, 1989, p.71.

initiated at the beginning of the Sixties when the government decided to control the city's urban growth, the location of various land-uses, and the installation of major infrastructure networks. In the following sections, the history of formal planning in Ar-Riyadh is presented in order to create a better understanding of the city. This will contain the Doxiadis Master Plan; the Revised Master Plan by the SCET International; and finally the work of the High Commission for the Development of Ar-Riyadh.

3.3.1 The Doxiadis Master Plan

Over the last 25 years, during the time in which the number of cars has increased more than ten folds, traffic problems in Ar-Riyadh have developed so rapidly that the situation is becoming critical. The government has realised the importance and seriousness of the urban growth and transportation problems. It has begun tackling some of these problems through different approaches. The first attempt at comprehensive physical planning for Ar-Riyadh was undertaken by the Town Planning Office of the Ministry of Interior for Municipal Affairs (the predecessor of the Ministry of Municipal and Rural Affairs). This involved the preparation of the first Master Plan for the city. Doxiadis was appointed in 1968 as consultant for the development of this planning scheme for the city. In 1971, the Master Plan of Ar-Riyadh was submitted to the Council of Ministers and was approved in

1973.[4] The purpose of the study as set out in the Ministry's contract was as follows:[5]

1. To estimate the potential growth of the city, on the basis of its economic, administrative, transportation, and other functions;
2. To estimate the approximate size of the city in the target dates set for the years 1975, 1980, and 2000 in terms of population and area needs;
3. To define the location of its major functions such as civic and commercial areas, administration, industry, education, health, sports, recreation etc.;
4. To provide a final plan as framework which will direct and control the future growth of the city;
5. To foresee and divide the phases of development for the target years that were set; and
6. To provide the outline of the development programme up to the year 2000, and immediate development programmes for the first two 5-year periods up to the year 1980.

According to Daghistani, the Master Plan report identified a large number of problems which should be tackled by the plan. Amongst the most important ones which related to the transportation issue was the effect of unplanned city growth. The consultant mentioned that in the past, Ar-Riyadh has grown haphazardly outwards "in a concentric form" around the periphery of the initial settlement. As a result most residential areas were poorly organised and roads had been constructed without taking into account community structure and transport needs. There was an absence of well

[4] Chaline, C. and Fares, A., 1986, p.204.

[5] Doxiadis Associates, 1971, in Daghistani, 1985, p.154.

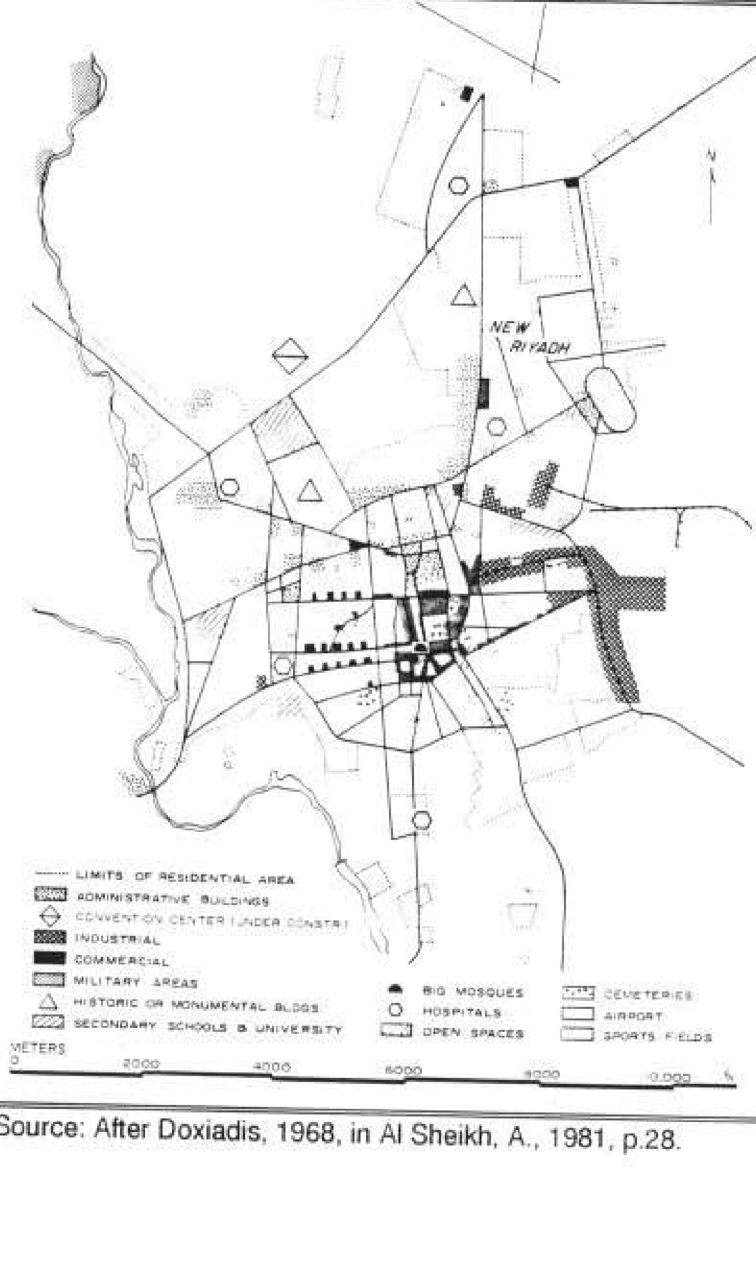
defined neighbourhood centres and a lack of amenities such as markets, schools, dispensaries, heath facilities, playgrounds and parks. In 1971, the consultant concluded that this type of random development was not appropriate and the "concentric pattern" was not suitable for future growth. The consultant observed that without appropriate planning, new developments were unsatisfactory in their facilities, number and location. There was over concentration of uses in the centre of the city which required the daily movement of greater numbers of people in and out of the centre than the existing streets could support. Services were not decentralised and located in and around the central business district. This created a two-fold problem; congestion of the city centre and a lack of facilities in new residential areas. The problem of traffic congestion in the city centre was exacerbated by the fact that fast moving through traffic mixed with slow moving local traffic within the centre. In 1968 there were no by-pass roads connecting the north with the south. Not only was there a large volume of traffic in the city centre there was also a large number of pedestrians which interfered with the flow of traffic.[6]

Ar-Riyadh's existing land-use in 1968 is presented in Figure 3-1. The plan shows expansion of Ar-Riyadh in all directions especially towards the north and east. Moreover, the plan shows a concentration of most facilities

[6] Doxiadis Associates, 1971, in Daghistani, 1985, p.154ff.

and services in the city centre. The size of the city is relatively small compared with the size of the city today: it is less than 8 km in the east-west direction and less than 12 km in the north-south direction.

Figure 3-1: Ar-Riyadh existing land-use in 1968



Source: After Doxiadis, 1968, in Al Sheikh, A., 1981, p.28.

(a) The main principles of the Doxiadis Master Plan

Doxiadis was applying a planning philosophy of new towns with neighbourhood concept which was prevailing in the 1960s. The main goal of the Doxiadis Master Plan was to provide guidelines for the form, size and structure of future land-uses. The Master Plan was based on three main principles as Daghistani mentions:[7] (i) A flexible structure; (ii) A balanced distribution of facilities and services; and (iii) A hierarchy of transportation systems. A description of each principle will be presented in the following.

(i) A flexible structure

A flexible structure which could cope with any rate of growth was considered to be the first requirement of the master plan. The original Doxiadis Master Plan proposal for the year 2000 is illustrated in Figure 3-2. It shows a central north-south spine designated for commercial business and civic developments. On either side of the spine the city is developed on grid structure which allows the city to grow outwards. Services and activities which were previously concentrated in the centre are relocated thus reducing city centre congestion.[8] There are secondary spines in east-west direction designated for administration, district commercial and civic centre.

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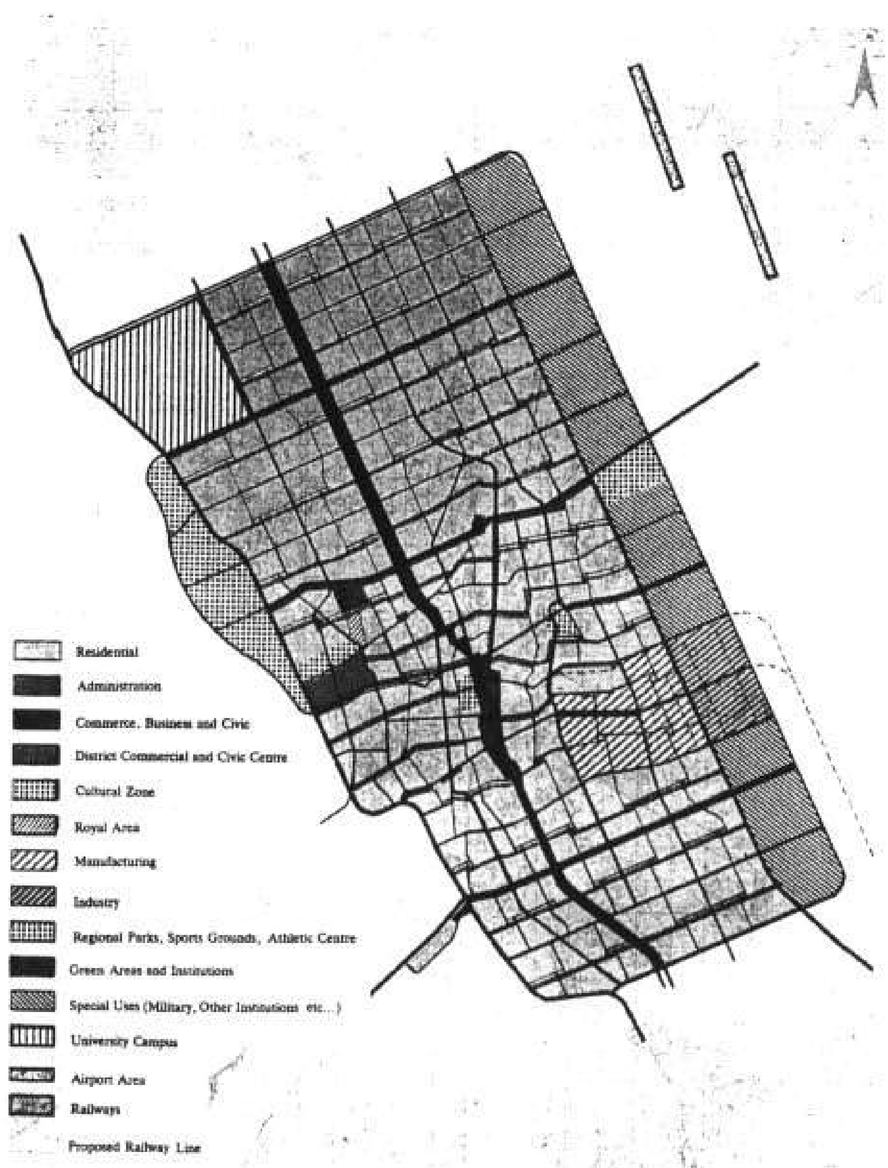
[7] Daghistani, 1985, p.157.

[8] Daghistani, 1985, p.157.

Figure 3-2: The Master Plan Proposal of Doxiadis 1971



Source: Doxiadis, 1971, in Daghistani, 1985, p.158.

(ii) A balanced distribution of facilities and services

The Master Plan proposed a hierarchy of communities and centres based on their population. There were seven classes within the hierarchy. The higher the class and population size, the more facilities such as shops, schools, mosques and parks would be created.[9] The hierarchy is shown in Table 3-1. To facilitate this, one important policy in the Master Plan is the provision of adequate land for community buildings, public facilities and open spaces, especially in the new development areas.[10]

Table 3-1: The hierarchy of communities in terms of size

Community Class	Population	Settlements' Ranks
I	40	--
II	250	--
III	1,500	--
IV	9,000	Neighbourhood or small city
V	50,000	City
VI	300,000	Large city
VII	2,000,000	Metropolis

Source: After Doxiadis, 1971, in Daghistani, 1985, p.157.

[9] Daghistani, 1985, p.157.

[10] Daghistani, 1985, p.160.

Using the hierarchy, Doxiadis suggested in 1968 that Ar-Riyadh with a population of 300,000 could be considered a Community Class VI and projected that by the year 2000 it might achieve Community Class VII with a population of 2,000,000.[11]

Figure 3-3 shows the proposed structure of communities within the Master Plan of Doxiadis for Ar-Riyadh. The plan shows a major linear (ribbon) civic centre Class VI-VII and six communities Class VI (Class VI = 300,000). Each community has two (in one case three) linear strips of centres Class V. The plan shows that one of the Class VI community is divided into nine communities Class V (Class V = 50,000) and one of the nine Class V community is divided into four communities Class IV (Class IV = 9,000). The existing airport is proposed to be relocated.

[11] Daghistani, 1985, p.158.

Figure 3-3: Proposed structure of communities by Doxiadis 1971

Source: Doxiadis, 1971, in Daghistani, 1985, p.159.

(iii) A hierarchy of transportation system

The Doxiadis Master Plan mentioned the need for a transportation system with a hierarchy of roads for different types of traffic. Other important policies in the Master Plan related to transportation system are as follows:[12]

- The importance of inter-urban communication links, particularly form Ad-Dammam city (east) to Al-Hijaz Region (south-west), and Ar-Riyadh to Al-Kharj town (south-east), in order to prevent heavy traffic from crossing the city.
- The provision of a balanced transportation network with a hierarchy of streets related to a balanced distribution of land-uses in the city.
- A relocation of handicrafts and industry to new locations (towards the east) in order to achieve a more balanced pattern of employment close to places of residence. This would help to reduce the length of journeys to work, and also help to reduce traffic congestion in the centre.
- The relief of congestion in the existing city centre, through the development of the linear centre, and elimination of through traffic.
- The proper location of community buildings and open spaces in order to minimise the conflict between pedestrians and cars.
- The development of new roads, as far as possible, around the existing neighbourhood units, with limited access into the residential areas. This will help to eliminate through traffic from residential neighbourhoods.

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[12] Daghistani, 1985, p.159f.

(b) Evaluation of the Doxiadis Master Plan

Chaline and Fares suggest that the Doxiadis Master Plan established an ensemble of City Planning concepts based on the model of Western countries, with scales, densities and structures which clearly contrasted with the traditional pattern of Ar-Riyadh.[13] However, as mentioned before, Doxiadis was applying a design philosophy of new towns with neighbourhood concept which was prevailing in the 1960s and the Master Plan was accepted by the Town Planing Office at that time and was not replaced by either the SCET Master Plan or later by the High Commission.

The most outstanding propositions of the Doxiadis Master Plan are based on functionalism theories, according to Chaline and Fares, concerned essentially with the physical arrangement of space. They briefly summarise these propositions as follows:[14]

- The city area is expanded to 304 square kilometre, which in 1968 seemed to be a reasonable provision of land for expansion; a sectorial development towards the north-west was encouraged. It was structured by a spinal cord, along which the administrative and commercial functions were located;
- The structure of the agglomeration was based on the grid pattern, abandoning the radial concentric pattern of the traditional city. Urban space become more homogeneous, and all the points equally accessible;
- The city was zoned into different functional areas, localising the fundamental activities of the capital as follows: a zone for the Royal

[13] Chaline, C. and Fares, A., 1986, p.204f.

[14] Chaline, C. and Fares, A., 1986, p.204.

Palace as well as a Diplomatic Quarter and the King Saud University in the north-west sector, and in the south-east sector a zone for industrial activities; (over concentration of uses in zones increases the car dependence and car problems)

- The realisation of a Ring Road, designed to allow a bypass round the agglomeration in order to ensure easy inter-regional traffic.

The Doxiadis Maser Plan affected city development considerably especially regarding the following four issues:[15]

1. A plan based on a grid pattern with a high degree of access to the development areas, favouring car traffic, combined with low density development, and a majority of individual dwellings;
2. Functional zoning, particularly in the peripheral areas;
3. The plan for the development of the tertiary and commercial sectors along the axis of *Makkah Road* (now *King Fahad Road*) towards the north-west;
4. The construction of a great Ring Road, six lanes wide, 84 km long, which was completed in 1983.

As mentioned before, there is a few sources of information regarding the Doxiadis Maser Plan. From these few sources, it was not clear where is the location of the Ring Road which mentioned by Chaline and Fares, how was the performance of public transport, how was the condition of air pollution, noise, car parking, traffic accident, and standard of roads in Ar-Riyadh at that time. In addition, it was not clear where is the location of the

[15] Chaline, C. and Fares, A., 1986, p.206.

inter-urban communication links which mentioned by Daghistani and the location of community buildings and open spaces.

(c) Difficulties which have prevented achievement of the Plan

One of the difficulties in creating a Master Plan which has a long term view of future development, is that, inevitably due to unforeseen events, it cannot be fully implemented. In spite of this many of the main elements of the Master Plan have in fact been implemented. For example, the development of the Al-Nasiriyyah district, the main boulevard to north, part of the Master Plan main axis, the location of the new airport, the Ring Road designed as a freeway, the Makkah Road within the urban fabric of the old city, and many street improvements.[16]

Fuller achievement of the Master Plan's objectives has been prevented by, as Daghistani mentioned, the spectacular growth of the city's population, which resulted from dramatic increases in the price of oil in 1974 followed by an increase in the Kingdom's overall rate of growth. This was not foreseen in 1970 when the plan was being prepared. The estimated population for the years 1975 and 1980 (525,000 and 685,000 respectively) were overtaken to the extent that the Plan's 1980 figure was reached around

[16] Daghistani, 1985, p.161.

1976. The growth in population was spectacular in terms of both the absolute numbers and the rate at which it occurred. Both of these factors created a high and urgent demand especially for housing and land development. The development of land for residential purpose was uncontrolled, so that the total growth far exceeded the forecast and the distribution of growth did not take place in the prescribed manner.[17] Although Daghistani suggests that the Plan itself was not at fault but events conspired to prevent the Master Plan from being enforced, the real problem with the Doxiadis Master Plan was the Ring Road which defined the outer perimeter and therefore size of the city. If Doxiadis has generated another form of transport for bypassing the city, this system of neighbourhoods could easily have been expanded to accommodate the growth in population.

Chaline and Fares also conclude that the Doxiadis Master Plan failed to predict the growth pattern of Ar-Riyadh accurately.[18] This is an unfair criticism, because Doxiadis must have obtained the data of the growth prediction from the Town Planing Office and so at the time his plan was considered to be appropriate. The real criticism to Doxiadis that his plan is final in size and structure. He should have provided an open-ended plan to

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[17] Daghistani, 1985, p.161.

[18] Chaline, C. and Fares, A., 1986, p.206.

accommodate the growth in population. It is not the fact that of larger population growth that is at fault but the rigidity of the plan. Any plan for the development of a city over long periods must be open-ended.

According to Daghistani, the creation of community hierarchies, a major principle of the Master Plan, was not implemented. Community centres were not created. The speed with which development took place is one explanation. However, more importantly the plan did not anticipate the use of roads as locations for commercial activities and the difficulty of controlling such developments. There was no development of intermediate levels of services within neighbourhoods as has been proposed. As the result the pressure on the central commercial area was not alleviated and the city centre became even more congested.[19] The redistribution of services throughout the city, a crucial part of the Master Plan, simply did not happen.[20] This maybe because development control at that time was not strict enough to ensure that the plan was acted upon.

In hindsight it is clear that Doxiadis could have been asked by the Town Planing Office to update his Master Plan in order to accommodate a range of population predictions. It could be argued that the grid pattern could

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[19] Daghistani, 1985, p.161f.

[20] Daghistani, 1985, p.162.

have easily been expanded to accommodate a sudden growth in population if the Ring Road had not become the final outer edge of development. Moreover, housing could have been designed so that its density could have been increased to meet the need of a growing population.

As the result of the failure of the Master Plan and the lack of development control, Chaline and Fares indicate that there was a mismatch between quantitative demands and spatial provision creating instability between the proposal and the requirements of various uses. A significant rise in real estate price was also noticed in the parts enclosed within the Ring Road, leading many inhabitants to seek plots of land outside the Ring Road and more and more distant from the city centre.[21] It is clear that development was not strictly controlled at that time. This practice caused three difficulties; (1) the Municipality was obliged to extend its networks out with the Ring Road;[22] (2) dispersal of the city urban structure; and (3) increase in volumes of car traffic. As mentioned before, this arose not so much from a mistake in the Plan although it was not flexible enough but because the Master Plan was not strenuously enforced.

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[21] Chaline, C. and Fares, A., 1986, p.206.

[22] Chaline, C. and Fares, A., 1986, p.206.

3.3.2 The SCET International Revised Master Plan

In 1975, the Ministry of Municipal and Rural Affairs became a fully independent Ministry. In 1976, the Deputy Ministry of Town Planning authorised a programme to review and revise its proposals. The new study was carried out over a four year period by a French consultant, SCET International, in conjunction with the local firm of Town Planners, Abdulaziz Samkary.

According to Daghistani, the new project "Ar-Riyadh Action Master Plans" proposed a radical change of approach to the planning process, taking into account the lessons learned form the first Master Plan project. The new approach is distinguished by its concern for implementation and action. The emphasis in the original Master Plan (Doxiadis Master Plan) was on long-term strategic planning. In contrast the main effort in the Ar-Riyadh Action Master Plan project has been the production of detailed guidelines for action and development which is to take place in the medium-to short-term.[23]

It appears that this approach was adopted for two reasons as mentioned by Daghistani. Firstly, it was acknowledged that the inherent uncertainty brought about by rapidly changing circumstances was not

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[23] Daghistani, 1985, p.164.

conducive with planning for the long term as in the original Master Plan. Secondly, it was realised that many of the proposals of the Master Plan were not implemented because the plan itself did not provide detailed advice and guidelines on implementation of its own proposals.[24] The original Master Plan provided the end but not necessarily the means.

The revised aim was to produce a plan which brought together the long-term plans in the original Master Plan, and the short-term annual planning adopted by Ministries and agencies in preparing and implementing budget proposals. A twelve year period from 1978 to 1990 is adopted in the new Master Plan.[25]

The population forecast of the Revised Master Plan is illustrated in Figure 3-4. By 1990 it was estimated that the population of Ar-Riyadh would be 1,750,000 given a growth rate of the Saudi population in the city of 3% per year. By the year 2000 the Master Plan predicted that the city might increase to about 2,500,000 million. Translated into physical growth this projected that the urbanised area would grow from 13,000 hectares in 1977 to about 52,000 hectares in 1990.[26]

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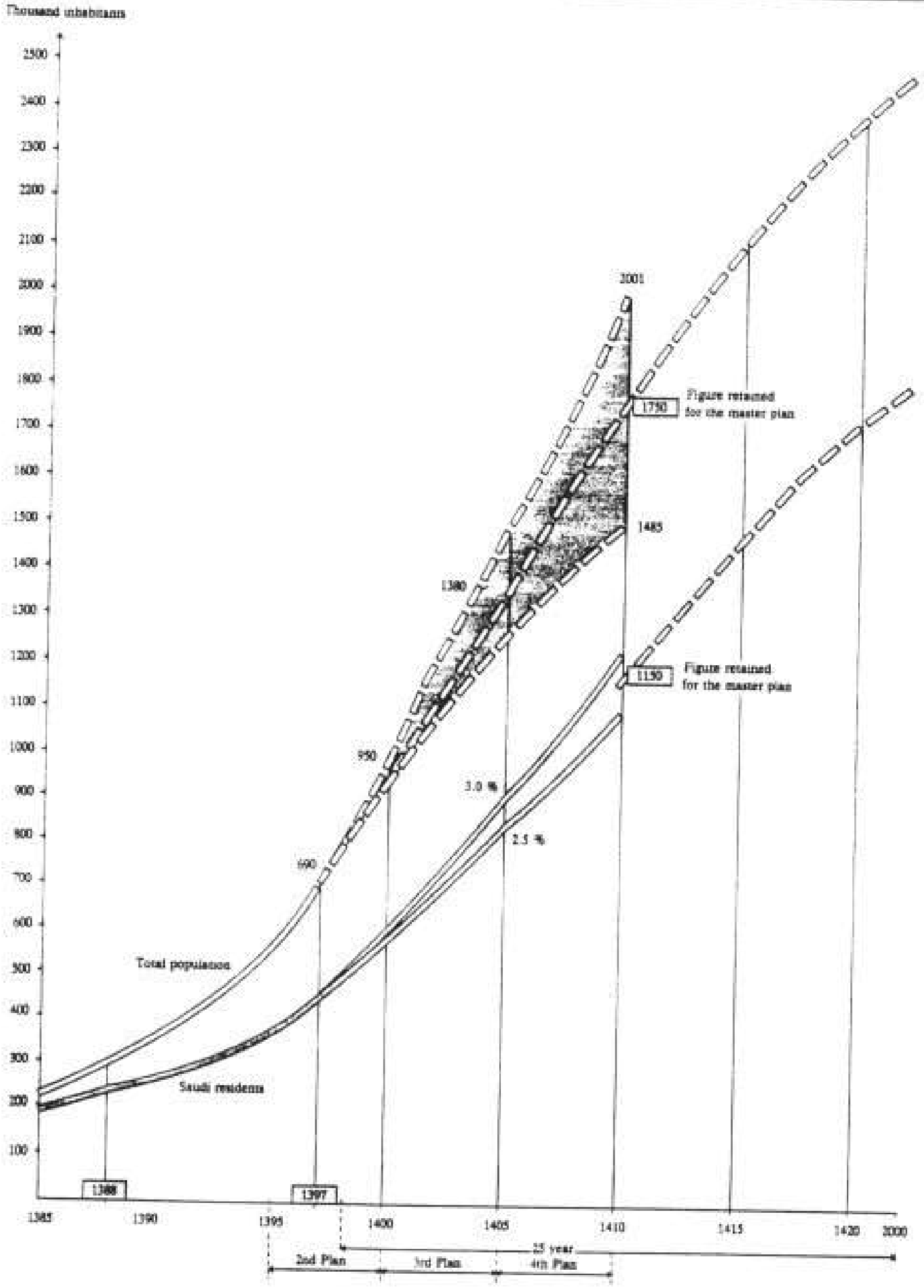
[24] Daghistani, 1985, p.164.

[25] Daghistani, 1985, p.164.

[26] Daghistani, 1985, p.164.

Figure 3-4: Revised Master Plan projection of Ar-Riyadh population



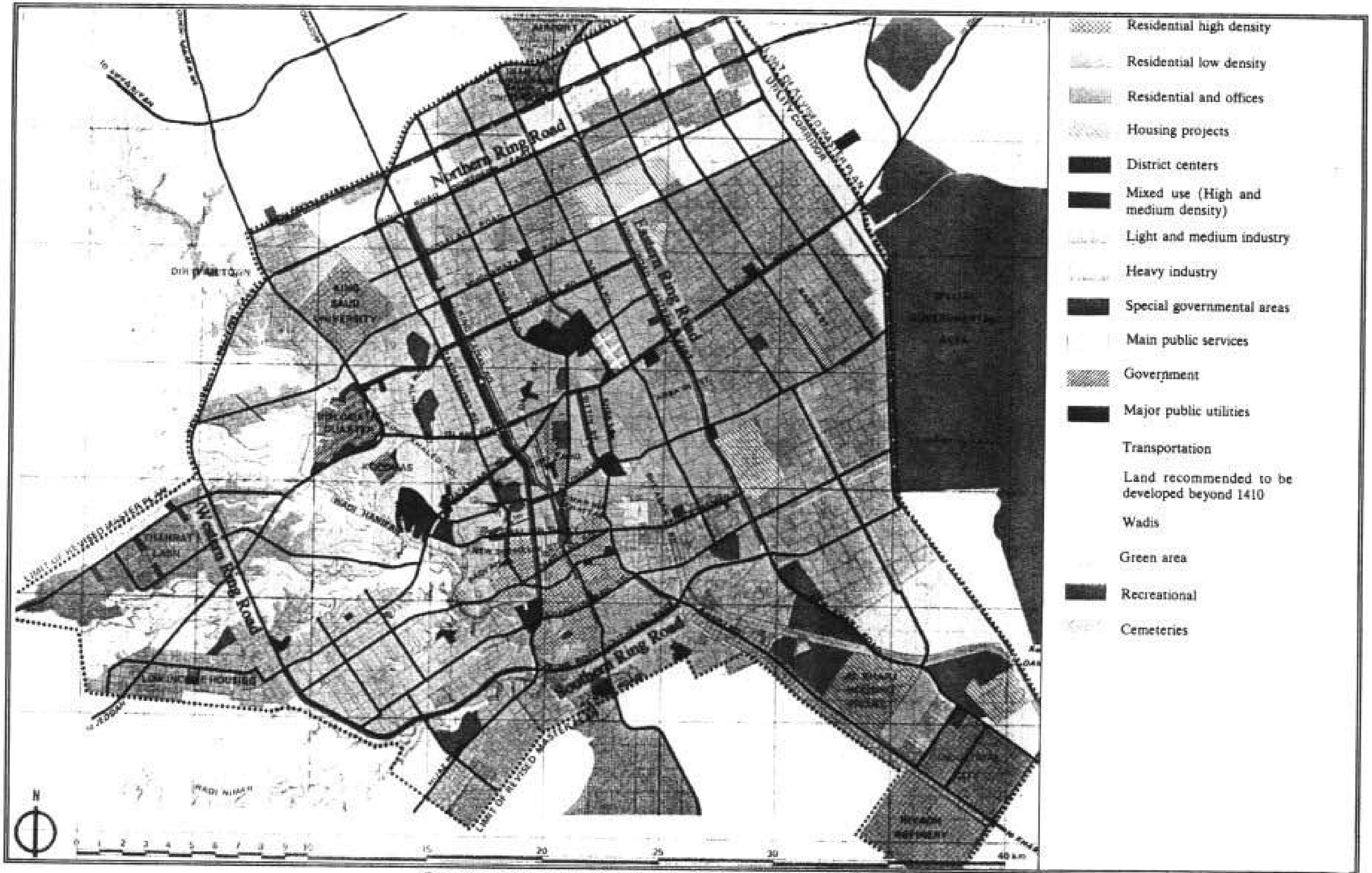
Source: SCET International, in Daghistani, 1985, p.167.

Figure 3-5 shows the proposed land-use by SCET International. The plan shows that the new growth is channelled along a major artery, *Makkah* Road (now called King *Fahad* Road) which runs north-south (shown in red colour) and also along the *Khurais* Road which runs east-west. According to Daghistani, the provision of services along major transportation routes would reduce the pressure for development in the city centre. Otherwise the centre would eventually become so congested with traffic that it would become inaccessible to the motorised population.[27] The differences between this plan and Doxiadis Master Plan are the following:

- This plan shows the Ring Road clearly which enclosed most part of the Doxiadis Master Plan;
- This plan shows enlargement of the urbanised area mainly towards east and west direction on a grid pattern;
- This plan shows different pattern of land-uses; and
- This plan shows no community centres which was illustrated on the Doxiadis Master Plan.

[27] Daghistani, 1985, p.169.

Figure 3-5: Proposed land-use by SCET international



Source: SCET International, in Daghistani, 1985, p.169.

In summary, the revised Master Plan updated the Doxiadis Plan and extended it considerably without cancelling the main options proposed in the original Master Plan. According to Chaline and Fares this new Master Plan did not propose new major alternatives, but it conceived methods of planning, and detailed programming, which were designed to guide the execution of options already adopted. This was the strategy of the "Action Areas", applicable as much to the ancient quarters in need of renovation as to the zones in process of urbanisation.[28]

3.3.3 The High Commission for the Development of Arriyadh

Until the seventies, the Ministry of Municipal and Rural Affairs exclusively held the responsibility for the development of Ar-Riyadh, since Ar-Riyadh Municipality, at that time, was insufficiently equipped with technical employees. Consequently, the Municipality's task was limited to responsibility for administration.[29]

In 1974, the High Commission for the Development of Arriyadh was introduced. It was supplied with wide powers of administration and co-ordination. It is presided over by the Prince of the Province of Ar-Riyadh, and its Secretary General is the mayor of the capital. It includes also representatives of the principal Ministries and officials from the major

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[28] Chaline, C. and Fares, A., 1986, p.206.

[29] Chaline, C. and Fares, A., 1986, p.212.

metropolitan services, such as water, electricity and telephone, in addition to some specialists from the city. The duties of the High Committee were defined in 1975 by a decree of the Ministry of Municipal and Rural Affairs. They can be summarised as follows:[30]

1. To establish a general policy for the growth of Ar-Riyadh;
2. To approve development regulations on the basis of the Master Plan;
3. To approve development programmes to be undertaken by government departments or the private sector;
4. To approve the timing of the Master Plan implementation;
5. To allocate property within the city boundaries for public use;
6. To approve programmes of public services, and their costs;
7. To approve the participation of the private sector in city development programmes;
8. To approve the implementation of the plan by the Municipality; and
9. To propose amendments to the plan when requested.

During the first decade the High Commission concentrated its efforts in organising Ar-Riyadh's growth, creating the city's infrastructure and planning its construction programme. After that, the High Commission began to extend its interests and activities to encompass the many varied aspects of urban development in its broadest sense. The Commission's focus widened to include the city's economic, social, cultural and urban development, in

[30] SCET International/SEDES, 1978, in Daghistani, A., 1985, p.153f.

Ar-Riyadh that Doxiadis Master plan is based on a grid pattern with a high degree of access to the development areas, favouring car traffic, combined with low density development, and a majority of individual dwellings.

In 1978, the revised Master Plan by SCET International updated the Doxiadis Master Plan and extended considerably its remit without cancelling the main options proposed. It has been mentioned that the new Master Plan did not propose major new alternatives, but it provided methods of planning, and detailed programming, designed to guide the execution of options already adopted. In 1974, the High Commission for the Development of Ar-Riyadh was introduced. During the first decade the High Commission concentrated its efforts in organising Ar-Riyadh's growth, creating the city's infrastructure and planning its construction programme. After that, the High Commission began to extend its interests and activities to encompass the many varied aspects of urban development in its broadest sense.

It is clear that all planning of Ar-Riyadh to this point was based on the cars as major modes of transport. As a result, there is a raped increase of car ownership and car use in Ar-Riyadh. Increases in car use lead to many problems in most of the world cities. As the volume of cars grows rapidly, roads become congested, road accidents increase, air pollution rates increase and insufficient parking spaces create even more problems.

If car traffic continues to increase in Ar-Riyadh, the result will be more car problems in the future. This will create more congestion, frustration, parking difficulties, car accidents, environmental pollution, health problems, more dispersal of urban growth, and more community disruption. No single improvement can resolve the problem, a new strategy and a comprehensive approach to the land-use and transport planning policies is required to control the growing car dependence. If we do not investigate for Ar-Riyadh alternative planning and design strategies now to control the increasing car dependence and minimise car problems, this will inevitably be very difficult in the future.

In Chapter Four, analysis of key trends in land-use patterns of Ar-Riyadh will be presented because them may be responsible for increasing car dependence in Ar-Riyadh. This will include the most important land-use factors which might reduce car dependence but increase mobility in Ar-Riyadh.

CHAPTER 4

ANALYSIS OF KEY TRENDS IN LAND-USE PATTERNS OF AR-RIYADH

4. ANALYSIS OF KEY TRENDS IN LAND-USE PATTERNS OF AR-RIYADH

In this chapter, the key trends in land-use patterns within the city of Ar-Riyadh will be explored. This will include three major topics: (1) Residential density which includes gross residential densities; net residential densities; and factors which might contribute to generating low density and fast urban growth in Ar-Riyadh, (2) Segregation and decentralisation of land-uses which includes decentralisation of the trade sector; decentralisation of the service sector; decentralisation of the government-uses sector; and high development of segregated land-uses, and (3) The influence of fast-road infrastructure on growth pressures in Ar-Riyadh.

Most data for this and the following chapter, with regard to analysis of key trends in land-use patterns and travel behaviour of Ar-Riyadh, were predominantly obtained from a survey of households within the city of Ar-Riyadh conducted by the ADA between March 1986 and April 1987 because no other sources were available. This survey was part of a major project called DELTA. Its purpose was to provide the ADA with an up-to-date data base that could be used for subsequent land-use, demographic, transportation, and economic studies with which to inform on-going planning activities within Ar-Riyadh.

4.1 Introduction

The data of the ADA's survey was spatially co-ordinated through the use of a geographically based hierarchical coding system. With some adjustments, the hierarchical coding system was based on sub-municipality and neighbourhood (*hara*) administrative boundaries. Names and locations of the Sub-Municipalities were provided by the Municipality as seen in Figure 4-1. These areas were further subdivided into sub-neighbourhood (*sub-hara*) blocks and parcels. The final product of the spatial subdivision of the city consisted of 22 Sub-Municipalities, 171 neighbourhoods (*haras*), 579 sub-neighbourhoods (*sub-haras*), 24,500 blocks and 185,700 parcels.[1] Figure 4-2 shows the hierarchical coding system.

The Land-Use Study Area includes a total of 1,012 square kilometres. Roughly 810 square kilometres (80 %) were actually surveyed; the remaining 202 square kilometres (20 %) consist primarily of the developed street network. Within the Land-Use Study Area (810 square kilometres), approximately 293 square kilometres (36 %) are developed, while the

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[1] ADA, 1987, p.259.

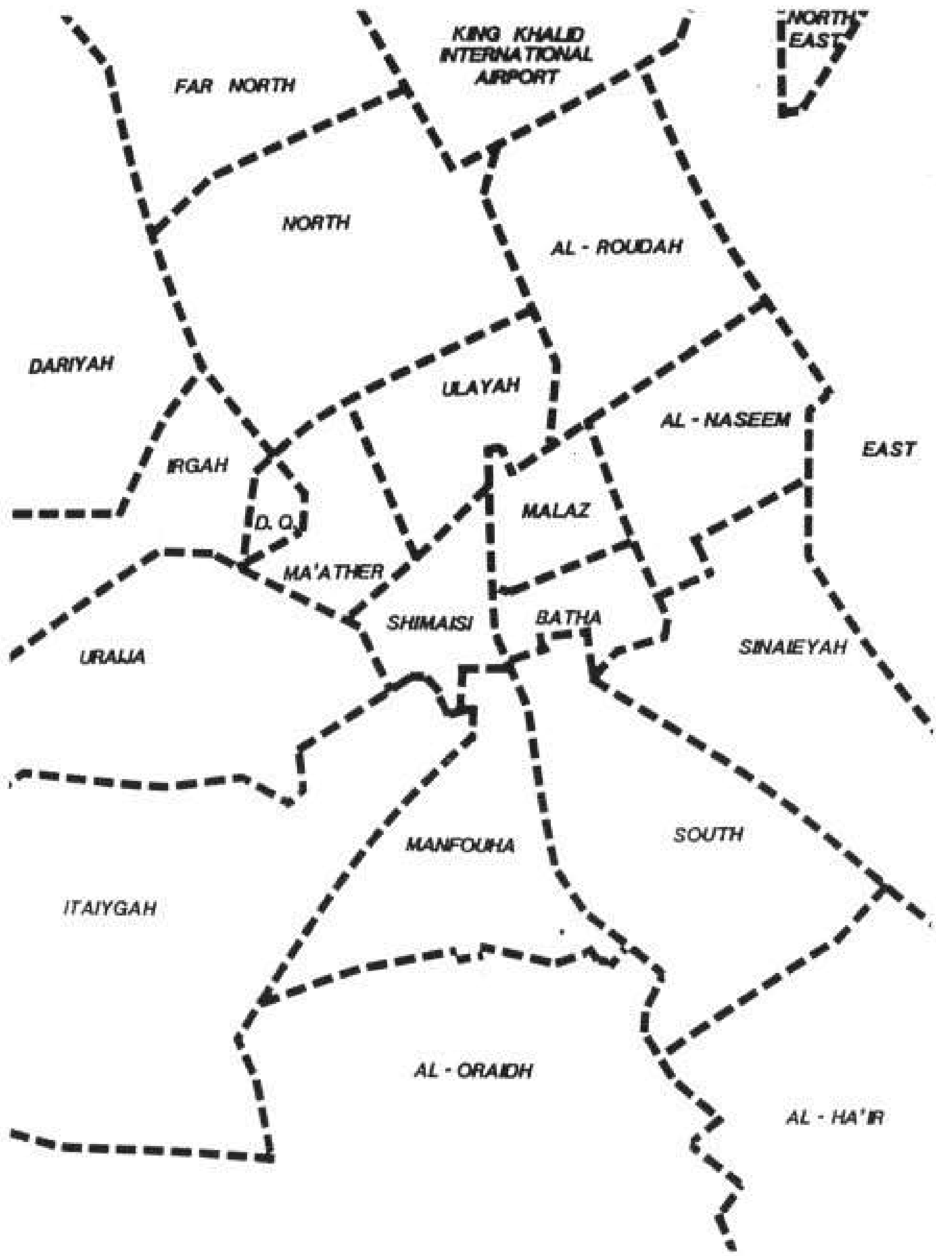
remaining 517 square kilometres (64 %) are vacant land. Figure 4-3 shows major vacant land located mainly in the city periphery.

4.2 Residential density

The residential area comprises the largest land-use within the city of Ar-Riyadh (except for vacant land). It constitutes roughly 31 percent of the developed land within the city.[2] Figure 4-4 shows the residential land area within the city and Figure 4-5 shows the distribution of dwelling units in the city. It clearly indicates the higher concentration of residential units in the central city, resulting from the relatively small land plots in that area. The figure also shows the growth of residential development close to major transport routes in northern, north-eastern and south-western directions.

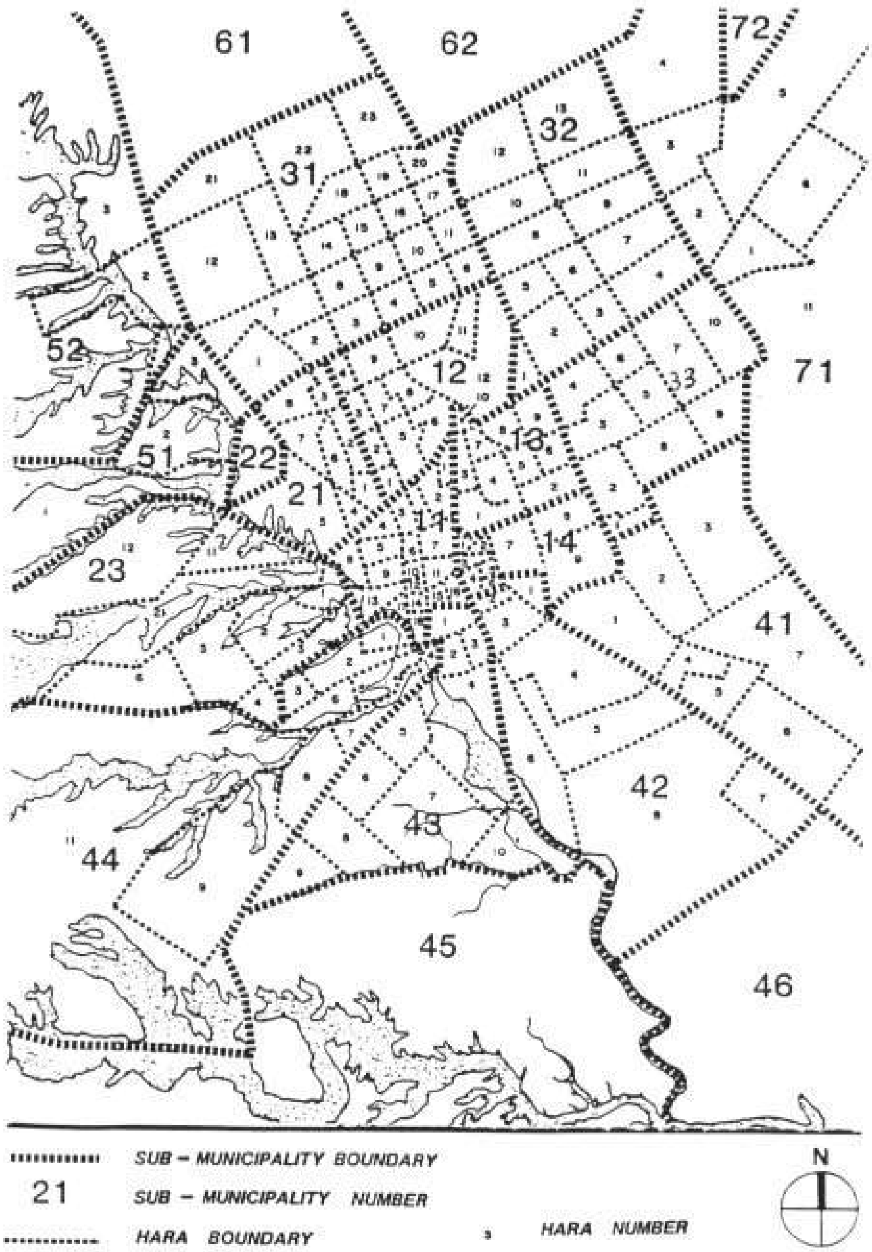
[2] ADA, 1987, p.54.

Figure 4-1: Names and locations of the Sub-Municipalities



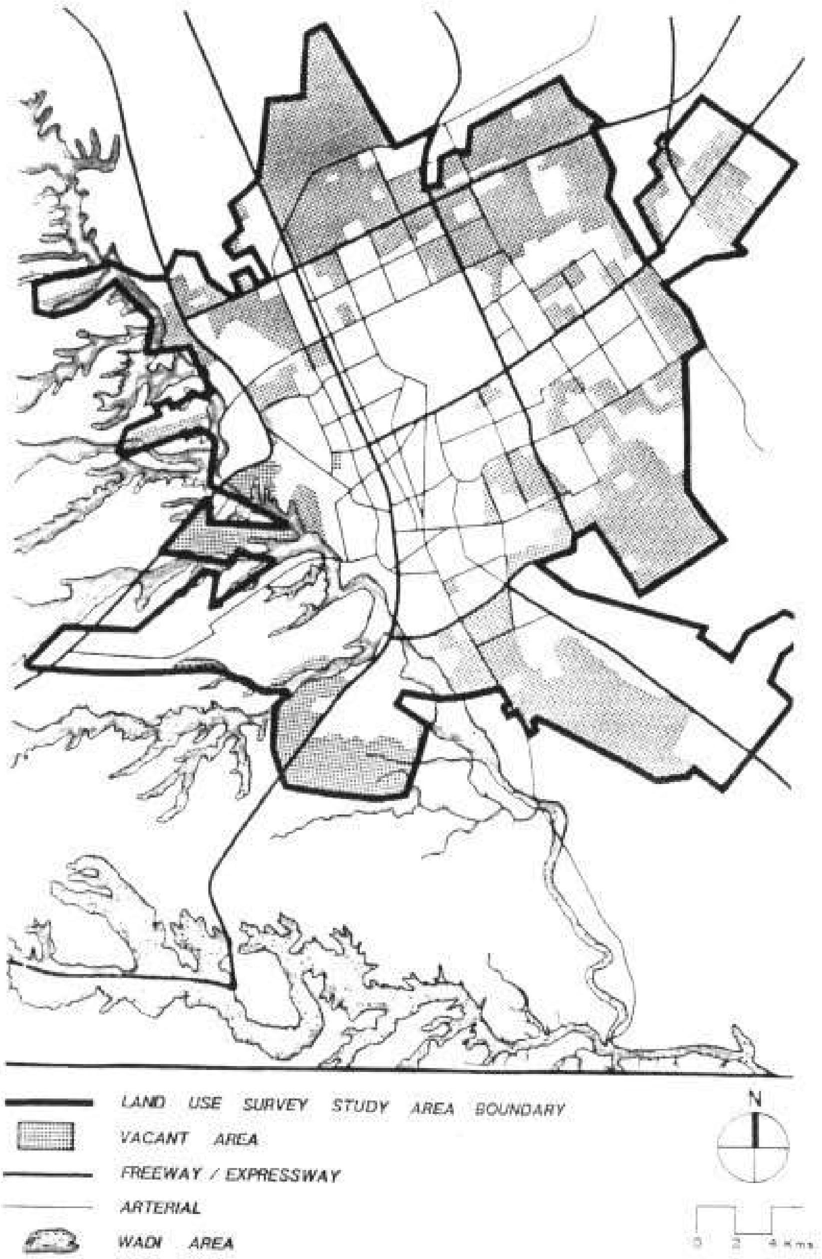
Source: ADA, 1987, p.8.

Figure 4-2: Hierarchical coding system of Ar-Riyadh



Source: ADA, 1987, p.9.

Figure 4-3: Major vacant areas



Source: ADA, 1987, p.101.

Figure 4-4: Residential land-area

Source: After the ADA, 1987, p.55.

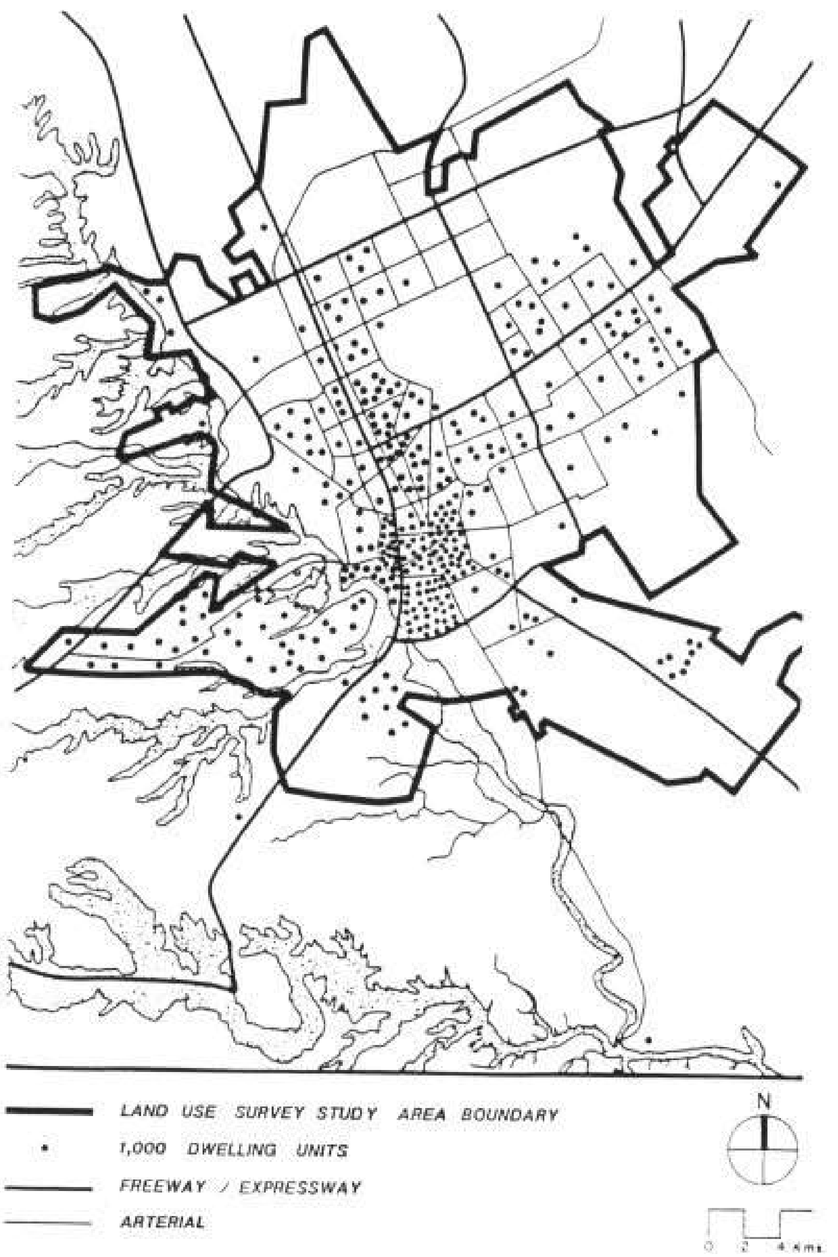
addition to concerns for preserving the environment, managing the urban development of the city and rationalising the provision of public utilities and services. As an important step in addressing these wide-ranging concerns, the Arriyadh Development Authority was established as the executive arm of the High Commission by Ministerial Decree in June 1983.[31] Chapter Four & Five illustrated some works of Arriyadh Development Authority.

3.4 Summary

In this chapter, the history of formal planning of Ar-Riyadh has been presented. During the Sixties, which witnessed the origins of car dependence in Saudi Arabian cities, the government decided to control the fast urban growth of Ar-Riyadh. A coherent plan of the whole city was initiated at the beginning of the Sixties. The first attempt at comprehensive physical planning for Ar-Riyadh was undertaken by Doxiadis. The data revealed that in spite of some achievements of the Doxiadis Master Plan, there have been difficulties which have prevented the realisation of most of the Plan's objectives. The most important point regarding influencing car dependence in

[31] Al Shaikh, M. in Arriyadh Development Authority (ADA), 1990, p.8.

Figure 4-5: Distribution of dwelling units
(• = 1,000 Dwelling Units)



Source: ADA, 1987, p.59.

4.2.1 Gross residential densities

"Gross" residential density is the number of dwelling units per total area, including all developed and vacant land and street's rights-of-way.[3] Table 4-1 shows the gross and net residential densities in each sub-municipality of Ar-Riyadh (net residential densities will be discussed in section 4.2.2). As the table shows, the gross residential densities indicate that there is an average of 3 dwelling units per hectare (19 persons/ha) city-wide, typical of relatively low-density development. Gross residential densities lower than five dwelling units per hectare (32 persons/ha) are located in 13 of the Sub-Municipalities as the table shows. Gross residential densities in the remaining six Sub-Municipalities are 18 units per hectare or lower (113 persons/ha or lower). The highest gross residential densities are located in Sub-Municipalities 11,14, and 43.[4]

In comparison, the average gross densities world-wide of the urban areas range from 12 persons/ha as in Los Angeles to over 400 persons/ha as in Moscow (a ratio of one to 33).[5] The low average gross residential densities of Ar-Riyadh reflects the partially developed character of the large area at the periphery of the city as shown in Figure 4-6.

[3] ADA, 1987, p.62.

[4] ADA, 1987, p.63.

[5] Doxiadis, C., 1968, p.126.

Table 4-1: Gross and net residential densities

Code	Sub-Municipality's Name	Dwelling Units/ Hectare (Gross)[6]	Persons/Hectare (Gross)[7]	Dwelling Units/ Hectare (Net)[8]
11	*Al-Shimaisi*	18	114	75
14	*Al-Batha*	11	70	160
43	*Manfouha*	9	57	71
13	*Al-Malaz*	7	44	32
12	*Al-Ulayah*	5	32	40
44	*Itaiygah*	5	32	24
33	*Al-Naseem*	4	25	16
21	*Al-Ma'ather*	3	19	16
23	*Al-Uraija*	2	13	32
32	*Al-Roudah*	2	13	33
52	*Al-Dariyah*	2	13	35
31	*North*	1	6	16
41	*Al-Sinaieyah*	1	6	14
42	*South*	1	6	38
22	*Diplomatic Quarter*	<1	<6	37
46	*Al-Ha'ir*	<1	<6	27
51	*Irgah*	<1	<6	34
61	*Far North*	<1	<6	<1
71	*East*	<1	<6	14
45	*Al-Oraidh*	-	-	-
62	*Airport*	-	-	-
Citywide Average		3	19	34

After table 7 in ADA, 1987, p.62.

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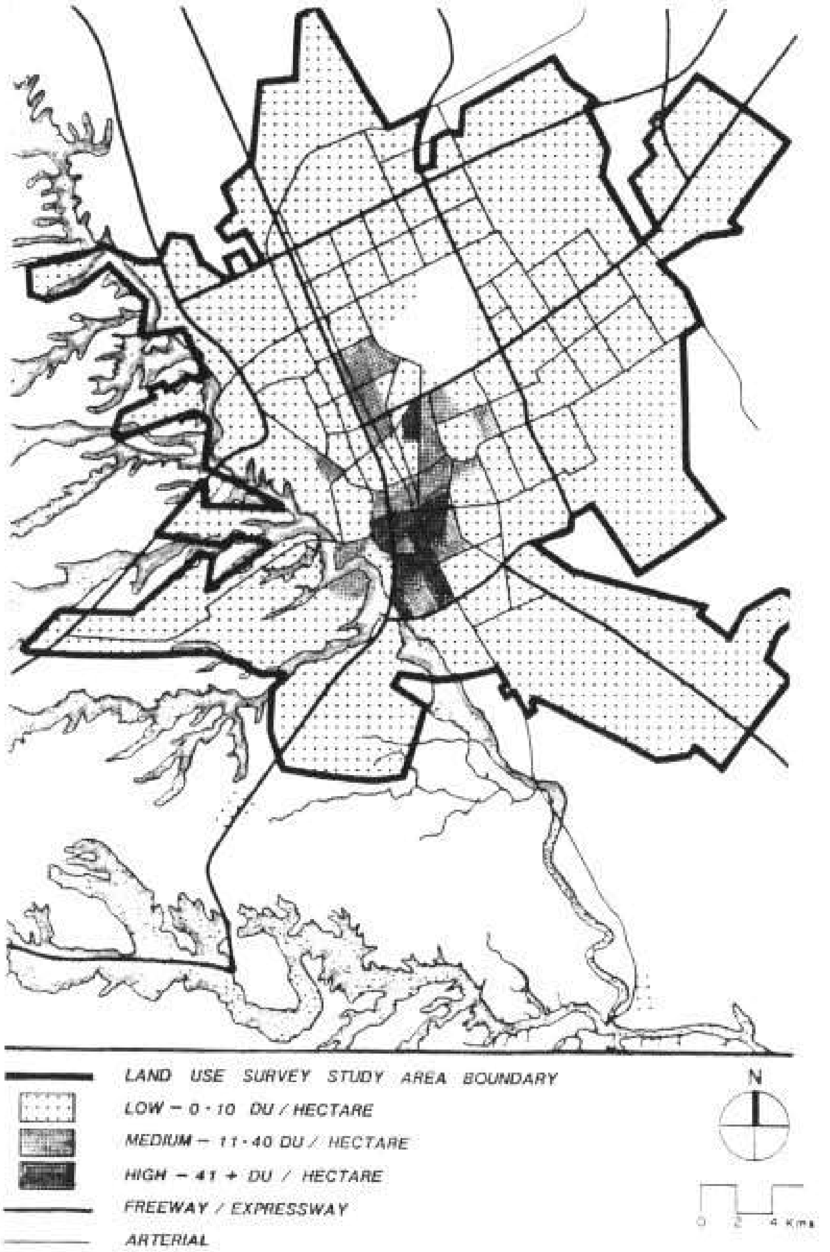
6 "Gross" residential density: The number of dwelling units per total area, including all developed and vacant land and street's rights-of-way.

7 Gross density Person/ha calculated as (number of dwelling units/ha) multiply by 6.34 (average number of persons per dwelling unit city-wide).

8 "Net" residential density: The number of dwelling units per area used for residential purposes only.

Figure 4-6: Gross residential density



Source: After the ADA, 1987, p.64.

4.2.2 Net residential densities

"Net" residential density is the number of dwelling units per area used for residential purposes only.[9] As seen in Table 4-1 and Figure 4-7, the highest net residential densities are located in Sub-Municipalities 11 (476 persons/ha), 14 (1014 persons/ha), and 43 (450 persons/ha) in the city centre. Those zones containing the lowest net residential densities (Sub-Municipalities 41, 61 and 71) are located around the periphery of the city.

In comparison, residential densities world-wide may range from as low as one persons/ha in some garden-cities within major settlement areas to as high as 7,500 persons/ha in parts of Hong Kong (a ratio of one to 7,500).[10] therefore, the overall net residential densities of Ar-Riyadh are relatively low compared with world-wide net residential densities.

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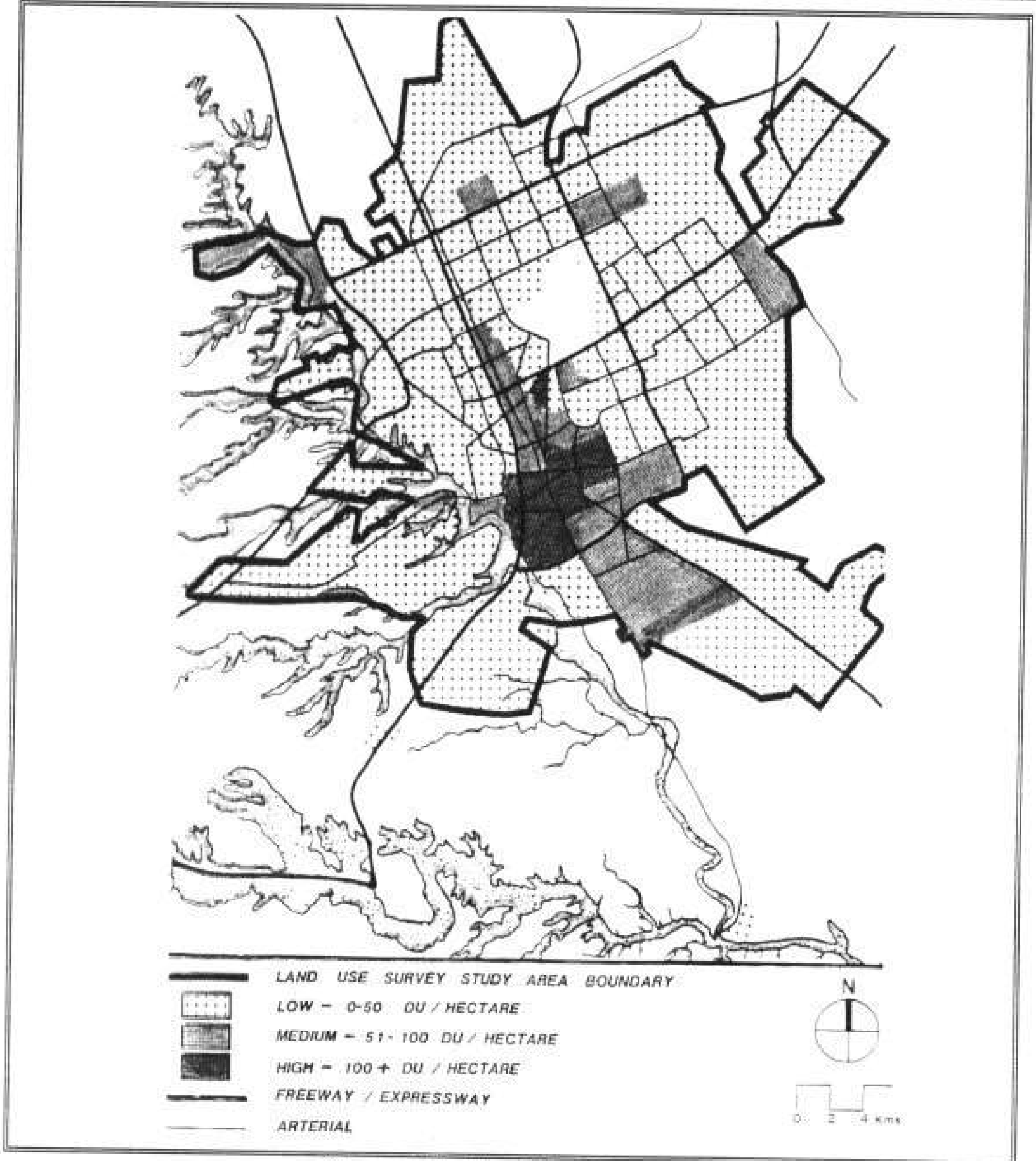
[9] ADA, 1987, p.62.

[10] Doxiadis, C., 1968, p.126.

Figure 4-7: Net residential density



Source: After the ADA, 1987, p.65.

4.2.3 Key factors influencing density and urban growth

The urban growth of Ar-Riyadh has been influenced by some factors which might help in generating low density and fast urban growth. Before the car became a part of most Saudi households, many people relied on walking for their transportation close to home. Once more and more people were able to afford their own cars, dependence on foot and public transport diminished. Since land farther away from city centre is less expensive, people from city neighbourhoods began to see the fulfilment of their dream of owing a big house (villa surrounded by garden). Development dispersal began when land developers learned that Saudi households would be willing to drive a little farther to buy even less expensive land. This practice, of developing less expensively and farther from the city land while leaving vacant more expensive land closer to the city, led to low density development, disperse growth, and scattered facilities. The car become the main means of transportation for suburban residents because public transportation was unsuitable (very costly within the new growth pattern).

Another factor is an unprecedented level of development of the transportation infrastructure in conjunction with the growing availability of private cars to most of the people. This has allowed them to live in any location they wanted, away from the expensive, old, congested city centre. The population of the new suburban sprawl has become dependent on the

private car. This practice, as Mumford mentions, has produced an anti-urban style. The car has made walking unsafe and the expansion of the suburb has made the walking distances impractical.[11] In the new neighbourhood structures in Ar-Riyadh which have been designed with the car in mind it becomes increasingly difficult to reach certain public facilities such as shops, schools, and recreation facilities without using the car.

The third factor is the governmental housing subsidies programmes as mentioned by Telmesani. Rapid growth has largely resulted from an unusual level of residential development, which was promoted by government housing subsidies through the Real Estate Development Fund (REDF). The objective of this policy was firstly to assist the development of private-sector housing, by providing interest-free loans to Saudi citizens to construct their own houses; and secondly to provide investment loans to individuals and corporations for commercial purposes.[12]

Many households took advantage of these personal interest-free loans. A large number benefited from the loan because there were very simple qualification conditions as shown in Appendix (A). One of the conditions required that the loan recipient should possess a plot of land (regardless of location) on which he or she intended to build a house. This

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[11] Mumford, 1961, p573-577.

[12] Telmesani, 1989, p.75.

condition influenced the location of many of the households and the entire pattern of the city's urban growth.[13] Because some households already possessed a cheap plot of land around or outside the periphery of the city.

Most of the REDF house building consists of free standing villas and apartment blocks. Villas are the most common building type comprising roughly 46 percent of the building stock in Ar-Riyadh.[14] Population density is generally lower in areas where single family villas are located than in areas where Arab houses and apartments are the dominant building style, therefore the three Sub-Municipalities with the highest net and gross residential densities (11, 14, and 43) also contain the largest number of old and contemporary Arab houses and apartment buildings. On the other hand, free standing villas are generally the most common residential building type in the less dense Sub-Municipalities beyond the central core of the city.[15] Roughly 60 percent of all villas are located in Sub-Municipalities 12, 13, 23, 32, and 33 where net residential densities range from 16 to 40 dwellings per hectare.[16] Villas are overwhelmingly occupied by Saudis (62 percent).[17] The average number of habitable rooms in free standing villas is eight.[18]

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[13] Telmesani, 1989, p.75.

[14] ADA, 1987, p.54.

[15] ADA, 1987, p.63.

[16] ADA, 1987, p.66.

[17] ADA, 1987, p.126.

[18] ADA, 1987, p.117.

According to the ADA transportation study in 1987, the free standing villas generated almost 9 car trips per day in Ar-Riyadh.[19]

4.3 Decentralisation of land-uses

With increased prosperity in Saudi Arabia, improved communication and the availability of the car, people sought higher standards of living and moved away form the city centre. In Ar-Riyadh, rapid urban growth has led to extensive dispersal of developments and the decentralisation of different land-uses throughout the city (residential, commercial, industrial, manufacturing, governmental and administrative offices, public service and other activities). Today, Ar-Riyadh has no original centre, people are commuting everywhere within the gridiron plan.

This new transformation of Saudi Arabian cities led to increasing car ownership and car use. The total number of cars in 1975 was 514,361. This number increased to reached 5,117,441 cars[20] in 1991.[21] This means almost ten folds increases in 16 years only. The car is now the dominating mode for all types of travel. The decentralisation of the trade sector, the service sector and the government sector will be presented in the following sections.

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[19] ADA, 1987, p.217.

[20] This number is accumulative number of yearly registered cars which include the damaged and exported cars. In 1991, The actual number of cars in Saudi Arabia was estimated at 3,711,685.

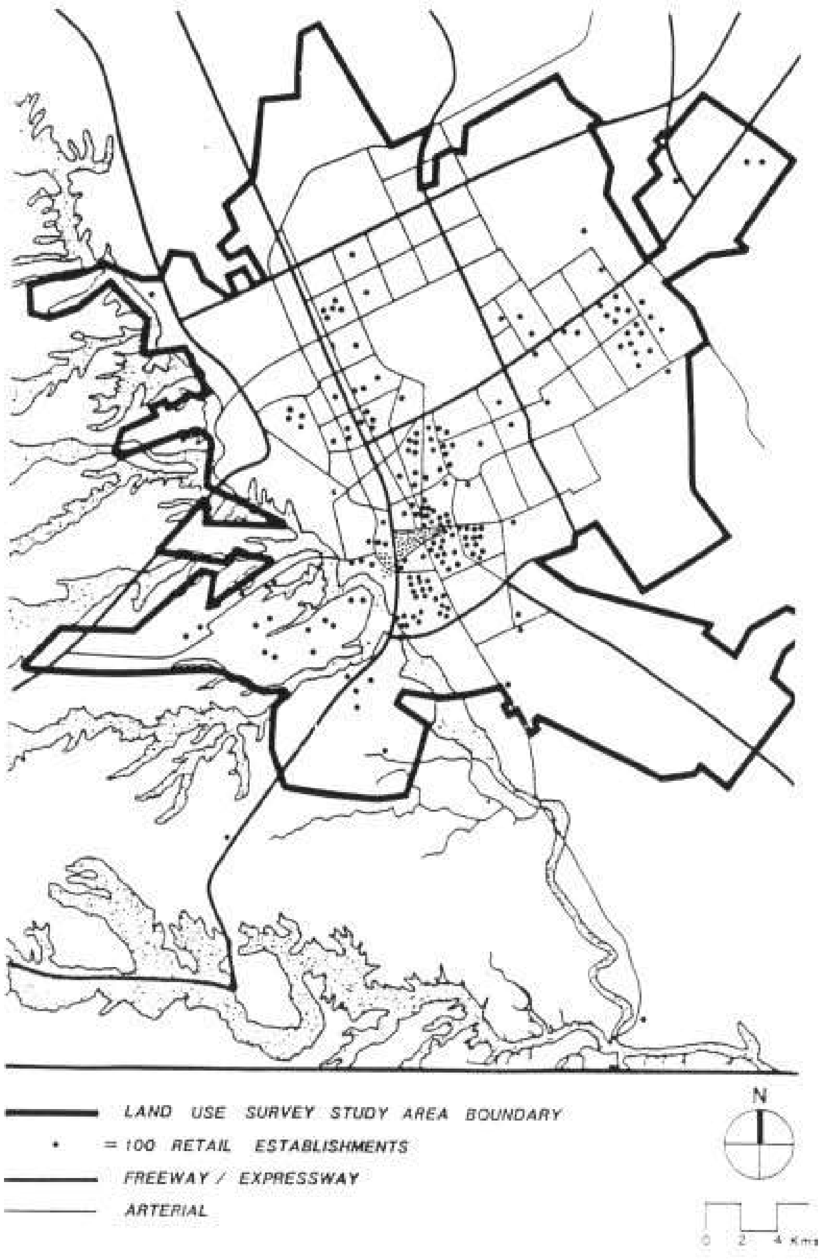
[21] Central Department of Statistics, 1991, P. 115.

4.3.1 Decentralisation of the trade sector

The trade sector includes retail businesses, wholesale distributors, restaurants, hotels and other related activities. This sector uses an area of less than 5 square kilometres, which comprises approximately 1.7 percent of the total developed areas of Ar-Riyadh.[22] The land-use survey indicates that 90 percent of the trade establishments are related to retail activities. The distributions of these establishments are shown in Figure 4-8. The figure shows a large concentration of retail activities within the central area of the city and along major roads. Some retail activities have become concentrated along these major roads forming retail sub-centres outside the city centre. The increasing number of sub-centres outside the city centre reflects the current decentralisation growth. The comparison between Figure 4-8 and Figure 4-5 shows the correspondence of the distribution of retail outlets with the distribution of dwelling units which indicates the strong linkages between the two sectors. Retail outlets are created close to where people live. This practice in general reduces travel demand. However, if people do not make use of the nearest retail outlets, in this case the effect creates diffuse patterns of trips which can not be served effectively by public transport.

[22] ADA, 1987, p.80.

Figure 4-8: Distribution of retail establishments



Source: ADA, 1987, p.83.

4.3.2 Decentralisation of the service sector

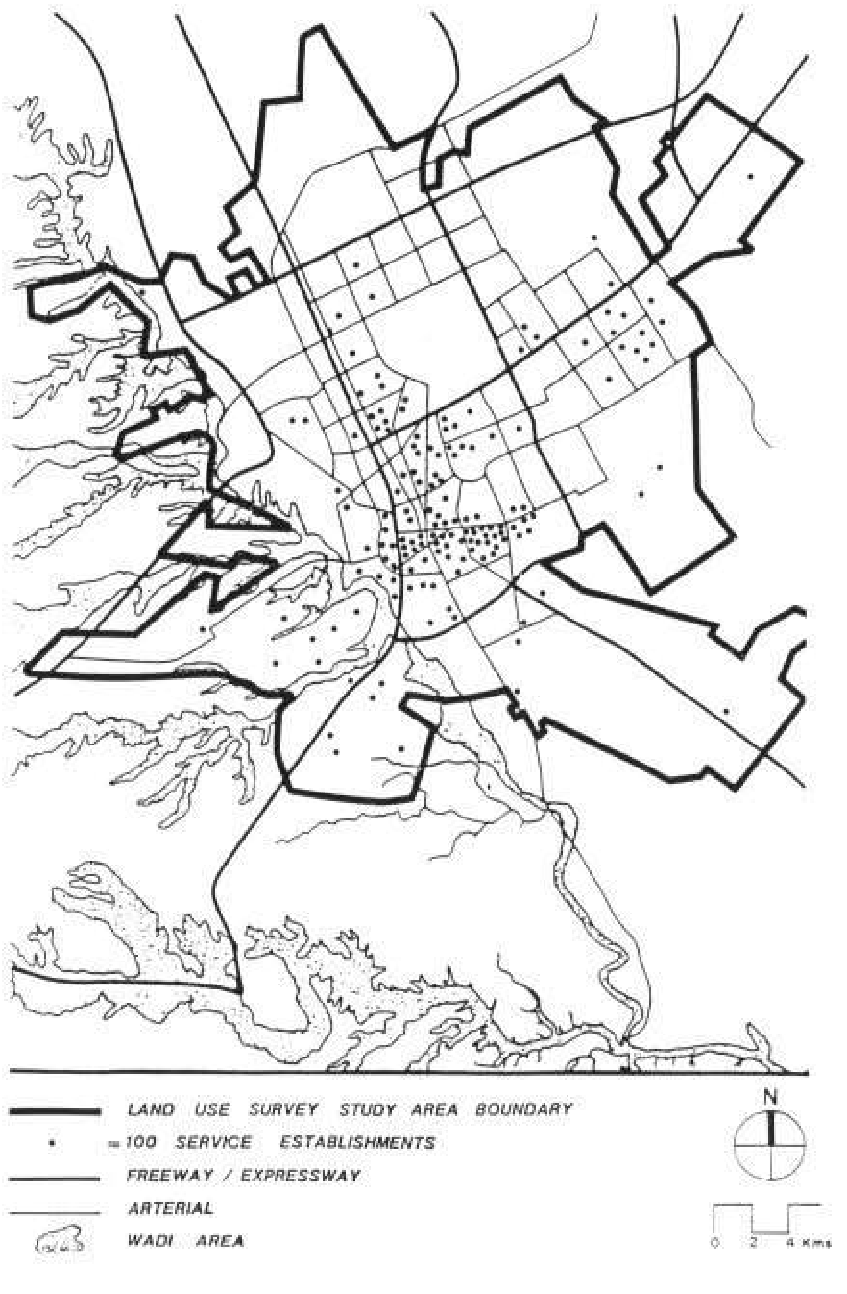
This sector comprises 31 square kilometres of land within Ar-Riyadh (over 10 percent of the total developed area of the city).[23] Figure 4-9 shows the distribution of service establishments in the city. There is a total of 15,823 service establishments within Ar-Riyadh.[24] Roughly 75 percent of all services establishments are located in six Sub-Municipalities (11, 12, 13, 14, 33 and 43). These are the same areas of the city with the largest number of trade establishments.

Once again, the comparison between Figure 4-9 and Figure 4-5 shows the similarity between the distribution of the service sector and the distribution of dwelling units which indicates strong linkages between the two sectors. The increasing number of service establishments outside the city centre reflects the current trend of decentralisation growth. Again this practice of decentralisation in general reduces travel demand if people use of the nearest service establishments. However, if people do not make use of that, in this case the effects create diffuse patterns of trips which can not be served effectively by public transport.

[23] ADA, 1987, p.84.

[24] ADA, 1987, p.85.

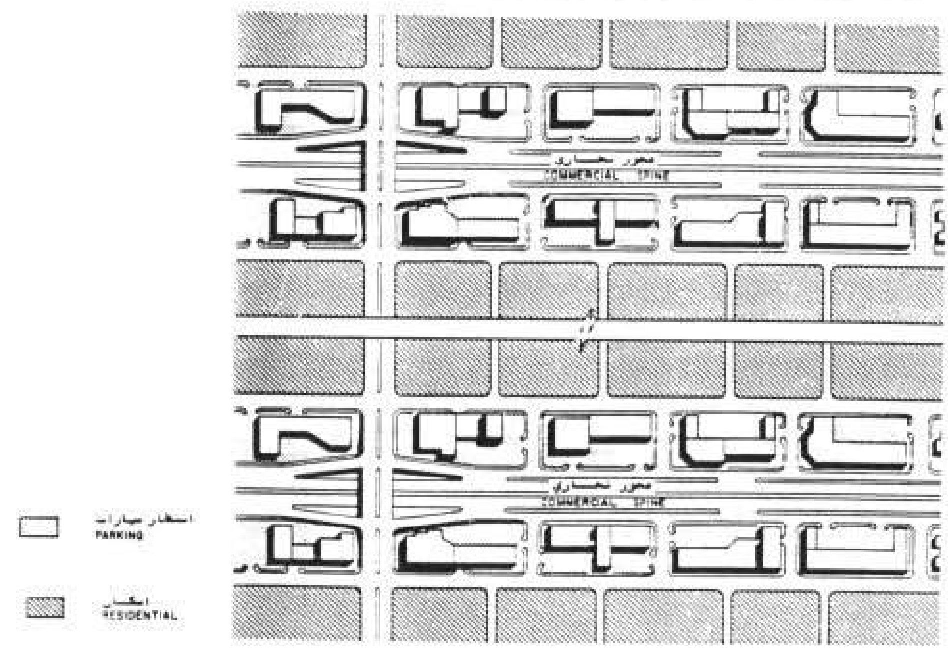
Figure 4-9: Distribution of service establishments



Source: ADA, 1987, p.87.

It is clear that current land-uses have begun to change in order to serve mainly the car users in the Saudi Arabian cities. Commercial strip developments line major roads, with large parking plots separating the street from the building as seen in Figure 4-10. Shopping and employment continue to move to strip locations to serve the car users. The strip developments are difficult for pedestrian circulation. This practice of land-use which mainly serves car users needs to be discouraged while compact convenience business centres near residential units or near public transport routes need to be encouraged. Consequently, this might encourage walking for short distances and the use of public transport for longer distances.

Figure 4-10: Proposal for commercial strip developments for Jeddah



Source: Sert Jackson International/SAUDCONSULT, 1980, p.163.

4.3.3 Decentralisation of the government-uses sector

The government and public-use sector comprise 18 percent of the developed land surveyed by ADA. Figure 4-11 shows the general areas used for government and public-uses. It clearly indicates the spread of these uses on a large area of the northern part of the city, and the area to the north of the central area, where major buildings for Ministries are located. The figure also shows some of the largest land consuming government-uses, which include: the old airport (temporary location for the Air Force Base), the campus of King Saud University, the campus of Imam Mohammed Ibin Saud University, National Guard installations, the Police Training Centre and the Diplomatic Quarter. Once more, a comparison of Figure 4-11 with Figure 4-5, Figure 4-8, and Figure 4-9 reveals that government land-use is located outside major housing, retail and service areas. However, government account for almost 40 percent of the total working age population in Ar-Riyadh. Saudis predominate in government employment, accounting for almost 70 percent of the employees of the Saudi Government.[25] The majority of government employees and users travel by cars to get to government-uses. This practice caused traffic congestion in the morning and afternoon and also caused parking problems around most government-uses.

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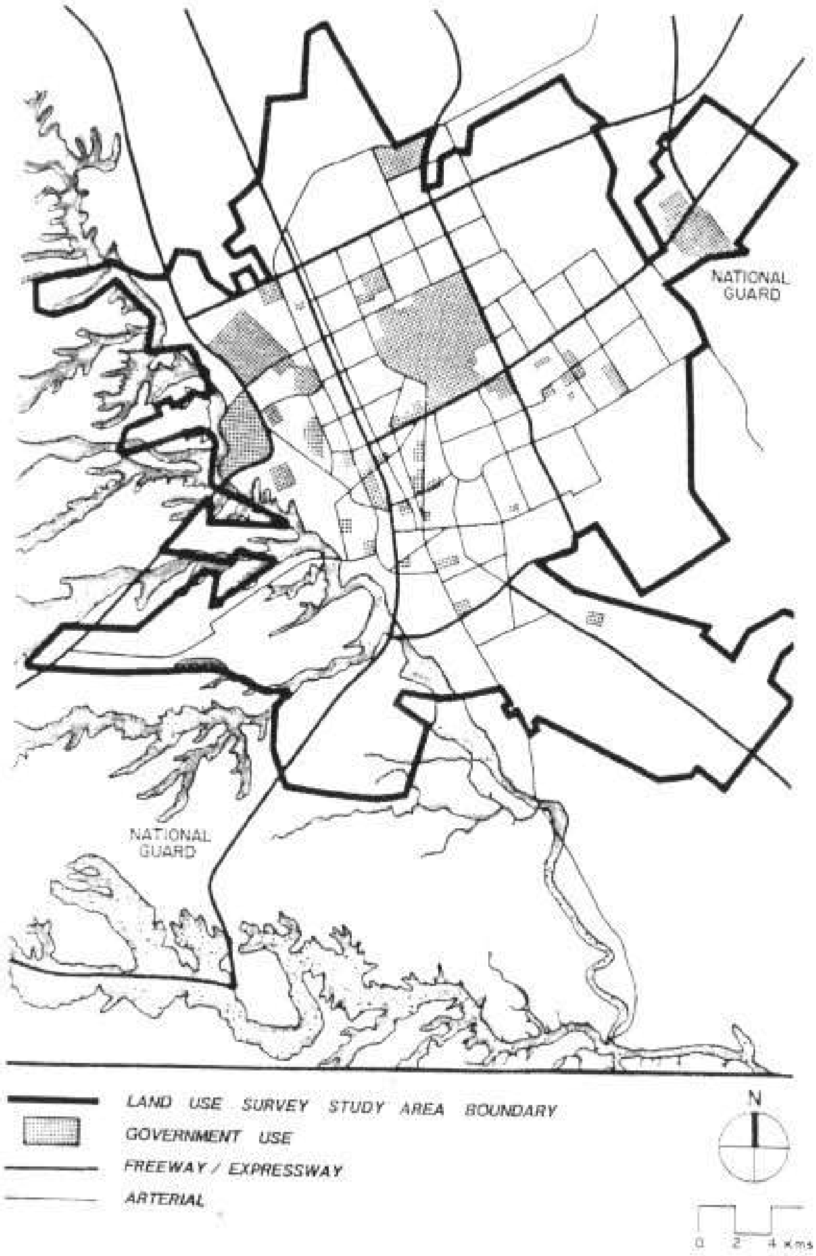
[25] ADA, 1987, p.150.

Figure 4-11: Distribution of government and other public uses



Source: ADA, 1987, p.89.

4.4 Single function land-uses

Ar-Riyadh today is characterised by low density development with segregated land-uses (single function land-uses). As mentioned before, there is some clustering of housing, retail, and services in the areas along major traffic routes in northern, north-eastern and south-western direction from city centre. However, based on the results of the ADA survey, in terms of land area alone, only 15.3 percent (45 square kilometres) of the developed area of the city is mixed uses[26] (This reflects the actual mixing of land-uses within a single parcel or building). That means almost 85 percent of the developed area of the city is developed as single function use. Figure 4-12 shows the distribution of land-uses within Land-Use Survey Study Area. As the figure shows, three types of mixed land-use were found: (1) mixing of residential and commercial land-use (ground floor shops with apartment units on the upper floors is common form) is located mostly in either the city centre or in the growth areas along most of the major streets, beyond the central core of the city (Sub-Municipalities 12, 31, 32, 33, 41 and 42); (2) mixing of residential and other uses (non-commercial uses) is common in Sub-Municipality 23 where residential and agricultural mixing is clear along *Wadi Hanifah*; and (3) mixing of non-residential uses such as mixing of

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[26] ADA, 1987, p.97.

government and commercial uses; trade and service uses; and warehousing and industrial activities with trade establishments are common. This practice is found mostly in Sub-Municipalities 11, 14 and 41.

Figure 4-12: Distribution of land-uses

Source: Graph developed by author based on ADA data, 1987, p.56.

4.5 Imbalance of the distribution of public uses

Table 4-2 shows the number of all major government and other public uses recorded during the Land-Use Survey. With regard to distribution of public uses in Ar-Riyadh, the table shows an imbalance in distribution or some shortages in some basic public uses. For example, there are only 19 central and local post offices and 49 kindergartens compared with 1670 *Juma'a* and neighbourhood mosque and 417 Public Toilets. There are 206

female primary schools compared with 309 male primary schools. The shortage of basic public facilities and imbalance of distribution (location) might contribute to the increasing demand for travel by car.

Table 4-2: Number of government and other public uses within Ar-Riyadh

Category Of Use[27]	No.	Category Of Use	No.
Government Agencies[28]	449	Female Primary School	206
Police Station	44	Male Intermediate School	99
Fire Station	14	Female Intermediate School	65
Civil Defence Station	10	Male Secondary School	35
Central Post Office	3	Female Secondary School	33
Local Post Office	16	Male College/University	13
Prisons	7	Female College/University	20
Public Toilets	417	Islamic University	1
Neighbourhood Mosque	1247	Special Training Schools	3
Juma'a Mosque	423	Vocational/Technical Schools	48
Eid Mosque	6	Special Education Schools	1
Pre-School & Kindergarten	49	School for Mentally Retarded	4
Male Primary School	309	School for Physically Handicapped	9
Special Government Services[29]	31		

Source: After table 23 in ADA, 1987, p.91.

[27] In addition to those major uses listed in this table, there were 230 other general government and other public uses recorded during the Land-Use Survey.

[28] Government Agencies include national, regional, and city administrative offices, as well as administrative offices of a country other than Saudi Arabia.

[29] Special Government Services include high security related activities associated with national defence and internal security.

4.6 Fast-road infrastructure and growth pressures

In this section, the analyses consider the provision of fast-roads infrastructure in Ar-Riyadh. Transportation policy in some world cities has been primarily "car-oriented". The primary goal of transport policy maker was to accommodate car growth by constructing more motorways which would have enough capacity to handle future demand. However, each new fast road built to cope with the existing traffic seems to create new traffic which in turn creates new congestion. For example, the King Fahad motorway[30] in Ar-Riyadh was designed to keep traffic on the move; but unfortunately, it is become congested almost as soon as it opened in 1991. Figure 4-13 shows part of King Fahad motorway. This experience of traffic increase is not restricted to Ar-Riyadh, the "Southeast Tangent" motorway[31] is another example. Shortly after the motorway opened for traffic, parallel streets experienced reduction of the car traffic but not for long. Now, the situation is worse both motorway and streets are congested as compared to the time before the opening of the motorway.[32] Every new motorway encourages a significant increase in car traffic. For example, the opening of a city motorway in 1984 through central Stockholm in a north-south direction is

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[30] A major motorway (12 lanes) running north-south and its average width almost 90 meters.

[31] The "Southeast Tangent" motorway connect the southern part of Vienna to the north.

[32] Knoflacherh, M. R., 1989 in Austrian Environmental Transport Association, 1992, p.27.

clear instance of increasing car traffic. Its consequences were an above-average increase of car traffic in this corridor from 74,000 cars/day in 1984 to 111,000 cars/day in 1987.[33] New motorways do not solve the problems of car traffic, they just shift them elsewhere.

Motorways not only increase car traffic, but also encourage more decentralisation of a city. As will be mentioned in Chapter Nine, many studies suggest that fast-roads encourage more decentralisation of a city, increase car traffic and change the nature of the city into more car-dependence.

According to the Ar-Riyadh Development Authority, the development of the Ring Road in Ar-Riyadh has contributed to the decentralisation of urban activities. About 75 percent of the new housing development which occurred after 1986, a time at which major sections of the Ring Road were in operation, went to outer areas. In addition, city centre of Ar-Riyadh contained about 50 percent of the city's commercial establishments before the opening of these sections; this dropped to 38 percent after the opening of this motorway.[34]

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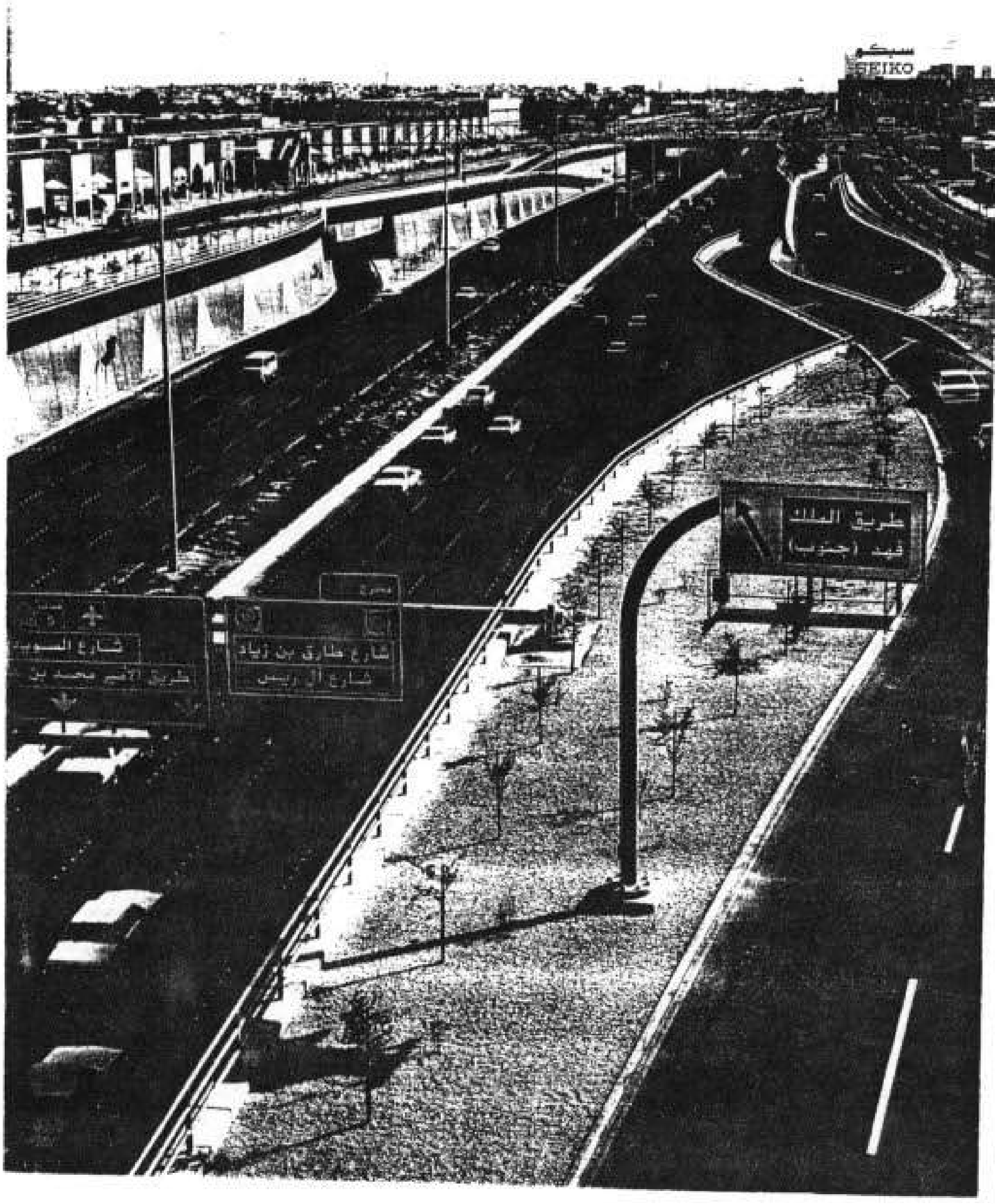
[33] PIARC-Congress, 1991, in Austrian Environmental Transport Association, 1992, p.28.
[34] ADA, 1992, in Alskait, K., 1993.

Figure 4-13: King Fahad motorway in Ar-Riyadh



Source: ADA, 1991.

Although evidence shows that fast-roads encourage more decentralisation of a city, increase car traffic and change the nature of the city into more car-dependence, there has been much investment in fast-road networks in Ar-Riyadh to meet the overwhelming demand of cars. Table 4-3 shows that almost 445 kilometres (61 percent) of the streets in Ar-Riyadh are high speed roads (freeways, expressways, and major arterial). Figure 4-14 and Figure 4-15 show examples of fast-road networks in Ar-Riyadh.

Planners and designers of land-use and transportation infrastructures should be aware that research has indicated that huge financial investment in new motorway construction which is dedicated to the rapid movement of car traffic is not necessarily the most effective method of solving transportation problems.

Table 4-3 : Street classification and cumulative lengths

Classification	Length (Kilometres)	Percent
Freeways	140.4	19.2 %
Expressways	50.1	6.8 %
Major Arterial	254.0	34.6 %
Minor Arterial	272.9	37.2 %
Collectors[35]	5.1	0.7 %
Sub-Collectors	10.7	1.5 %
Total	733.2	100.0 %

Source: The primary source of this data is classification of streets in ADA, 1987, p.165.

[35] Collectors and Sub- Collectors were classified for only one sub-area.

Figure 4-14: Makkah Road an Example of fast-roads

Figure 4-15: Another example of fast-road networks

4.7 Summary

In this chapter, current Ar-Riyadh's land-use patterns are investigated and analysed. In the first part, residential density of Ar-Riyadh was presented. It was revealed that the overall gross and net residential densities of Ar-Riyadh are relatively low compared with world-wide net residential densities. These low-density developments are causing an increase in the demand for motorise travel and reducing the choice of alternative means of travel.

The comparison data of facilities distribution in Ar-Riyadh shows the similarity between the distribution of retail outlets and service establishments with the distribution of dwelling units. This indicates strong linkages between the three sectors. The increasing number of retail outlets and service establishments outside the city centre reflects the current trend of decentralisation growth. This practice of decentralisation in general reduces travel demand if people use of the nearest retail outlets and service establishments. However, if people do not make use of that, in this case the effects create diffuse patterns of trips which can not be served effectively by public transport.

In contrast to the distribution of retail outlets and service establishments, the data reveals that government land-use is located outside major housing, retail and service areas. Government account for high

percentage of the total working age population in Ar-Riyadh. The majority of government employees and users travel by cars to get to government-uses. This practice caused traffic congestion in the morning and afternoon and also caused parking problems around most government-uses.

Regarding distribution of land-uses in Ar-Riyadh, it was revealed that the rapid urban growth in Ar-Riyadh has led to imbalance distribution of some public uses. The shortage of basic public facilities and imbalance of distribution (location) might have contributed to the increasing demand for travel by car.

In the last part, the effect of building fast roads on growth pressure was presented. The data shows that there has been much investment in motorways and fast-road networks to meet the overwhelming demand of cars in Ar-Riyadh. New motorways do not solve the problems of car traffic, they just shift them elsewhere and also they change the nature of the city into more car-dependence.

CHAPTER 5

ANALYSIS OF KEY TRENDS IN TRAVEL BEHAVIOUR IN AR-RIYADH

5. ANALYSIS OF KEY TRENDS IN TRAVEL BEHAVIOUR IN AR-RIYADH

The city that resulted from Master Plans and development control was utterly dependent on the car as major modes of transport. If car traffic continues to increase in Ar-Riyadh, the result will be more car problems in the future as mentioned in Chapter Three. This will create more congestion, frustration, parking difficulties, car accidents, environmental pollution, health problems, more dispersal of urban growth, and more community disruption.

This chapter reviews evidence of trends in travel behaviour, travel purpose, trip patterns, and predicted growth in travel demand in Ar-Riyadh. Proposals for a future transport policy have to start from an understanding of present transport patterns and how they have come about. There are many issues which affect transport patterns in Ar-Riyadh. How many trips are made, to where, by whom and for what purpose is of critical importance. Without this information it is not possible to plan for the future. In this chapter a review of data from the Ar-Riyadh Development Authority (ADA) is provided. One of the key issues in considering travel is that women are not allowed to drive for socio-cultural reasons. Therefore particular emphasis is given to women's travel in Ar-Riyadh.

It is possible to draw some broad comparisons of travel behaviour in Ar-Riyadh and in major industrialised countries, although such comparisons need to be treated with caution because of the differences in the cultures and the methods of estimation used.

5.1 Car dependence and travel of women

In Saudi Arabia, car dependence not only has an environmental and economical impact, as in the industrialised countries, it also has a social dimension. Female travel is restricted because women are not allowed to drive in Saudi Arabian cities. As a result, families are highly dependent on adult males for transport. This section will discuss the following topics: (1) restrictions on female travel, (2) high family dependence for travel on the adult males, (3) potential demand for travel by women, and (4) the need for special transport planning strategies.

5.1.1 Restrictions on female travel

The life of Saudis is determined by religious and social values. Consequently, their attitudes and behaviour have developed a different context from the Western culture. All women in Saudi society are required to veil to all men but their husbands, children and all male relatives who can not marry them. Women's privacy is extremely important. To secure that privacy and allow women to unveil, men and women are totally segregated in work

places, schools, universities, wedding halls, etc. Male-female segregation is practised as part of the Islamic principle.

Before the introduction of the car in the Saudi Arabian society, men and women walked from their homes to most of the daily activities in a friendly atmosphere. Most destinations were within walking distance because the overall city size was limited, with pedestrian scale streets and mixed land-uses. Since 1970, as land-uses have been segregated and travel has changed from foot to car, the city's structure has changed too. Whereas previously the focus of daily services was within neighbourhood boundaries, now daily services are dispersed and not easily accessible without a car.

Today, moving about in Saudi Arabian cities for people without cars is extremely difficult. Distances between home and other amenities are becoming larger and larger. The conversion of traditional neighbourhoods, from communities where people walked to communities dependant on cars, especially inconvenienced people who have limited access to cars such as women, older people, younger people, handicapped persons, and persons unable to drive.

Even though, the various roles of women as mothers, housewives, workers, and students may demand more daily trips of women, but in the new structure of Saudi Arabian cities which are based on the car as major means of transport, women are disadvantaged. For females (almost 50% of the population) travel is becoming extremely difficult because they are restricted

by three major factors. First, Saudi Arabian regulations prohibit women from driving cars. Secondly, the existing public transportation is inefficient. Thirdly, existing public transport dose not provide adequate privacy for women.

5.1.2 High family dependence for travel on the adult males

In Saudi Arabia, most travel by women has been accomplished by total dependence on either close-relative males (husband, brother, uncle, etc.) or by a male driver hired as a full-time driver (mostly non-Saudis). Table 5-1 shows the age-gender structure of the Saudi population of Ar-Riyadh. The table reveals that almost 76 percent of the Saudi population are not permitted by law to drive a car (children and women). That means only about 24 percent (adult males) are qualified to drive a car. Thus 76 percent of the population is dependent on the 24 percent adult males. This low percentage of 24% might be even lower because it includes old men, handicapped men and adult men who are unable to drive.

By contrast, the non-Saudi population illustrates a different demographic profile. Table 5-2 shows a large surplus of males in the age-gender structure (64.14 percent males to 35.86 percent female). This reflects the prevalence of male workers among the non-Saudi population.[1] This may be partially attributed to the increasing number of non-Saudi male drivers.

[1] ADA, 1987, p.124.

Table 5-1: Age-gender distribution of Ar-Riyadh Saudi population

Saudi				
Age	Male		Female	
Children 0-17	5,574	28.24%	5,266	26.68%
Adult 18 +	4,786	24.25%	3,112	20.83%
Total	10,360	52.49%	9,378	47.51%

Extract from table 42 in ADA, 1987, p.124.

Table 5-2: Age- gender distribution of Ar-Riyadh non-Saudi population

Non-Saudi				
Age	Male		Female	
Children 0-17	1,946	15.78%	1,832	14.86%
Adult 18 +	5,963	48.36%	2,590	21.00%
Total	7,909	64.14%	4,422	35.86%

Extract from table 42 in ADA, 1987, p.124.

It is the author's experience that the high family dependence on adult males for driving has further repercussions. First, although most Islamic scholars have not approved of women going alone with a non-related man,

the number of full-time male drivers for families has increased. Secondly, some under-age Saudi males are forced to drive early due to the increasing needs for family mobility. Thirdly, some old Saudi males who face difficulty in driving are forced to continue driving, again due to the increasing needs for family mobility and inefficient public transportation. Car driving by young or old persons is illegal and clearly not in the public interest due to the high risk of car accidents.

There is accordingly a clear conflict between city structure and transport system on the one hand and social behaviour pattern on the other. The existing city's structure is counterproductive to almost 76 % of the Saudi population. This conflict points at several potential remedies: either restructuring of the city; or introducing alternative means of travel such as pedestrian ways for short distance and efficient public transport for long distance; or both. This will be discussed later.

5.1.3 Potential demand for travel by women

As mentioned earlier, moving about in Saudi Arabian cities for women is extremely difficult. If women travel is difficult today, it may get worse in the future because the increasing demand for travel by women. The employment status of the Ar-Riyadh population in 1987 is presented in Table 5-3. There were almost 375,000 men and almost 50,000 women in employment. Women formed only 12 percent of the total work force in 1987. For comparison,

Greater Copenhagen as example of a Western city had a very high proportion of working women. About 78 percent of women aged 20 to 66 years were working.[2] In Britain, women formed 45 percent of the total work force in 1985.[3]

Although the percentage of working women in Ar-Riyadh is low compared with Copenhagen and Britain, the number of working women has increased dramatically since 1974. As Table 5-4 shows, there were only 2,583 working women in Ar-Riyadh which represented only 3 percent of the work force at that time compared with 49,011 working women in 1987 which represented 12 percent of the working force. That means the number of working women has increased almost 19 times between 1974 and 1987. This indicates that there was also a large increase in the demand for travel by working women in Ar-Riyadh. Moreover, there could be a potentially large demand for travel by working women in the future especially now that the total number of female students is high as shown in Table 5-5. The table shows that in 1993 there was a total of 1,759,186 female students and 137,750 female teachers and administrators in all education levels in Saudi Arabia. Most of these female students will join the work force as soon as they

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[2] Hartoft-Nielsen, Peter, The Danish Experience: Copenhagen, in Department of the Environment, 1993, p.4.

[3] Herbert, D. and Thomas, C., 1990, p.288.

graduate. There will accordingly be a large demand for travel by females in Saudi Arabia in the future.

Table 5-3: Employment status by gender
1987

	Men	%	Women	%	Total
Employed	374,753	88%	49,011	12%	423,764
Unemployed[4]	98,265	28%	251,158	72%	349,423
Total	473,018		300,169		773,187

Extract from table 49 in ADA, 1987, p.144.

Table 5-4: Employment status by gender
1974

	Men	%	Women	%	Total
Employed	81,056	97%	2,583	3%	83,639
Unemployed	6,887	9%	70,749	91%	77,636
Students	91,387	59%	63,612	41%	154,999
Total	179,330		136,944		316,274

Extract from table 18 in Al Sheikh, A., 1981, p.119.

[4] Students and housewives are the largest groups of unemployed.

Table 5-5: Total number of female students, administrators and teachers at all education levels

Education Levels	Schools	Students	Teachers & Administrators
Girls kindergartens	233	17,552	2,272
Girls elementary schools	4,750	933,198	68,970
Girls intermediate schools	1706	325,642	27,762
Girls secondary schools	809	171,877	15,012
Female-teachers inst. & coll.	178	46,463	2,617
Girls technical education	25	1654	336
Girls adult education	1402	67,783	5,799
Girls special education	18	2,166	630
Girls other schools	339	66,205	4,112
Girls private schools	1,471	99,628	8,971
Girls higher education	14	27,018	1269
Total	10,941	1,759,186	137,750

Extract from table 1 in General Presidency for Girls Education, 1994, p.4.

5.1.4 The need for special transport planning strategies

Islam's principle and Social traditions in Saudi Arabia are very important factors when planning any transport strategies. Transferring transport planning strategies formulated in the other countries to the Saudi Arabian society without considering the Saudi culture is not feasible; it would create social problems. With regard to the choice of transport planning

strategy, Thomson has warned about the seriousness of transferring transport planning principles and techniques without understanding the target society. He states that:

> "...It is dangerous to try to import into one city practice observed in another without understanding how they fit into the overall strategy of each city. The choice of transport strategy is not simply a calculation of cost-effectiveness. It is also a choice of a way of life. Moreover it is a choice which may affect different sections of the population very differently. It is therefore a highly political question...In most cities the most important factor bearing on the choice of strategy is the existing structure and transport system...There is no serious possibility of transforming a city like London into one like Los Angeles, or vice versa...Probably the decisive factor determining strategic decisions in many cities has been the particular way in which planning power has been distributed."[5]

The question to be investigated is whether social conditions in Saudi Arabia are sufficiently similar to those of the other societies to justify transferring some if not all their transport planning principles and techniques. As seen in the earlier sections, there are major differences between industrialised societies and Saudi society regarding women's mobility. Herbert and Thomas mentioned that even within Britain there are significant differences between groups such as recent Asian immigrants and the native British population.[6]

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[5] Thomson, J. Michael, 1977, p. 322f

[6] Herbert, D. and Thomas, C., 1990, p.288.

Today, with the growth in demand for travel by women in Saudi Arabian cities, the main question is what needs to be done to improve the mobility of women and at the same time preserve cultural values. Permitting women to drive in the Saudi society is impossible for religious and cultural reasons as mentioned earlier. However even assuming it was possible, it would certainly improve women's mobility but would also worsen the problem of car-dependence which is the core of this thesis. Investigating alternative land-use strategies and improving public transportation might make a contribution to minimise the problem. This will be discussed later.

5.2 Current Ar-Riyadh's Transport Patterns

This section reviews evidence of trends in travel behaviour, travel purpose, trip patterns, and predicted growth in travel demand in Ar-Riyadh. Proposals for a future transport policy have to start from an understanding of present transport patterns. The study of the transportation characteristics of Ar-Riyadh will include the following topics: (1) Basic census and car ownership, (2) Person trip rates, (3) Trip purpose, (4) Mode of travel, and (5) Trip rates by gender and age. A brief description of each topic will be presented in the following.

5.2.1 Basic census and car ownership

According to the ADA study, Saudis form the largest part of the population and households in Ar-Riyadh. They comprise 62 percent of the population and 53 percent of the households as shown in Table 5-6. However there is a high percentage of non-Saudi households in the city which comprise almost 50 percent. The average household size in Ar-Riyadh ranges from 7.24 persons per household for Saudi families to 5.10 persons per household for non-Saudi families. The overall average household size of 6.17 persons is approximately twice the average household size of many American cities.[7] Moreover, as the table shows, cars per household range from 1.48 cars per household for Saudi families to 0.95 cars per household for non-Saudi families. Moving about in Ar-Riyadh for people without car is extremely difficult. For that reason, only 1.3 percent of the Saudi households own no cars and, city-wide, average of the households who own no cars is only 2.6 percent. This very low percentage indicates a high degree of car-ownership and car-dependence in Ar-Riyadh. In comparison in the UK, almost a one third of households do not own a car.[8]

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[7] ADA, Riyadh Transportation Study, Phase 2, p.16.

[8] Royal Commission on Environmental Pollution, 1994, p.12.

Table 5-6 : Basic census and car ownership

Item	Saudi	Non- Saudi	Total
Population	782,180	481,350	1,263,530
Households	107,960	96,840	204,800
Average households size	7.24	5.10	6.17
Cars	159,400	91,200	250,600
Car / households	1.48	0.95	1.22
Car / person	0.20	0.19	0.20
Percent of zero car / households	1.3%	-.-	2.6%

Extract from table 3.1 in ADA, Riyadh Transportation Study, Phase 2, p.18.

5.2.2 Person trip rates

As Table 5-7 shows, a total of 2,698,460 person trips is made each weekday in Ar-Riyadh. The total daily person trips rates are 14.54 for Saudi household and 11.66 for non-Saudi household (city-wide 13.18). According to the ADA study, the overall household trip rates are higher than household trip rates recorded in the American cities. Yet, it should be remembered that the average household size in Ar-Riyadh around twice the typical American household size. Therefore, as the ADA study mentions, the trip rates per

person as opposed to households in Ar-Riyadh (2.14) are generally lower than recorded in American cities. In 1980, trip rates in the American cities, ranged from about 2.8 to 3.5 trips per person per day.[9]

Table 5-7 : Daily person trips and trip rates/household

Item	Saudi	Non- Saudi	Citywide
Home-based work	235,110	412,460	647,570
Home-based school	413,350	157,980	571,330
Home-based other	453,560	236,330	689,890
Non-home-based	467,420	322,250	789,670
Total	1,569,440	1,129,020	2,698,460
Daily Person Trip Rates / Household			
Home-based work	2.18	4.26	3.16
Home-based school	3.83	1.63	2.79
Home-based other	4.20	2.44	3.37
Non-home-based	4.33	3.33	3.86
Total	14.54	11.66	13.18
Total Trips / Person	2.01	2.33	2.14

Extract from table 3.1 in ADA, Riyadh Transportation Study, Phase 2, p.18.

9 ADA, Riyadh Transportation Study, Phase 2, p.17.

5.2.3 Trip purpose

Table 5-8 summarises trips from the residential survey into ten major categories. In broad purpose categories, 29.3 percent of the total daily trips are non-home-based, 24.0 percent are home-based work, 21.2 percent are home-based school, 8.2 percent home-based shop, and the remaining 17.4 percent are home-based other. Two important points can be noted in this table. First, almost one third of the total daily trips in Ar-Riyadh are non-home-based which indicates multi-purpose trips (more than one purpose trips). Secondly, there is a relatively high percentage of daily trips to school (21.2%). This might be due to the unbalanced distribution of schools especially in the new areas.

Table 5-8 : Person trips by general trip purpose

Purpose	Trips	Percent Of Total
Non-home based	789,600	29.3%
Home-based to work	647,600	24.0%
Home-based to school	571,400	21.2%
Home-based to shop	221,500	8.2%
Home-based to social	199,400	7.4%
Home-based to personal	128,200	4.8%
Home-based to medical	64,100	2.4%
Home-based to job related	36,800	1.4%
Home-based to other	38,200	1.4%
Home-based to home	1,600	0.1%
Total	2,698,400	100.0%

Extract from table 3.2.1 in ADA, Riyadh Transportation Study, Phase 2, p.19.

5.2.4 Mode of travel

Table 5-9 shows the modal split of trips in Ar-Riyadh and Table 5-10 shows the modal split of trips in Great Britain for comparison. Three important points can be noted in Table 5-9. Firstly, only 1.6 percent of all trips are being made on public buses compared with 9 percent in Great Britain. Secondly, 8.3 percent of the total trips in Ar-Riyadh are made in private vans (mini-buses). This relatively high percentage might be due to the big household size (average Saudi household size in Ar-Riyadh is 7.24 persons). Thirdly, almost 97 percent of the trips are made in private cars in Ar-Riyadh (including private mini-bus) compared with 74 percent in Great Britain as Table 5-10 shows. This indicates a high percentage of car dependence in Ar-Riyadh.

Table 5-9: Trips by mode in Ar-Riyadh

Mode Of Travel	Percent Of Total
By car (55.8% car driver and 32.7% car passenger)	88.5%
By private van (mini-bus)	8.3%
By public bus	1.6%
By truck	0.8%
By taxi / limousine	0.6%
By motorcycle	0.1%
Total	100.0%

Extract from table 3.3 in ADA, Riyadh Transportation Study, Phase 2, p.21.

Table 5-10: Trips by mode in Great Britain

Mode Of Travel[10]	Percent Of Total
By car (46% car driver and 28% car passenger)	74%
By public bus	9%
On foot	9%
By rail	2%
In other ways	6%
Total	100.0%

Extract from table 2.1 in Royal Commission on Environmental Pollution, 1994, p.11.

5.2.5 Trip rates by gender and age

Table 5-11 shows trip rates by gender and age in Ar-Riyadh. The table shows, on the average, Saudi males of 16 years and older make almost five times as many weekday trips than Saudi females in the same age group. This indicates, as mentioned by ADA study, that there could be a potentially large demand for travel by females in Al-Riyadh if the social characteristics change to allow more female mobility.[11] However, according to the same study, some care should be exercised in interpreting Table 5-11. It is possible that the low average trip rate for adult females is due to consistent underestimates of trips

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[10] According to the report, this analysis excludes journeys of less than a mile and distances travelled outside Great Britain.

[11] ADA, Riyadh Transportation Study, Phase 2, p.20.

by female members of households. This could have resulted from cultural customs making surveys of adult female members of the family more unreliable than surveys of adult male members of the same family.[12]

Women in Britain also have problems of access to cars even though they are permitted to drive. About one-third own cars and only half the women in car-owning households have regular access to the family car which causes them to rely on public transport.[13] Car mileage driven by men is also higher than by women. The ratio of car mileage driven by females in the United Kingdom rose from 16 percent in 1975/76 to 25 percent in 1989/90.[14] Moreover, in the same period the ratio of average annual distance travelled in a car by females to the average for men rose from 0.53 to 0.67 in the age group of 17-29 and from 0.43 to 0.56 in the age group of 30-59.[15]

Table 5-11: Trip rates by gender and age

Gender	Age	Average Trips / Person
Male and Female	5-15 Years	0.87%
Male	16 + Years	2.78%
Female	16 + Years	0.58%

Extract from table 3.4 in ADA, Riyadh Transportation Study, Phase 2, p.22.

[12] ADA, Riyadh Transportation Study, Phase 2, p.20.

[13] Herbert, D. and Thomas, C., 1990, p.289.

[14] NTS, 1989/91 in Royal Commission on Environmental Pollution, 1994, p.16.

[15] Royal Commission on Environmental Pollution, 1994, p.16.

5.3 Performance of public transport operating in Ar-Riyadh

In this section, the current public transport in Ar-Riyadh will be presented followed by public transport shares in other developed countries.

5.3.1 Current public transport

There are two kinds of public transport operating in Ar-Riyadh. (1) a bus system operated by the Saudi Arabian Public Transport Company (SAPTCO) as seen in Figure 5-1; and (2) Mini-bus systems, private mini-buses individually operated where there is no arrangement for female passengers. According to the ADA study, the estimated average number of annual weekday public transport passengers in Ar-Riyadh is 70,300 passengers. The number of SAPTCO passengers is 35,140 (48 %)[16] and number of Mini-bus passengers is 38,160 (52%).[17] Since 1983, as seen in Figure 5-2, SAPTCO's yearly passenger numbers have declined sharply from over 35 million in 1982 to less than 6.2 million in 1991.[18]

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[16] ADA, 1987, p.185.

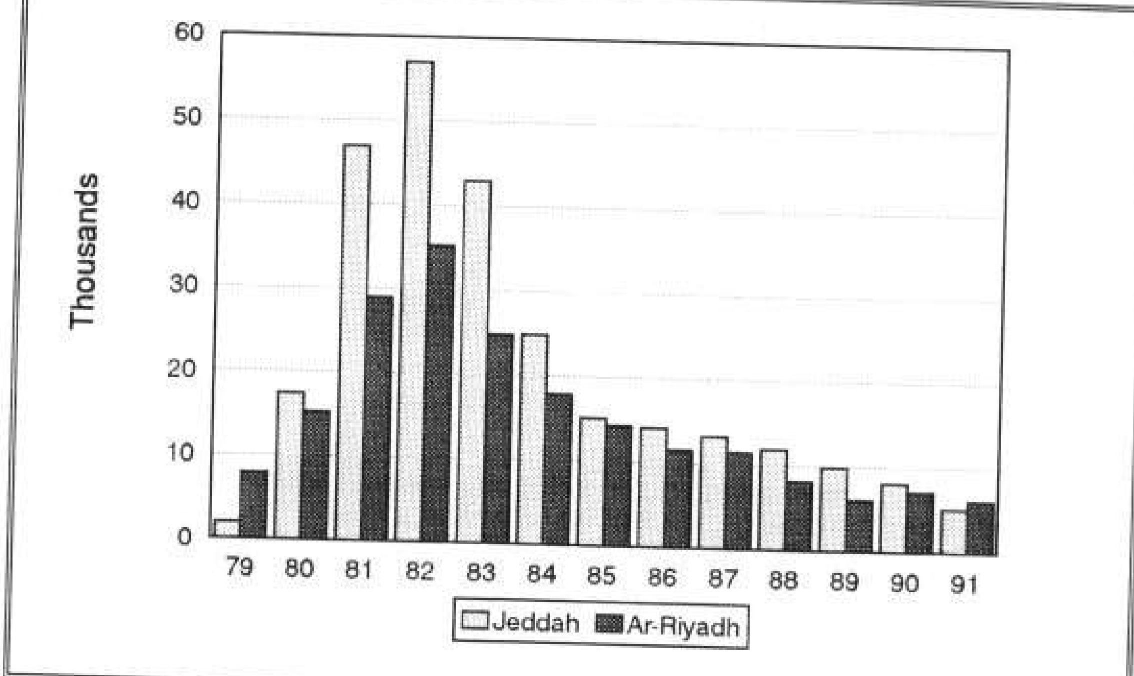
[17] ADA, 1987, p.187.

[18] Saudi Public Transport Company, Annual Report, 1991, p.19.

Figure 5-1: Bus fleet of SAPTCO

Source: The Annual Report of the Saudi Public Transport Company, 1991, p.36.

Figure 5-2: Decline in SAPTCO passengers (1979-1991)



Source: Graph developed by author based on the Annual Report of the Saudi Public Transport Company, 1991, p.19.

A summary of the passenger profile data indicates that the percentage of female passengers in the SAPTCO is only about 9 percent as seen in Figure 5-3. The study shows also that only about 13 percent of SAPTCO passengers are Saudis and only 14 percent are children under 16 or old people over 50 years.[19] The passenger profile for mini-buses is similar to that for SAPTCO except that there is no arrangement for female passengers on these mini-buses.[20] In 1992, another study was evaluated the performance of the public transportation in Ar-Riyadh. The study shows that only 6.1 percent of SAPTCO passengers are Saudis.[21]

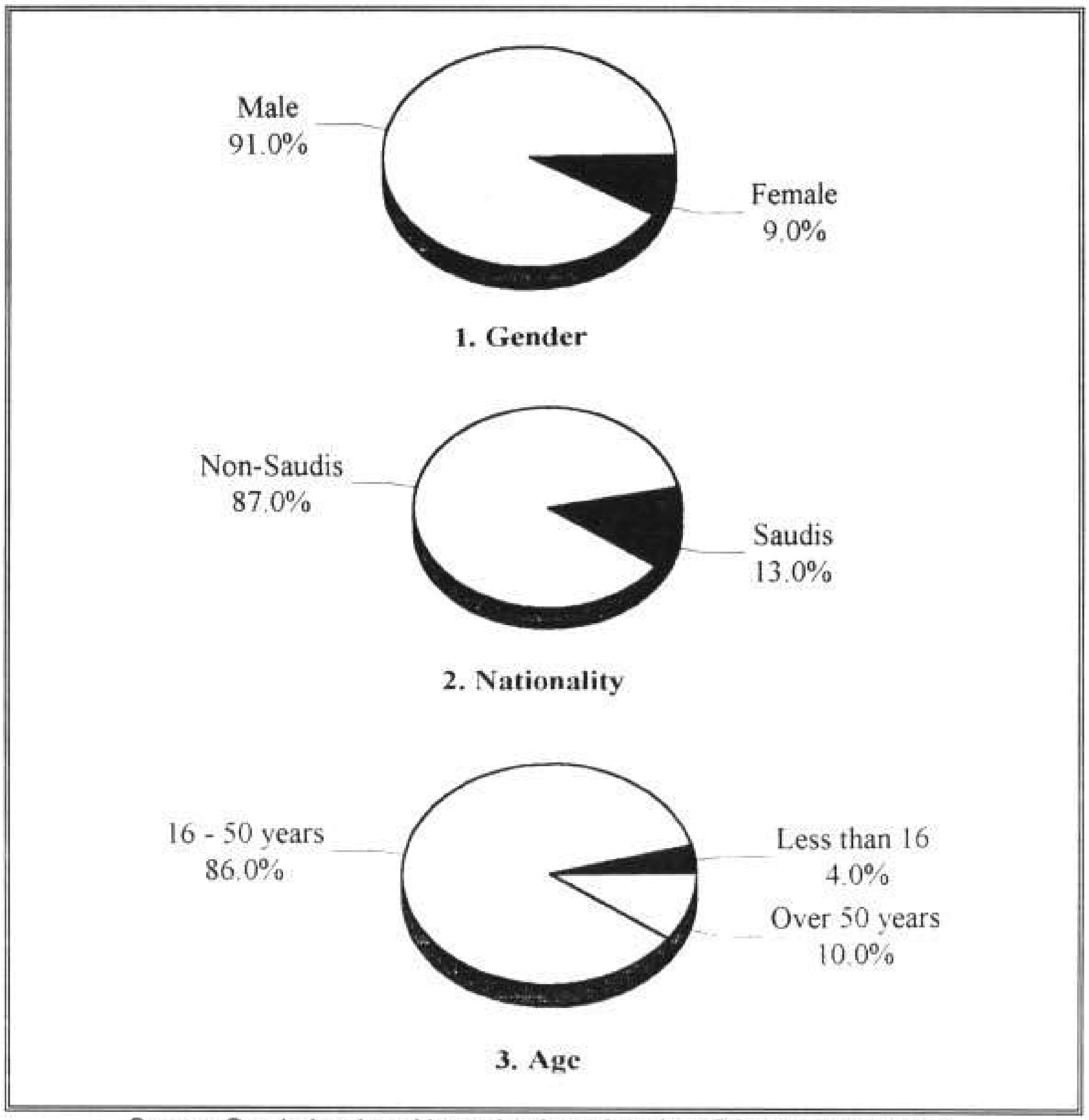
The above figures indicate that existing public transport is inefficient especially for women passengers, children under driving age, and old people. This leads to greater car dependence especially where distances continue to increase.

[19] ADA, 1987, p.184.

[20] ADA, 1987, p.187.

[21] Al-khadi, S., 1992, p.60.

Figure 5-3: SAPTCO's passenger profile



Source: Graph developed by author based on the ADA data, 1987, p.186.

5.3.2 Public transport shares in other countries

Table 5-12 compares the proportion of public transport in Ar-Riyadh with public transport in other countries. The table shows the proportion of

personal travel (passenger-kilometres travelled annually) by car and public transport (bus & rail) in a number of developed countries in 1991. The table illustrates the significance of public transport in Japan (47 % share of personal travel) and its insignificance in the United States (only 2 % share of personal travel). The UK, has (with 12%) the lowest percentage of public transport in Europe. In Ar-Riyadh the proportion of public transport is even less than in the USA (1.6 % share of personal travel).

Table 5-12: Modes of personal travel in developed countries[22]

Country	Car	Public Transport (Bus & Rail)
Japan	53%	47%
Spain	73%	27%
Denmark	79%	21%
Italy	79%	21%
Portugal	81%	19%
Belgium	82%	18%
Germany	84%	16%
Netherlands	84%	16%
France	85%	15%
Sweden	85%	15%
Great Britain	88%	12%
USA	98%	2%

Source: Extract from TSGB, 1993 in table 6.3 in Royal Commission on Environmental Pollution, 1994, p.90.

[22] According to the Royal Commission on Environmental Pollution, shares are of total personal travel by car, bus and rail, measured as passenger-kilometres and disregarding travel by other modes.

5.4 Summary

In this chapter, travel of women in Saudi Arabia was described along with the socio-cultural restrictions on women's use of cars. Travel for women is becoming extremely difficult. Saudi Arabian regulations prohibit women from driving cars, and the existing public transport, which is largely inefficient, does not provide adequate privacy for women. The data indicated that there was a large demand for travel by females in Saudi Arabia and that there could be a potentially very much larger demand for travel by females in the future. The number of working women increased almost 19 times between 1974 and 1987. Moreover, today the total number of female students who will be working in the near future is very high.

The data also revealed that almost 3/4 of the population is dependent on 1/4 for travel. This low percentage might be even lower because it includes old men, handicapped men and adult men who are unable to drive. This led to three major problems in the Saudi Arabian cities. First, although most Islamic scholars have not approved of women going alone with non-related man, the number of full-time male drivers for families has increased. Secondly, some under-age Saudi males are forced to drive early due to the increasing needs for family mobility. Thirdly, some old Saudi males who face difficulty in driving are forced to continue driving, again due to the increasing needs for family mobility and inefficient public transportation.

The current transportation patterns within the city of Ar-Riyadh were investigated and analysed. It revealed the following information: high percentage car-ownership per household, high total daily person trips rates for households, and high percentage of car use and low use of public buses.

Finally, the performance of public transport in Ar-Riyadh was reviewed. The data revealed that since 1983, SAPTCO's yearly passenger numbers have declined sharply. A summary of the passenger profile data indicated that the percentage of Saudis passengers in the SAPTCO was very low. The study shows also low percentage of female passengers, children under 16, and old people over 50 years in the SAPTCO. The data suggests that existing public transport is unacceptable especially to women passengers, children under driving age, and old people.

This conflict in Ar-Riyadh city points at several potential remedies such as: restructuring of the city, changing in the land-uses, and introducing alternative means of travel such as pedestrian ways for short distance and efficient public transport for long distance. In the following chapters, the development and impact of the urban transport systems on the Western cities will be presented in addition to the possible approaches to reducing car dependence as background for a specific Ar-Riyadh study. The development of Western cities is closely associated with innovation in transport technology. Therefore, a study of current conditions in Western cities could give clues to major car problems and potential remedies.

CHAPTER 6

IMPACT OF CARS ON THE DEVELOPMENT OF SOME CITIES IN WESTERN COUNTRIES

6. IMPACT OF CARS ON THE DEVELOPMENT OF SOME CITIES IN WESTERN COUNTRIES

As mentioned before, the development of Western cities is closely associated with innovation in transport technology. Cities in Western countries are a generation further into the development of urban transport systems than Saudi Arabian cities. Saudi Arabian cities are now approaching the phase that the Western cities went through a generation ago. Therefore, a study of current conditions in Western cities might give clues as to what will happen in Saudi Arabian cities if cars are to be maintained as main transport system and could give potential remedies.

In the following therefore, a summary of the development and impact of the urban transport systems on the Western cities will be presented as background for a specific Ar-Riyadh study. Absolutely, comparisons between Western cities and Saudi Arabian cities need to be treated with caution because of the differences in the two cultures. The phenomenon of car dependence is spreading with severe consequences in Third world countries. There may be different kinds of problems facing these countries than the Western counties.

6.1 Development of Western cities

Most of the Western cities began as walking cities and city's spatial form originated as places of high housing density and mixed land-uses. Therefore historical data show high population densities. For example, Warner's study of Philadelphia showed that in 1860, its population density was 364 person/ha, but by 1905 the railway era had reduced its population density to 129 person/ha.[1] In 1905, Jefferson carried out a land-use study of eight major cities and showed the following population density: New York 227, Chicago 93, Boston 108, St. Louis 89, London 154, Paris 278, Berlin 227 and Vienna 143 persons/ha.[2]

Chandler and Fox provide population density estimates through their study of 3000 years of urban growth. For mediaeval cities, they suggest that population densities were probably around 100 persons/ha rising to 200 persons/ha before crowding led to new outer walls. Genoa seems to have been the most crowded with 600 persons/ha in the late Middle Ages and Edinburgh was almost as dense by 1750. With the exception of these densely packed cities, data support the image of the historic walking city as

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[1] Warner, 1986, in Newman & Kenworthy, 1989, p.79.

[2] Jefferson, 1909, in Newman & Kenworthy, 1989, p.79.

approximately between 100 and 200 persons/ha.[3] The introduction of car transportation has reduced the population density of most of the World's cities. The suburbanisation and decline in population density will be discussed later in Section 6.3.1.

6.2 Summary of transport system development

According to Herbert and Thomas "in all cities there are close interactive relationships between transportation, urban morphology and spatial patterns of urban functions".[4] Table 6-1 shows Herbert and Thomas' illustration of the development of the transport system in the Western cities. The generalised stages in the development of an urban transport system in Western cities are closely associated with innovations in transport technology, as seen in Figure 6-1. Herbert and Thomas suggest that this development sequence is most applicable to medium-sized cities in which development began in the Nineteenth century and that it has resulted in strongly centralised urban systems.

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[3] Chandler and Fox, 1974, in Newman & Kenworthy, 1989, p.78f.

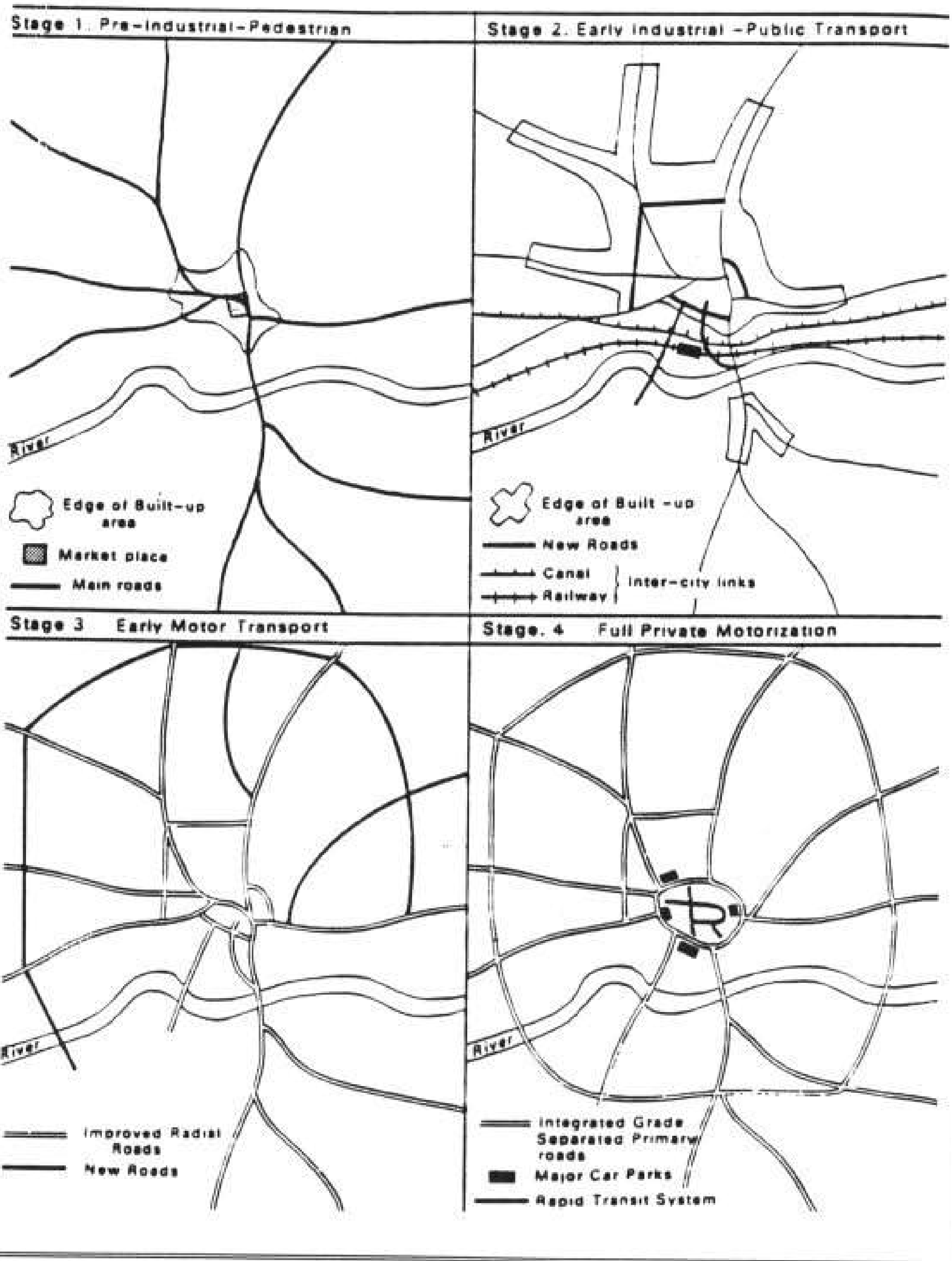
[4] Herbert and Thomas, 1990, p.157.

Table 6-1: Development of the transport system of Western cities

Stages	Urban functions	Transport technology	Transportation system	Urban form
Stage 1 Pre-industrial	defence, marketing, political-symbolic, craft industry	pedestrian, draught-animal	route convergence, radial	compact
Stage 2 Early Industial	basic industries, secondary manufacturing	electric tram, streetcar, public transport	radial improvements, incremental additions	high population density sub-urbanisation, stellate form
Stage 3 Industrial	broadening industry, tertiary service expansion	motor bus, public transport, early cars	additional radials, initiation of 'ring' roads (incomplete)	lower population density sub-urbanisation, industrial decentralisation
Stage 4 Post-indstrial	addition of quaternary activities	towards universal car ownership	integrated radial and circumferential road network	low population density sub-urbanisation, widespread functional decentralisation

Source: After Herbert and Thomas, 1990, p.159.

Figure 6-1: Development stages of urban transport systems for the Western city



Source: Herbert and Thomas, 1990, p.158.

6.3 The transformation of Western cities as result of new transport technology

In the railway era, as seen in Figure 6-1, railway stations were a major determinate of the land-use location, but nowadays, motorways, highways, and expressways have become major determinants of the land-use location. Failure to understand the relationships between land-use and transportation in cities has resulted in the generation of many problems in urban transportation. In the following sections, the physical transformation of the traditional city as result of new transportation technology will be presented (public transportation & the car). It includes the following issues: (1) the suburbanisation and decline in population density of cities; and (2) the decentralisation of industry.

6.3.1 The suburbanisation and decline in population density

The introduction of modern transportation systems has reduced the population density of most of the World's cities. For example, the introduction of railway lines has allowed development spread outward from the compact core. Urbanisation extended outward from the centre along the railway lines. In New York and Philadelphia, for example, decline of population density started as early as 1860 due to the railway age.[5] European cities also

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[5] Blumenfeld, 1965, in Newman & Kenworthy, 1989, p.79.

decreased in population density as public transport expanded the urban area outwards, but the change has always been much slower than in the United States.[6] For example, in 1931, the population density in London declined to 90 persons/ha[7] and by 1972, to 75 persons/ha.[8]

The history of the transformation of the original suburbs has been described by Mumford.[9] He describes how suburbs created between 1850 and 1920 owed their appearance essentially to the railway. After 1895, the growth of suburbs close to the central city was an outcome of the electric trolley car (tramway) and the underground. The scale of the suburb (pedestrian scale neighbourhood) was not totally the outcome of its "open planning" (which favoured low population density). There was a physical limit to the spread of any neighbourhood. Houses had to be arranged within short walking distances of the railway station; and only those rich enough to afford a house and carriage could live farther away from the railway station. As a result the initial suburbs were relatively dense close to stations and the city expanded into a star like shape.

Mumford also states that when the private car was introduced, the original suburb was destroyed. The suburb became a diffused low-density

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[6] Newman & Kenworthy, 1989, p.79.

[7] Hall, 1973, in Newman & Kenworthy, 1989, p.79.

[8] Newman & Kenworthy, 1989, p.79.

[9] Mumford, 1961, p.573-577.

mass and ceased to be a pedestrian-scale neighbourhood unit. Once that limit was gone, the suburb was no longer an alternative to the city and became part of the inescapable metropolis. Moreover, not only did the advent of the car destroy the former pedestrian scale of neighbourhoods as Mumford mentions; it also led to an increase in the number of cars required per family, and it changed the suburban housewife into a "full-time" driver. The dependence on car travel became even more crucial because the appearance of the car was accompanied by the intentional abandoning of the electric transportation system. Instead of persisting with a mixed transportation system, offering alternative choices of direction and speed to fit the circumstance, the new suburban sprawl has become dependent on the private car. This practice, as Mumford mentions, has produced an anti-urban style. The car has made streets unsafe for pedestrians and the expansion of the suburb has made the walking distances impractical. The need to use the car for work, shopping, etc., requires that each new building (such as factory; office; department store or shopping centre) has a large car parking area.[10]

The era of the private car has reduced the city's density to a much higher degree than any previous transportation system because the car allows unlimited access to any place accessible by roads. According to Friedman for example, between 1934 and 1954, the suburban population of

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[10] Mumford, 1961, p.573-577.

the US increased 75% while the whole population increased 25%.[11] The cities of the United States declined rapidly in population densities after 1940.[12] The car as predominant means of transport allowed and encouraged urban growth dispersal. In most of the world's cities, the newest developments are totally dependent on the car. As a result, large percentages of land are assigned to roads and parking spaces. Roads and parking areas acquire up to 30 percent of land in European cities and more than 50 percent in North American cities.[13] According to Pederson, today, the private car is the only available form of transportation that operates well in low-density conditions but one disadvantage of the private car is that it does not operate well in high-density conditions. It requires a big area per passenger carried, it demands parking areas when not in operation, and it is inefficient when required to stop and start repeatedly.[14]

6.3.2 Current trend of decentralisation of industry

The rapid spread of the car has been accompanied by even more rapid land-use changes. For example, in the American city decentralisation of offices, manufacturers, and traders started with the car era. According to

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[11] Friedman, p.120.

[12] Weaver, 1977 and Edmonston, 1975, in Newman & Kenworthy, 1989, p.80.

[13] Richards, 1990, p.1.

[14] Pederson, 1980, p.12.

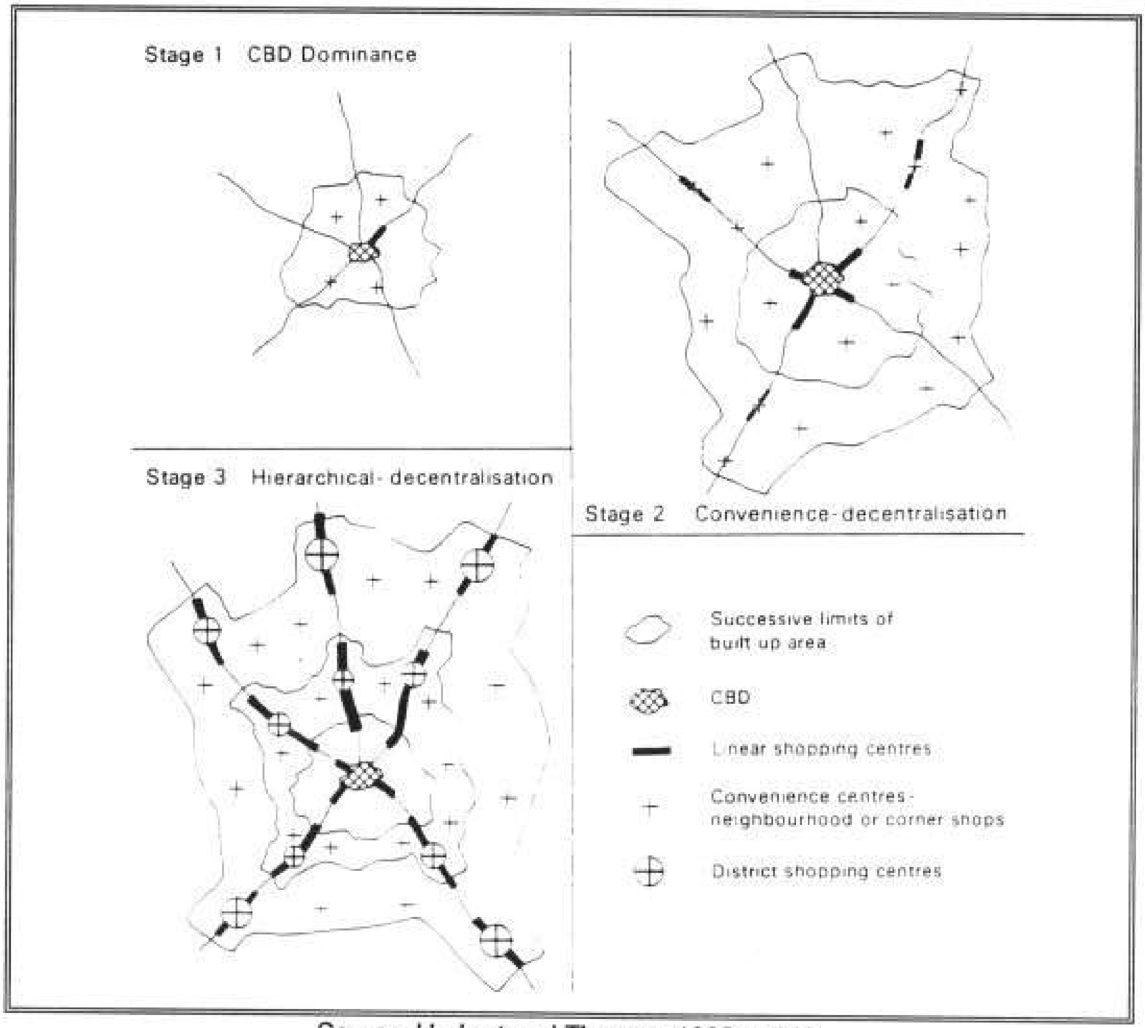
Pederson, in the late 30s and especially from 50s to 60s, traders found that they could gain more by placing large stores outside the city centre. After the 60s, many offices moved away from the city centre, manufacturers placed new factories near major motorways at the edge of the city. Motorways have become a major determinant of land-use location.[15] The main reasons for decentralisation are: first, the cost of land outside the city is cheaper. Second, construction of accommodation is cheaper as on multi-storey inner-city structures are required. Third, access for car users is easier (avoiding congestion and parking shortages in the city centre). Lastly, improvement in communication's technology, e.g., computers, faxes, etc. has reduced the need for concentration of facilities in on place.

According to Herbert and Thomas, with the physical growth of the cities beyond the original centres, remarkable numbers of people are living too far away from the most required goods and services in city centre. New suppliers of frequent goods and services (lowest order functions) respond by establishing businesses in locations reachable by the suburbs' population. Generally, these additional functions will not respond to the most accessible of the original non-central areas, and in the process, create a sequence of "second-order service centres". These centres will not usually accomplish the degree of specialisation found in the main city centre. This occurs because

[15] Pederson, 1980, p.19.

these second-order centres will be less accessible to the city-wide population necessary to maintain the "highest-order centres".[16] Figure 6-2 shows schematic representation of the process as described by Herbert and Thomas.

Figure 6-2: Schematic representation of the process of retail decentralisation



Source: Herbert and Thomas, 1990, p.188.

[16] Herbert and Thomas, 1990, p.187.

Moreover, Herbert & Thomas mention that since the Fifties the powerful forces promoting retail decentralisation in American cities have resulted in the transformation of the urban system of shopping centres. Planned car-oriented shopping centres have been developed at a profusion of accessible sites on the urban motorway network.[17] According to Lord, between 1950 and 1980 the number of shopping centres increased from 100 to 22,000. Recently developed shopping centres have tended to increase in size from neighbourhood to regional status as personal mobility has increased.[18] The growth of stores and centres outside the city has increased dependence on cars.[19] In the UK, between 1982 and 1992 more than half of new retail floor-space opened was in sites outside the city. Between 1988 and 1992, the number of superstores increased by more than half.[20]

Brotchie suggests that the practice of dispersion of homes away from the cities into low-density suburban development is long established in many Western countries, and is becoming much more evident even in those European countries with a long history of high-density apartment housing and planning policies that prevent dispersion.[21] The practice of segregation

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[17] Herbert and Thomas, 1990, p.188f.

[18] Lord, 1988 in Herbert and Thomas, 1990, p.189f.

[19] Royal Commission on Environmental Pollution, 1994, p.17.

[20] Royal Commission on Environmental Pollution, 1994, p.16.

[21] Brotchie, 1985, p.137.

and decentralisation of land-use has led to increasing distances and led to an increasing demand for travel between different uses.

According to Pederson, modern American and many European cities take the segregation of land-uses for granted, for example the segregation of housing from workplaces and shopping. A community is either residential or non-residential, and non-residential areas are further segregated into manufacturing, wholesaling, and retailing zones.[22] However, this is not true in some cities such as Los Angeles today and Copenhagen in the late 1940 which will be discussed in chapter Ten.

If the workplaces, schools, shops, and other amenities are far from the users' homes, they need to travel to those places quickly. Most often, cars are the most convenient means of travel compared to other forms of transport. This has led to increasing dependence on cars.

The practices of isolated land-use (single function land-use) increase distances outward. New neighbourhoods move away from businesses, offices, and other activities. Some writers suggest that the modern transportation systems, especially the private car, help the development of isolated land-uses. For example Pederson says:

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[22] Pederson, 1980, p.9.

"This 'natural segregation' is a product of improved urban transportation, which made it possible for workers to live away from their place of work..."[23]

Newman & Kenworthy also suggest that:

"Inner areas, developed prior to [the] dominance of the car, have much more mixed land-use patterns (corner shops, apartments above shops etc.) than the rigidly zoned suburban areas of the automobile era."[24]

In the United States, planning with it standard rigid zoning practice that separates land-uses over different parts of the city has added to car dependence. Zuckermann suggested that the main cause of car dependence in the United States is the kind of land-use planning that leaves people with no choice but to depend on their cars.[25] Some of the World's cities duplicate this practice of land-use segregation.

One view has been advocated that a major contributory factor to increasing car dependence is the tendency for increasing distances to be established between homes and destinations of daily trips. This increase in the radius of activities produces a higher level of personal trips and longer journeys. These in turn impose greater needs for motorised travel, especially

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[23] Pederson, 1980, p.9.

[24] Newman & Kenworthy, 1989, p.14.

[25] Zuckermann, 1991, p.223.

by private car. As a result, people walk less and depend more on motorised transport throughout the city, whereas the old city used to be compact with high population density and mixed land-uses.

Untermann suggested that recent car oriented developments leave us with two kinds of planning problems: firstly, an existing land-use and transportation pattern that is not appropriate for the reducing in car dependence. Secondly, car oriented attitudes, ideas and beliefs that are completely embedded in the minds of the planners, decision-makers and the population. These attitudes have led to the development of high levels of funding for new road construction and car oriented standards for street design that increase car dependence.[26]

6.4 Summary

This chapter presented the transformation of Western cities as result of new transport technology. Spatial form of Western cities typically originated as a small compact centre with high development density and mixed land-uses. Most destinations were within walking distances because the overall city size was limited. However, with the advent of the private car, the density of a city has been reduced to a much higher degree than by any

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[26] Untermann, Rich, Why you can't walk there: strategies for improving the pedestrian environment in the United States, 1984, in Tolley, R., 1990, p.175f.

previous transportation system. Car-use has encouraged urban growth dispersal. In most of the world's cities, the newest developments are totally dependent on the car. The rapid growth in car-use has been accompanied by even more rapid land-use changes. The data in this chapter revealed that in the American city decentralisation of offices, manufacturers, and traders started with the car era. After the Sixties, many offices moved away from the city centre, manufacturers placed new factories near major motorways at the edge of the city. Motorways have now become a major determinant of land-use location.

It is clear that the new structure of modern cities led to an increasing demand for mortised travel between different land-uses. If the workplaces, schools, shops, and other amenities are far from the users' homes, they need to travel to those places quickly. Most often, cars are the most convenient means of travel. This situation has led to increasing dependence on cars.

This is a "snowball" effect. As more people have cars, it encourages more diffuse developments which in turn encourage greater car-use and greater need of cars. As a result, people walk less and depend more on motorised transport throughout the city.

CHAPTER 7

ENVIRONMENTAL IMPACT AND ECONOMICAL COST OF INCREASING CAR-USE IN MAJOR INDUSTRIALISED COUNTRIES

7. ENVIRONMENTAL IMPACT AND ECONOMICAL COST OF INCREASING CAR-USE IN MAJOR INDUSTRIALISED COUNTRIES

This chapter considers the impact of car-dependence on the environment and the economy in major industrialised countries. Since the beginning of the car era, until the sixties, governments and local authorities everywhere, especially in the Western countries, regarded car transportation as the vital fluid of economy. It was felt that the car must be given every support (roads, car facilities, etc.) to move freely. But after the sixties, the appearance of world-wide car problems started to change that philosophy. There came about a change in fundamental transportation strategies.

In the following sections, a description of increasing car ownership and car-use will be presented followed by a discussion of the environmental and the economic impact in cities as a result of increases in car use. The recent solutions to traffic and car problems that have been made in the Western countries and the possible approaches to reducing car-dependence will be presented in the following chapters.

7.1 Increasing car ownership and car-use

The number of cars has been increasing in the world far more rapidly than the number of humans. According to Zuckermann, world car production has risen from 8 million cars per year in 1950 to nearly 40 million per year in 1988. Similarly, the number of cars in use world-wide has risen from 53 million in 1950 to 500 million today (almost a ten fold increase in 40 years). Currently, 50 million new cars are added annually. Overall about one hundred new cars are added to already congested roads every minute.[1]

In Western countries, car ownership began to increase dramatically in the early 1950s, with the ending of post-war restrictions and increased economic growth. Friedman described the seemingly exponential growth of car ownership in the United States from 4,192 cars purchased by 1900 to more than 176,000,000 cars purchased by 1987. Similarly, in 1910, one household in 44 owned a car; one in every 1.3 families owned a car in 1930; and from 1988, there was an average of almost one car for each person in the United States.[2] In the United Kingdom, official forecasts predict up to 142% growth in traffic by 2025.[3] Moreover, according to the PTRC, between 1991 and 2010, a seventy percent increase in car-use is expected, whereas

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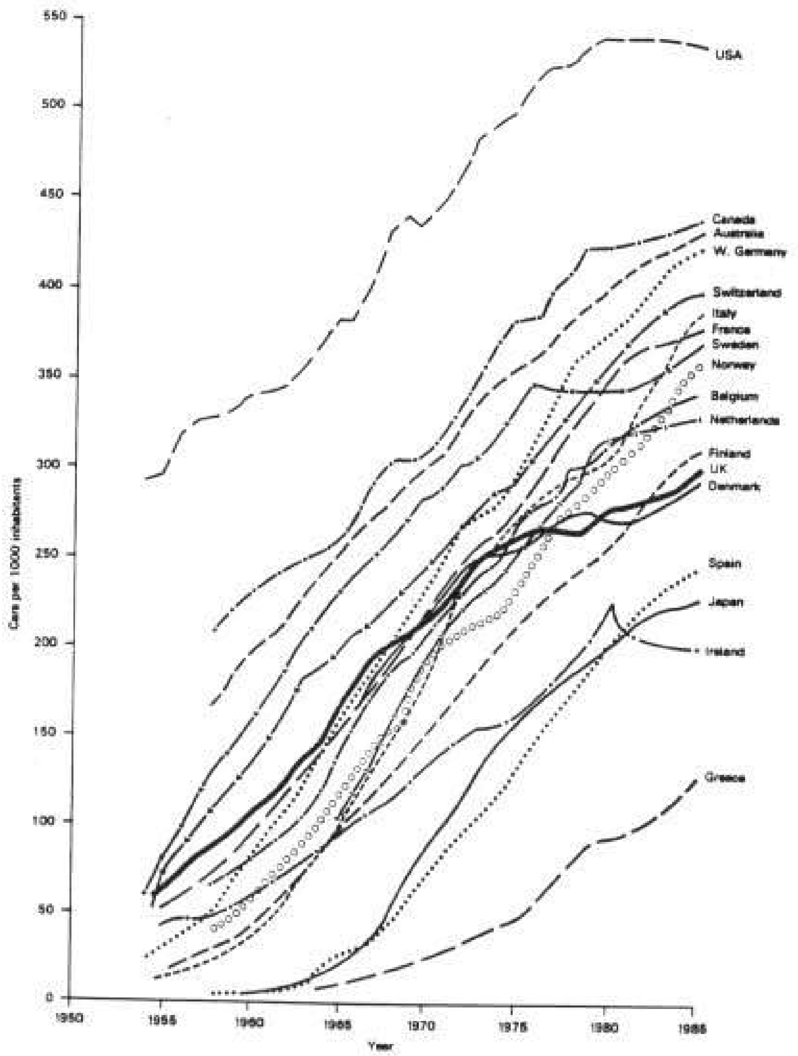
[1] Zuckermann, 1991, p.22.

[2] Friedman, p.112.

[3] Whitelegg, 1992, p.169.

the use of public transport will stay almost unchanged.[4] Figure 7-1 shows car ownership growth in a number of countries.

Figure 7-1: Car ownership growth in a number of countries



Source: International Road Federation Statistics in Institution of Highways and Transportation with Department of Transport, 1987, p.13.

[4] PTRC Education and Research Services Ltd, 1991, p.1.

7.2 The environmental impact

Increases in car use lead to problems in urban areas. As the volume of cars grows rapidly, roads become congested, road accidents increase, air pollution rates increase and insufficient parking spaces create even more problems. The following is a brief description of each problem:

7.2.1 Traffic congestion

Most cities today suffer from traffic congestion. This happens especially where people have to travel in the same area at the same time because of the concentration of specific uses, e.g., work places, shops, schools, etc., in specific areas. The traffic congestion defined as the situation that arises when road networks are no longer capable of accommodating the volume of movement that occurs on them. The physical transport framework, the pattern of land-use and their associated trip-generating activities determine the location of congested areas within a town.[5]

In some Western cities, the effects of increasing congestion are becoming unacceptable, especially in the United States. Traffic congestion in some cities has produced delays that inconvenience the car users and the efficiency of many of the activities. Moreover, congestion produces more

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[5] Hoyle & Knowles, 1992, p.82.

environmental pollution and more energy wastage. The cost of traffic congestion to society will be discussed later in Section 7.3.

7.2.2 Road accidents

Road accidents are social and economical disasters. As Morlok states, one of the most disturbing by-products of transportation is injury and loss of life. For example in 1970, over 58,000 persons lost their lives in the United States as a result of transport accidents. About 91 percent of car fatalities (52,780) occurred on highways.[6] More than 250,000 people die annually on the world's roads.[7] Moreover, according to the World Health Organisation, deaths resulting from accidents with cars in 1983 were 300,000 and there were more than 12,000,000 injuries.[8] In 1993, road accidents killed 3,820 persons and caused 44,890 persons serious injuries in Great Britain.[9]

In Saudi Arabia, there were 13,475 road accidents in 1975, with 10.532 injuries and 1,594 persons lost their lives in these accidents. This number increased to reach 37,127 road accidents in 1991 with 25,516 injuries and 3,232 persons lost their lives in these accidents. That mean in

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[6] Morlok, 1978, p.61.

[7] Whitelegg, 1992, p.169.

[8] Al-Saif, 1984, in Al-Tukhi, 1990, 11(1): p.2.

[9] Department of Transport Statistics Directorate in Royal Commission on Environmental Pollution, 1994, p.52.

1991, nearly 714 road accidents each week and 102 accidents each day and nearly 9 persons lost theirs live each day in road accidents. According to Al-Tukhi, road traffic accidents are one of the leading causes of death (after infectious diseases) in Saudi Arabia and the Gulf Countries.[10] Saudi Arabia reported the highest pedestrian injury rate of all the Gulf countries (52% of all injuries of road traffic accidents).[11] In 1983, there were 37 deaths in the Gulf countries per 100,000 population compared with 21 in the USA.[12]

In 1991, almost 56% of all the traffic accidents in Saudi Arabia occurred in Ar-Riyadh Metropolitan Region.[13] There were 20,775 road accidents with 3,867 injured persons and 299 lost their lives in these accidents.[14] Moreover, 20,166 of these car accidents occurred inside the cities.[15] That mean almost 97% of car accidents in Ar-Riyadh Metropolitan Region occur inside the cities. This is clearly unacceptable situation. The cost of road accidents to society will be discussed later in Section 7.3.

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[10] The Gulf Counters are: Saudi Arabia, Kuwait, Bahrain, Qatar, Oman, and the United Arab Emirates.

[11] Al-Tukhi, Majdi, 1990, p.1.

[12] Al-Saif, A., Development Methods and Organisation of Traffic Department, 1984, in Al-Tukhi, Majdi, 1990, p.2.

[13] Saudi Arabia is divided to 14 administration areas, Ar-Riyadh Metropolitan Region is on of these areas. It covered Ar-Riyadh city and other towns and villages.

[14] Central Department of Statistics, 1991, p.241.

[15] Central Department of Statistics, 1991, p.242.

7.2.3 Car parking

In most Western cities, the supply of car parking spaces in city centres for workers and shoppers is a considerable problem. It has critical implications for land-use planning due to the increasing number of cars and the shortage of places where cars can be parked. For example, Southern Californian cities experience considerable parking problems in their city centres. Often car drivers are forced to endlessly drive around the business district in search of parking spaces. According to Brownell, only a few years after the Los Angeles parking crisis, a Nashville business publication lamented that the "lack of parking spaces causes purchasers to patronise suburban rather than downtown stores."[16]

Many workers drive on their own to work because they are able to park their cars free. Downs mentions that in the USA, the amount these workers save from free parking is considerably larger than the petrol cost of commuting. He also point out that free parking is an employer-provided tax-free benefit, whereas public transport travel allowances paid by employers are subject to income taxes. If free parking was not given to single occupancy cars, many workers would stop driving alone.[17] For example, in 1975, when the Canadian government discontinued free parking (even though parking

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[16] Brownell, A symbol of modernity, in Bottles, 1987, p.90.

[17] Downs, A., 1992, p.70.

was still subsidised) single occupancy car-use dropped by 21% while public transport, car pools, and other means increased by 24%.[18] In another study, 275 county and federal workers commuting to Los Angeles city centre were compared. The federal employees paid for their parking while parking was free for county employees. In all other respects the two groups were equally matched, use of cars with single occupants dropped by almost half for federal employees, while car pool use in the same group increased by two third and public transport use nearly tripled.[19]

7.2.4 Air pollution

The use of cars carries with it the side-effects of pollution. The emission of various gases and particles from the increasing number of cars into the atmosphere creates severe problems of environmental degradation. Some of the pollutants emitted by cars are carbon dioxide, carbon monoxide, hydrocarbons, nitrogen oxide, sulphur oxide, and lead. As illustrated by the Royal Commission on Environmental Pollution, Figure 7-2 shows the principal ways in which petroleum-powered cars give rise to pollution. Such gases can contribute to global warming either directly or indirectly.

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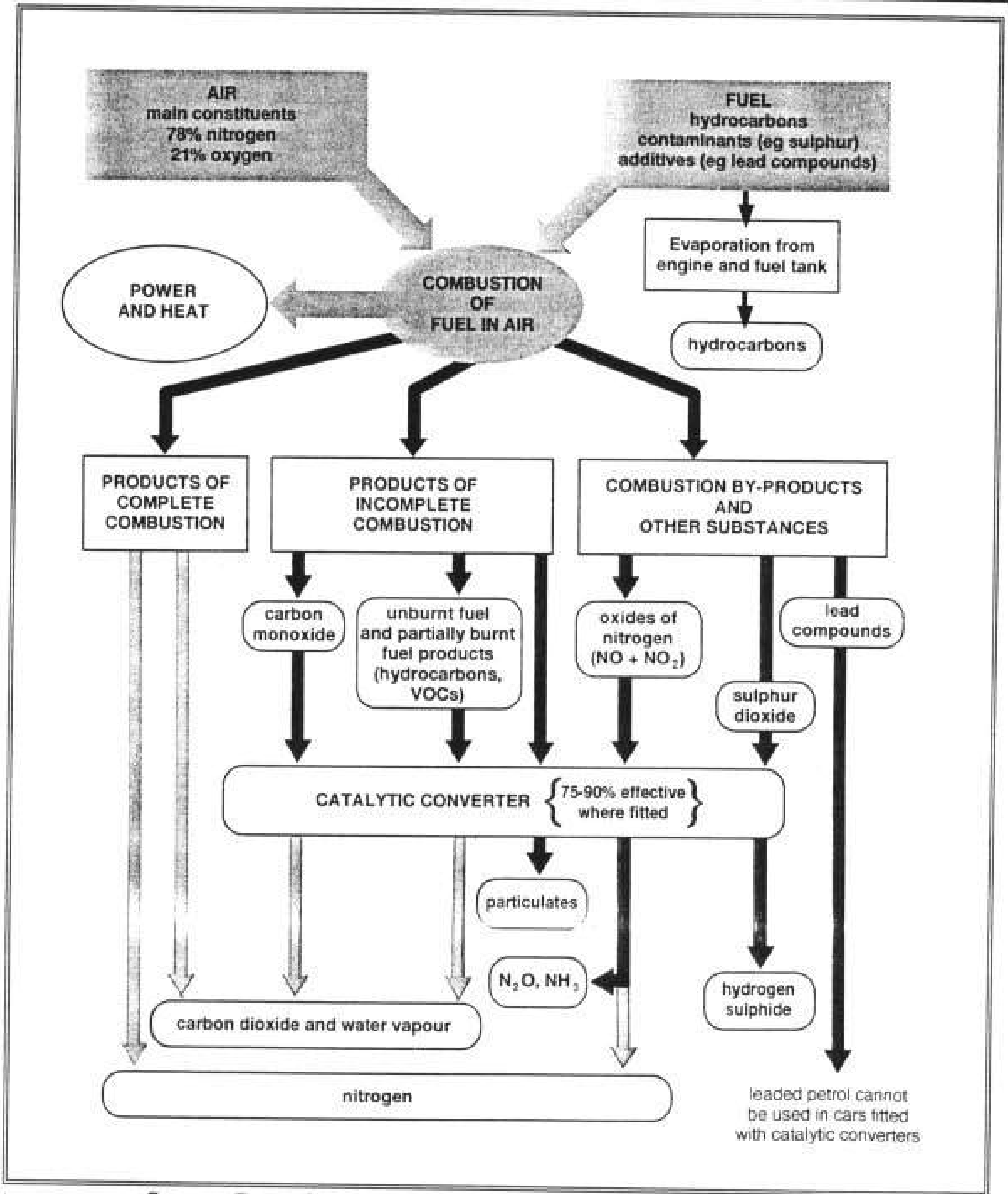
[18] Szoboslay, Akos, 1988, in Zuckermann, 1991, p.127.

[19] Szoboslay, Akos, 1988, in Zuckermann, 1991, p.127.

Figure 7-2: Pollutants emitted by petroleum-powered cars



Source: Royal Commission on Environmental Pollution, 1994, p.22.
Note: Pollutants are represented by black arrows

Carbon dioxide is the most important greenhouse gas discharged from the cars. Each year, the average car gives out more than four times its body weight in carbon dioxide into the environment.[20] More than 4 billion tonnes of carbon dioxide are discharged annually by the world's cars.[21] New petrol-cars are now fitted with three-way catalytic converters designed to reduce emissions of carbon monoxides, and hydrocarbons by 75-90 percent.[22] In spite of this, and assuming a gradual increase in the fuel efficiency of the global car fleet, the expected rise in the number of cars will increase carbon dioxide emissions to 7 billion tonnes by the year 2030.[23]

According to the HORIZON programme titled "California Dreaming" which transmitted on BBC-2 in 1991, there are 8,000,000 cars for 12,000,000 people in Los Angeles, California. The car has created environmental problems such as a yellow pall over the city; visibility is reduced to 3 miles; smog fills the lungs, especially of children during summer days. Cars congest every major city in the world, and still 130,000 new cars are produced, globally, every day.[24]

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[20] Johann, M., 1993, p.5.

[21] Tanja P. T. Et al, 1992, in Johann, Michael, 1993, p.5.

[22] Royal Commission on Environmental Pollution, 1994, p.24.

[23] Johann, M., 1993, p.5.

[24] HORIZON Programme Transcript, 1991, p.3.

In the European Community (EC), 113 million cars travel 1320 billion kilometres per year, burning up 150,8 billion litres of fuel.[25] In 1990 in the EC, transport contributed 673 million tonnes of carbon dioxide gas.[26] The private cars' contribution to European transport CO_2 emissions is around 370 million tonnes.[27] Figure 7-3 shows the increasing carbon emission world-wide.

Zuckermann mentions some of the serious effects of the pollutants emitted by cars on the human body. He says:

> "Carbon monoxide, 65% to 80% of which comes from vehicles, is toxic. It causes respiratory tract irritation and coronary damage and combines with other pollutants. Oxides of nitrogen emissions react chemically with other pollutants to form ozone and other highly toxic pollutants. Hydrocarbons, still another category of pollutants, a third of which come from motor vehicle emissions, include benzene which is of substantial carcinogenic concern and can cause leukaemia, while other hydrocarbons, though relatively non-toxic, cause side effects like eye irritation, coughing, sneezing, and drowsiness. Most hydrocarbons also react with nitrogen oxides in the presence of sunlight to produce the ozone of photochemical smog."[28]

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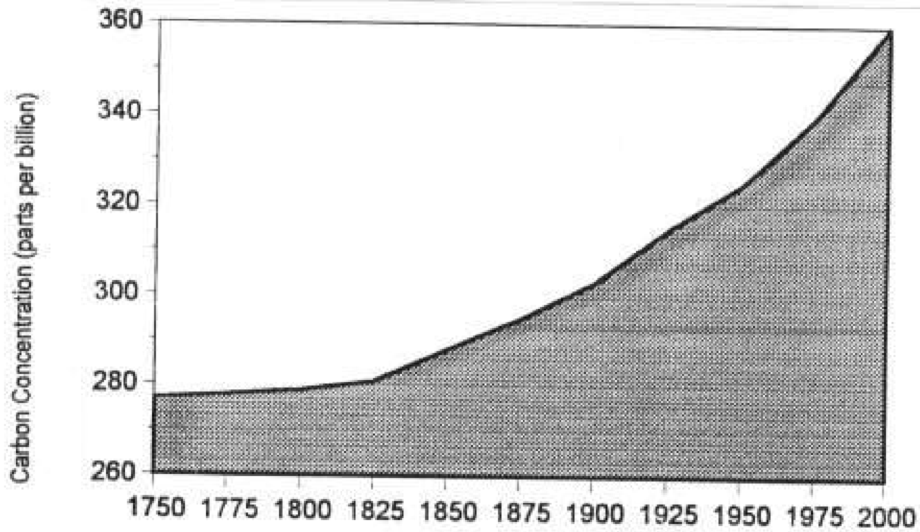
[25] Tanja P. T. Et al, 1992, in Johann, Michael, 1993, p.7.

[26] Tanja P. T. Et al, 1992, in Johann, Michael, 1993, p.7.

[27] EC-Commission, 1992, in Johann, Michael, 1993, p.7.

[28] Zuckermann, 1991, p.27.

Figure 7-3: Increases in carbon emissions world-wide



Source: Graph developed by author based on Zuckermann, 1991, p.30.

In the United States, 30,000 people die prematurely each year as a result of air pollution caused by the car.[29] According to Whitelegg, motorised transport is a major polluter compared to other modes of transport. This is clearly presented in the work of the *Enquete Kommission of the German Bundestag*[30] which is summarised in Table 7-2. The table shows specific energy and pollution factors for passenger transport and Table 7-1 summarises the differential impact of rail and road passenger transport on number of environmental variables.

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[29] Roberts, 1991, in Whitelegg, 1992, p.169.

[30] Hopfner et al, 1989, in Whitelegg, 1992, p.170.

Bottles mentions that the car not only pollutes our air but also produces sprawling suburbs, has crippled our sense of community, and damaged inner-city neighbourhoods.[31] If land-use policies permit continued dispersal of development and a high reliance on the car, other policies to reduce the environment impact of transport may be less effective or at higher cost.[32] The cost of environmental pollution on society will be discussed later in Section 7.3.

Table 7-1: Differential impact of rail and road passenger transport on number of environmental variables

	Car	Air	Rail	Bus	Bike	Pedestrian	Unit
Land-use	120	1.5	7.00	12	9.00	2.00	m^2 /person
Primary energy use	90	365	31	27	0.00	0.00	g coal equivalent unit/pkm
CO_2 emissions	200	839.5	60	59	0.00	0.00	g/Passenger Kilometre (pkm)
Nitrogen Dioxide emissions	2.2	6.4	0.08	0.2	0.00	0.00	g/Passenger Kilometre (pkm)
Hydrocarbons	1.00	1.4	0.02	0.08	0.00	0.00	g/Passenger Kilometre (pkm)
CO emissions	8.7	8.1	0.05	0.15	0.00	0.00	g/Passenger Kilometre (pkm)
Air pollution	38000	95000	1200	3300	0.00	0.00	Polluted air m^3 /pkm
Accident risks	11.5	1.4	0.4	1.00	0.2	0.01	Hours of life lost/1000 pkm

Source: After Teufel, 1989b, in Whitelegg, 1992, p.174.

[31] Bottles, 1987, p.1.

[32] Department of the Environment and Department of Transport, PPG 13, 1994, p.3.

Table 7-2: Specific energy and pollution factors for passenger transport

Passenger Transport (Billion Passenger - Km/yr)

Total Motorised Passenger Transport = 751

	Car	Motorcycle	Bus	Urban Tram Tram Metro	Railway	Air
Passenger Transport (Billion Passenger - Km/yr)	525	8	68	11	40	98
Specific Primary Energy Consumption (KJ/passenger-Km)	2,580	1,370	680	1,020	1,270	2,140

Specific Total Emissions (g/passenger - Km)

	Car	Motorcycle	Bus	Urban Tram Tram Metro	Railway	Air
CO_2	180	100	48	61	79	180
CH_4	0.3	0.7	0.07	0.2	0.2	0.2
VOC	2.2	6.5	0.29	0.15	0.31	0.31
NO_x	2.1	0.16	0.79	0.15	0.46	0.71
CO	11	10	0.28	0.01	0.13	0.28

VOC = Volatile Organic Compounds

Source: Hopfner et al, 1989, in Whitelegg, 1992, p.172.

7.3 The economical cost

For the UK, congestion imposes measurable costs on communities which have been calculated by the Confederation of British Industry (CBI) to

be 15 billion Pounds annually.[33] In 1984, Adelson mentioned that the Southern California Association of Governments estimates that the cost of congestion in the Los Angeles region was over seven million dollars per day, and over two billion dollars per year. In 1992, it is of the order of 12 million dollars per day, or 3 billion dollars per year, and rapidly increasing.[34] Whitelegg mentions also that the costs of environmental abuse have been estimated for West Germany by Schulz. His work is based on that of Wick (1986) who estimated in 1985, that the cost of the total environmental damage in West Germany amounted to DM 103.5 billion in one year. This was total damage from all sources. In 1989, Schulz estimated the percentage of this total that could be assigned to cars. This is shown in Table 7-3. Schulz adds to this the cost of road traffic accidents which amounted to DM 35 billion in 1985.[35]

According to Whitelegg, Teufel has compared the total costs imposed by motorised transport with the taxation which lorries and cars pay. This leaves a considerable shortfall which is the cost maintained by society. With regard to cars, the total amount collected through taxation lies between 26 per cent and 29 per cent of the total cost. Thus car users are paying less than 1/3 of the total costs they impose on society, as Whitelegg mentions,

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[33] Confederation of British Industry, 1989 in Whitelegg, 1992, p.170.

[34] Adelson, Marvin, The car, the city, and what we want, in Wachs, 1992, p.291f.

[35] Whitelegg, 1992, p.171-175.

leaving the remainder to be generated by general taxation and private expenditures.[36] A summary of the calculations for cars is given in Table 7-4.

Table 7-3: An environmental damage balance sheet
(costs in billion DM per year)

Pollution item	Total costs of damage	Damage by motorised traffic
Atmospheric	48.0	12.0
Noise	>32.7	30.0
Water	>17.6	?
Ground	>05.2	?
Totals	>103.5	>42.0

Source: After Schulz, 1989, in Whitelegg, 1992, p.175.

Table 7-4: Total costs and taxation income for cars in West Germany in 1987
(All figures in billion DM per year)

Costs	1960-1986 (cumulated)	1986 (one year)
Costs of expenditure on roads	551	29
Accident costs not covered	456-710	27-35
Air pollution costs	265	18
Noise costs	625	35
Total costs	1900-2150	109-117
Total income from taxes	441	31.4
Deficit	1460-1710	78-86

Source: After Teufel, 1988, in Whitelegg, 1992, p.176.

36 Whitelegg, 1992, p.175f.

7.4 Summary

This chapter examined the impact of car-dependence on the environment and the economy in major industrialised countries. The data reveal that car numbers and car use is rapidly increasing world-wide. As a result, this practice create urban problems such as: car congestion, road accidents, air pollution, health problems, and insufficient parking spaces in most industrialised cities. The statistics in this chapter suggested that car users impose very expensive costs on societies. Some of these costs are the cost of cleaning the environmental, the cost of car congestion, the cost of road accidents, the cost of health problems generated by air pollution, and the cost of expenditure on road construction and maintenance.

In conclusive, it is clear from the data that excessive car-use is having adverse economic and environmental consequences in the industrialised countries. Therefore, if dependence on the car continues to increase in Ar-Riyadh, the result will be inevitably a very expensive costs in the future. Now, integration of land-use planning and transport in Ar-Riyadh is very important measures to control the economic and environmental consequences of car dependence.

CHAPTER 8

POSSIBLE APPROACHES TO REDUCING CAR-DEPENDENCE

8. POSSIBLE APPROACHES TO REDUCING CAR-DEPENDENCE

Throughout the world's cities, a wide range of approaches have been devised and implemented in order to reduce travel demand and increase the choice of alternative modes of travel. The focus of this thesis is on land-use planning measures that might reduce travel demand and increase the choice of alternative travel modes which will be discussed in Chapter Nine. However, land-use planning measures by themselves can only provide opportunities for reducing growth in travel demand and choice of travel mode. If they are to realise their potential, they must be supported by other measures. It is helpful therefore to review briefly major measures and approaches such as: (1) influencing demand through economic measures; (2) influencing demand through management and regulation measures; and (3) influencing demand through encouraging shifts to alternative means of travel. In the following sections, a brief description of each measure will be presented.

8.1 Influencing demand through economic measures

A number of economic procedures have been developed by many authorities in different countries as mechanisms for reducing travel demand and hence car-dependence. These include: road pricing, central area pricing system (area licensing), car pricing and taxation, high charges for parking meters and parking fines, and increasing fuel prices. Zuckermann, mentions specific economic controlling methods as follows: Some cities have introduced increased parking fees or control of parking places; others have used traffic calming techniques, for instance the creation of pedestrian areas; others have used road pricing or licensing fees (area licensing); and some finally have simply closed the city off and placed guards at all entrances to stop access for certain categories of cars.[1] In addition higher taxation has been introduced by some authorities (e.g. on petrol, on car price, and on road usage).

In 1977, Thomson mentions a "traffic-limitation strategy" which attempts to reach the economic root of the problem by introducing methods of direct traffic restraint. It is designed mainly to confront the private car users

[1] Zuckermann, 1991, p95.

with the cost they impose on the environment. Thomson described the objective of the traffic-limitation strategy as follows:

> "The objective of a traffic-limitation strategy is not to minimise the volume of traffic. In theory, at least, it would be possible to arrange a city so that everyone walked to work, but this would not be an efficient arrangement. The purpose of traffic limitation is to avoid needless or needlessly long journeys, to plan activities so that travel desires are concentrated in corridors that can be effectively served by public transport, and to discourage the use of private transport, whenever [this] creates heavy social costs."[2]

In the following, a brief discussion of the road pricing system will be presented followed by a brief discussion of the central area pricing system and then the effect of increasing fuel prices on car-use will be presented followed by a brief evaluation of the economic measures.

8.1.1 Road pricing

The history of road pricing has been mentioned by Roth. He says that the idea that drivers should pay for the privilege of driving on congested roads was first put forward in 1959 in Washington DC, and subsequently in London in 1964 by the Smeed Committee. These ideas came at a time when these cities were equally congested and traffic speeds in London were around 19 km/h. It was suggested that road space was so valuable that it should be charged for. It was considered feasible that a device could be

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[2] Thomson, J., 1977, p.264.

developed and attached to each car which would contain so many units of use, which could be purchased regularly and replaced when the units were used up by driving over cables set in the road bed.[3] In 1983, the first pilot scheme for road-pricing began in Hong Kong.[4]

The British Road Federation is opposed to road pricing on the grounds that it is too difficult to implement and too difficult to monitor.[5] Some professionals are also oppose to the idea of road pricing. For example, Bennett says:

> "We do not think road pricing is a reasonable way of controlling city traffic. If measures like removing through-traffic from city centres, increasing expenditure on public transport, park and ride schemes and traffic calming measures are put in place, you should not need road pricing"[6]

Transport planners and other transport professionals should consider the following four difficulties before applying a road pricing system:

1. **Less popularity among the public:** In spite of a wide range of transport professionals having largely been convinced of the merits of charging for road use, it is less popular among the public, at least as a tool for controlling demand. Certainly, schemes for road pricing in both Hong

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[3] Roth, 1967, in Richards, 1990, p.67.

[4] Richards, 1990, p.67.

[5] Clegg, G., 1993, p.31.

[6] Bennett, S., in Clegg, G., 1993, p.31.

Kong and the Netherlands have been dropped because of the unpopularity of the measure among the public.[7]

2. **Discrimination against poorer drivers:** There is a large demand for car travel in most of the world's cities and there would always be relatively rich drivers and companies who would be prepared to pay the price for road pricing, thus traffic congestion and parking problems may not in the end be reduced, but some relatively poorer drivers would be replaced by relatively richer ones.
3. **Increase suburban development:** Central area road pricing would increase the pressure for suburban development with drivers preferring to switch their destination rather than their mode of transport.[8]
4. **Possibility to increase environmental effects:** Some car drivers who do not want to pay for road use might make longer alternative routes to avoid the road for which a road pricing programme is being introduced, therefore using more fuel and producing more air pollution.[9]

The scope for the economic measures contribution in Ar-Riyadh will be discussed in Section 8.1.4.

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[7] Jones, Peter, What the pollsters say, in Whitelegg, 1992, p.12f.

[8] Adams, 1989, in Bainbridge, 1992, p.79.

[9] Royal Commission on Environmental Pollution, 1994, p.95.

8.1.2 Central area pricing system (area licensing)

Reducing the number of cars in central areas has the potential to improve the city's environmental quality. Singapore is a good example of the direct prohibition of car-use at specific times and in specific places. Singapore has been using an area pricing system successfully since 1975, because of growing congestion in the business district by 74,000 cars in the morning peak hours. Cars have to buy a weekly or daily permit if they want to enter the city centre during morning peak hours. Permits are checked by police at the city's 29 entry points. According to Richards, area licensing in Singapore has been estimated to reduce the entry by cars by about 50%.[10] In London, the Greater London Council proposed an area licensing programme in 1974. They proposed a cordon around the city centre covering an area of about 3.4 km by 6.4 km. Around 200 signed entry points were to be located around the cordon area and about 400 additional police were needed to control the licensing which would be effective on weekdays only between 8 a.m. and 6 p.m. The traffic outcomes were calculated to result in a decrease of a third in the city centre and a tenth in the inner zone.[11] The scope for the economic measures contribution in Ar-Riyadh will be discussed in Section 8.1.4.

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[10] Richards, 1990, p.71.

[11] Richards, 1990, p.72.

8.1.3 Increasing fuel prices

Many studies suggest that increasing fuel prices can reduce car-use especially in the long-term. Goodwin suggests that a 10 percent increase in petrol prices in the long-term might result in a 7 percent decrease in the total amount of petrol used; and that reduced car ownership and car use might account for about half the decrease.[12] Another study suggests that in the long run a 10 percent increase in fuel prices might result in a decrease of 2 to 3 percent in car-use.[13] The Royal Commission on Environmental Pollution assumed that each one percent increase in the price of fuel (in real terms) will reduce the use of fuel by 0.3 percent in the short-term and 0.7 percent in the medium-term in the period to 2020.[14]

The long-term effects of petrol price increase on petrol use can be analysed by comparing different countries. A study of 32 world cities shows a significant correlation between petrol use and price and also between petrol use and national car fuel efficiency. This relationship is minimised when car fuel efficiency is adjusted for urban average speed.[15] Another study of 14

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[12] Goodwin, P., 1992 in Royal Commission on Environmental Pollution, 1994, p.111.

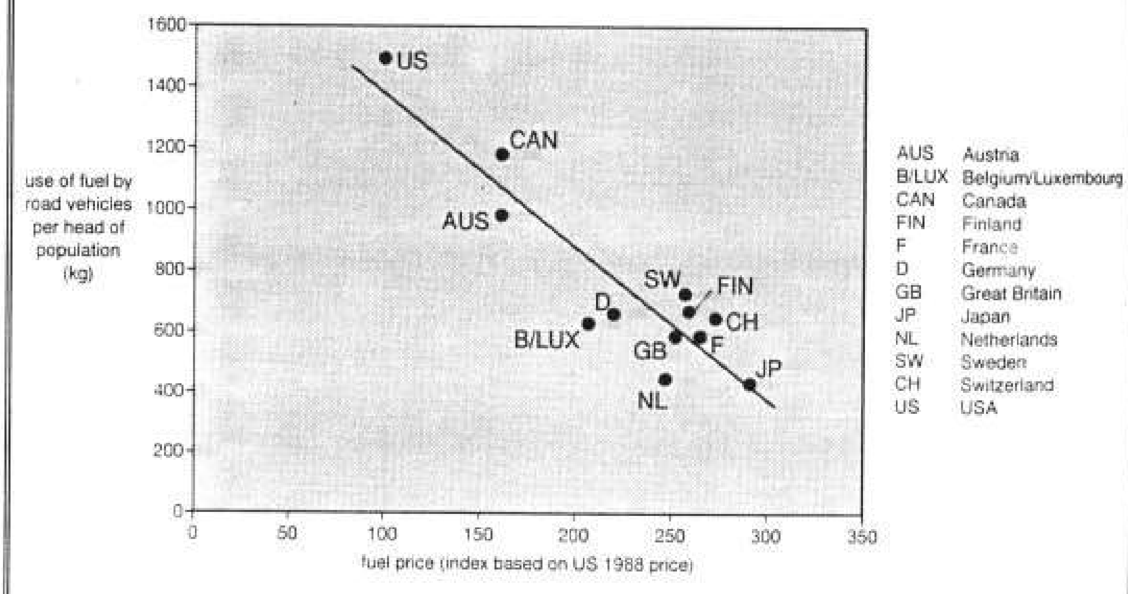
[13] Oum, T., Waters, W., and Jong-Say Yong, 1992 in Royal Commission on Environmental Pollution, 1994, p.112.

[14] Royal Commission on Environmental Pollution, 1994, p.112.

[15] Newman & Kenworthy, 1989, p.71.

developed countries reached similar conclusions.[16] As Figure 8-1 illustrates, 14 countries showed a strong negative correlation between real fuel price and fuel use per head of population. Moreover, the study mentioned that other factors, especially differences in income, justified some of the differences between countries but fuel prices were considered to have had an important influence on fuel use.

Figure 8-1: Relationship between fuel price and fuel use by cars in 1988



Royal Commission on Environmental Pollution, 1994, p.114.

[16] Weizsacher, E. and Jesinghaus, J., 1992 in Royal Commission on Environmental Pollution, 1994, p.112.

The main question is whether such measures would be effective in Saudi Arabia. By comparing Saudi Arabia with other countries, it is found that the price of petrol in Saudi Arabia is the cheapest in the world after the Soviet Union as Figure 8-2 shows. The figure also shows that the price of petrol in Saudi Arabia is almost 1/7 of the price of petrol in Great Britain and almost 1/10 of the price of petrol in Italy. Although petrol prices in the UK are higher than in Saudi Arabia, the report of Royal Commission on Environmental Pollution recommended that fuel duty be increased year by year so as to double the price of fuel (relative to the prices of other goods) by 2005.[17] The extremely low price of petrol in Saudi Arabia encourages people to use their cars. To reduce this practice, policies which gradually increase petrol prices[18] may be effective in conjunction with improving alternative modes of transport. It can, therefore, be clearly predicted on the basis of evidence found elsewhere that increase of petrol prices will on its own not result in a sufficient reduction on car use and that land-use policies and planning are needed to solve the problem.

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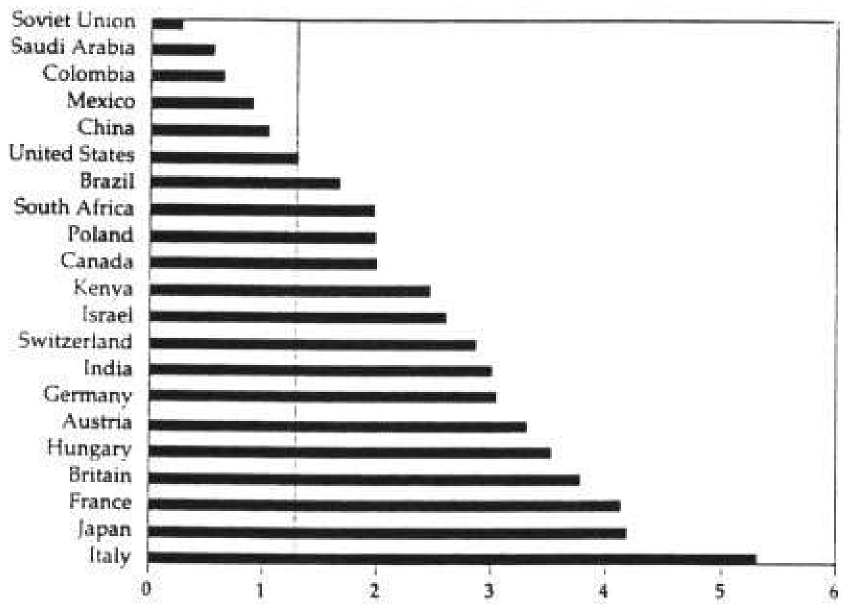
[17] Royal Commission on Environmental Pollution, 1994, p.114.

[18] Saudi Arabia just announced on 1/1/95 an increase in petrol prices by almost 90%.

Figure 8-2: Petrol prices in selected countries (1991)
(Dollars per gallon)



Source: Downs, Anthony, 1992, p.68.

8.1.4 Brief evaluation and the scope for the economic measures contribution in Ar-Riyadh

According to the report of ECOTEC, economic measures may lead to some reduction in car use. However, this view is contentious. In fact, measures such as car pricing and taxation policies might encourage users to buy lower-powered cars, but only by taxing ownership rather than restricting car-use. Road pricing has more relevance to the efficient allocation of road capacity, relieving congestion or funding road infrastructure than to reducing overall car use. Control of car parking (road management) is also relevant as traffic demand management measure and may have significant impacts on

modal choice. However, pricing policies which encourage alternatives to the private car will be ineffectual unless planning policies encourage development pattern which facilitate a growth in public transport.[19] Economic restrictions of car-use will not work if not combined with four factors: (1) encouraging development patterns which integrate land-use planning and transport; (2) providing alternative modes of travel, (3) providing education programmes, and (4) encouraging changes in life style and habits.

Ar-Riyadh exhibits high travel demand and car ownership, as stressed in Chapter Five. This is probably a consequence of the high percentage of vacant lands, a relatively low overall population density, high degree of decentralisation of population, employment, and services throughout the city, and the existing public transport is inefficient. Therefore, the potential scope for the economic measures to reduce car-dependence now in Ar-Riyadh is less than that evident in other world's cities which have alternative modes of travel. Today, the introduction of alternative modes of travel and the contribution of land-use planning to encourage development pattern which facilitate a growth in public transport must be given first priority in Ar-Riyadh before introducing any economic measure. However, land-use planning measures can not work alone to reduce travel demand without the support of the economic measures.

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[19] ECOTEC, 1993, p.26.

8.2 Influencing demand through management and regulation measures

There are many management and regulation measures used in different parts of the world. One measure was enforced in Los Angeles. The Southern California Air Quality Management District adopted in 1987 Regulation 15 to encourage the car sharing as a result of a serious pollution problem. This law requires all employers of 100 or more persons to advise their workers arriving between 6:00 and 10:00 to reduce their use of private cars. These big employers must submit trip reduction plans to the Air Quality Management District for approval. Regulation 15 seeks to create a regionwide average commuter car ridership of 1.5, with a target of 1.75 for downtown Los Angeles workers. In addition the only new cars allowed to enter the city centre of Los Angeles by the end of the century will be electric cars.[20]

Athens provides another example of management and regulation measures. An effort was made to restrict the number of cars entering the city centre by allowing only cars with odd number plates to enter on one day and those with even number plates the next day. Unfortunately, some people get round this restriction by buying a second car with a different plate number.[21]

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[20] Clegg, G., 1993, p.30

[21] Clegg, G., 1993, p.30.

8.3 Influencing demand through encouraging shifts to alternative means of travel

There are several measures closely related to planning which could help bring about reductions in car dependence through encouraging shifts to alternative means of travel. These include: the provision of pedestrian and cycle priority measures; the provision of public transport priority measures; car pooling schemes; and the provision of park-and-ride facilities. Pedestrian and cycle measures work only for short distances and are dependent upon population density and mixed land-uses. Public transport requires development concentration along public transport corridors, and park-and-ride facilities need public transport systems.

8.3.1 Pedestrian and cycle

Creating pedestrian (traffic-free) zones for short distances will hopefully lead to reduced street levels of noise and air pollution and reduced congestion. People prefer to keep distances short when they want to walk, especially between places frequently visited. This is best accomplished by packing as many activities as possible into a small land area, by making people live closer together and by locating their amenities among them, close enough to be reached by walking or cycling. To improve the pedestrian environment in the USA cities, Untermann suggested in more details seven

development directions necessary to restructure existing communities to better accommodate pedestrians. These directions are: (1) improving public transportation; (2) introducing mixed land-uses; (3) changing zoning ordinances (avoiding the single and isolated land-uses; avoiding the deep setbacks from the streets; and avoiding high parking ratios); (4) setting new road standards (avoiding car-oriented streets; more pedestrian friendly streets); (5) providing comfortable pedestrian facilities; (6) carrying out more research, especially long-term research; and (7) adjusting values through education.[22] It is important that planning measures should be closely co-ordinated with the provision of infrastructure which encourages the use of other modes.[23]

8.3.2 Public transport

The are a variety of public transport in world's cities such as rail ways, guided light transit, buses (trolley buses and minibuses), people movers, taxis, and boats. The service provided by public transport might not be sufficiently attractive because of price, frequency, reliability, speed, comfort, safety, and convenience. These factors might restrain people form using public transport.

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[22] Untermann, Rich, Why you can't walk there: strategies for improving the pedestrian environment in the United States, 1984, in Tolley, R., 1990, p.180f.

[23] ECOTEC, 1993, p.26.

Public transport has to be more attractive than complete journeys by private car. Some ways to improve local public transport services are: (1) encouraging clustering of developments around public transport nodes, (2) granting some priority to public transport (e.g. by reserving road space and manipulating traffic signals for buses, and by fiscal measures to limit the private car use), (3) encouraging the integration of different public transport services, (4) using the latest information technology for public transport operations (e.g. closed circuit television cameras), (5) improve information for passengers, (6) introducing new fares structures, and (7) improve the environment on public transport and stations (e.g. security, cleanness, no smoking, etc.).

Most countries provide support to public transport which called "subsidy" or "public contribution". Most of the time this contribution is made to the public transport operator to meet the cost of concessionary fares for particular groups, however, in some circumstances assistance may be given directly to potential travellers. The Royal Commission on Environmental Pollution mentioned five justification for a public contribution to the costs of public transport operators: (1) ensuring continued mobility for particular groups in the population "social desirability", (2) ensuring continued access to shops and other services for remote rural communities, (3) benefiting to road users form a reduction in congestion resulting from the availability of

public transport, (4) benefiting the environment, (5) saving in road infrastructure costs.[24]

In the United Kingdom, some of the factors which influence the level of subsidy needed are mentioned by Simpson as the following: (1) land-use patterns and densities of occupation which affect the number of public transport users; (2) policies towards the private car; (3) levels of fares; (4) frequency of public transport services; (5) routes of public transport services (the number of socially necessary/loss making routes); and (6) period of operation of services (the number of off-peak services).[25] The report of the Royal Commission on Environmental Pollution has warned that public contribution might lead to inefficiency. The report says:

> "A danger with a public contribution to costs in any field is that it will encourage inefficiency. Future public contribution to the costs of public transport should be designed in a way that provides operators with incentives to manage the system efficiently. For example the amount of any revenue contribution should be tightly controlled and of a predetermined amount. Any capital contribution should be linked to specific improvements in the level or quality of services."[26]

8.3.3 Car pooling

Car pooling is another way to improve alternative means of travel and to reduce traffic density. Car pooling has been used for a long time by many

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[24] Royal Commission on Environmental Pollution, 1994, p.115f.

[25] Simpson, B., 1994, p.8.

[26] Royal Commission on Environmental Pollution, 1994, p.117.

American cities to reduce the overall number of cars on the roads. Car pooling involves employees who live in the same area and work in the same place. During the 1973 fuel crisis, car pooling became widespread in American cities. Authorities regularly encourage car pooling to reduce congestion and single-car occupancy. For example, in Pleasanton, California, where local planning requirements have encouraged car pooling single-car occupancy at peak hours has been reduced by 36 per cent.[27] To encourage people to make use of car pooling in some of the American cities, high occupancy car lanes have been introduced. These are separate less congested lanes alongside the motorways, which can only be used by cars with more than two (or three) people.

According to the report of ECOTEC, pedestrian and traffic calming measures will not necessarily, by themselves, reduce transport emissions. However, they could encourage a shift from cars to walking and cycling for short trips. Combined with the intensification of development and the provision of improved public transport some benefits may be gained in the long term.[28]

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[27] Orski, 1988, in Richards, 1990, p.63f.

[28] ECOTEC, 1993, p.70.

8.3.4 Park-and-ride

In the United Kingdom, park-and-ride schemes were initiated in seven towns from 1981 to 1986 and in 29 towns form 1987 to 1990.[29] Park-and-ride is carried out for two main purposes: (1) to shift the modal split towards public transport, and (2) to reduce needs for parking.[30] Park-and-ride schemes have not been tested in terms of their impact on overall car dependence. However, they may have an important long-term role in reducing congestion and encouraging the use of alternative means of travel.

For park-and-ride to succeed, Simpson mentions some ways to improve park-and-ride schemes such as: (1) park-and-ride has to be more attractive than complete journeys by private car by introducing measures to make travelling by private car less attractive (e.g. parking restrictions, charges, road traffic restraint), (2) encouraging positive measures including good suburban car parking and attractive public transport services,[31] (3) parking should be available on the edge of the area where road traffic needs to address, with easy access and should be easily visible, (4) parking should be in shout supply beyond the park-and-ride car park into town.[32]

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[29] Department of Transport, 1991b, in Simpson, B., 1994, p.177.

[30] Simpson, B., 1994, p.178.

[31] Simpson, B., 1994, p.171.

[32] Simpson, B., 1994, p.180.

8.4 Summary

This chapter is briefly reviewed a range of measures that could reduce travel demand and car dependence in the Western countries such as economic measures, management and regulation measures, and improving alternative means of travel. These measures will be tested within the Saudi Arabian cities. What can be learned from a comparison is that some of these measures are already solving parts of the problem but they need to be introduced, if as all, in conjunction with land-use planning policies in order to reduce the demand for travel. For example, it is evident that the economic measures listed in this chapter will not on their own really improve traffic problems sufficiently because of the growing demand for traffic (growth of population, businesses, etc.). So land-use planning needs to be introduced in addition to real improvement to alternative means of travel. Therefore, the introduction of alternative modes of travel and the contribution of land-use planning to encourage development pattern which facilitate a growth in public transport must be given first priority in Ar-Riyadh before introducing any other measure. However, land-use planning measures can not work alone to reduce travel demand without the support of the economic measures.

CHAPTER 9

INTER-RELATIONSHIPS BETWEEN LAND-USE, TRANSPORT INFRASTRUCTURE AND TRAVEL BEHAVIOUR

9. Inter-relationships Between Land-use, Transport Infrastructure and Travel Behaviour

This chapter presents the inter-relationships between land-use, transport infrastructure and travel behaviour also the scope for a planning contribution in Ar-Riyadh. Today, a wide variety of economic and social changes as well as technological developments are progressing to spread the areas over which people and businesses manage their activities. As a result, these trends have important implications for travel demand.[1] The inter-relationship between land-use and the increase in the use of the private car with the associated decrease in other means of travel can be influenced by planning policies. This topic forms the subject of this chapter. In the final part, the scope for a land-use planning contribution in Ar-Riyadh will be presented.

Most data for this chapter, with regard to the inter-relationships between land-use, transport infrastructure and travel behaviour, were

[1] ECOTEC, 1993, p.31.

predominantly obtained from two sources: (1) The report of ECOTEC in association with Transportation Planning Associates, Reducing Transport Emissions Through Planning, Commissioned by the Department of the Environment and Department of Transport, 1993. And (2) The report of the Royal Commission on Environmental Pollution, Transport and the Environment, 1994.

9.1 Introduction

According to the report of ECOTEC, the interrelationships between land-use patterns and travel demand behaviour are too complex and insufficiently well understood. It is therefore difficult to create comprehensive models in a form which would be applied in practise.[2] However, it is clear that the spatial distribution of population and activities would benefit from a variety of types of travel. Equally, the patterns of accessibility associated with the available transport infrastructure and other determinants of real travel costs are an important influence on pressures for changes in the spatial distribution of land-uses. The approach to these issues has been a pragmatic one, drawing upon a wide variety of evidence from case studies, statistical

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[2] ECOTEC, 1993, p.31.

analysis and current research studies from United Kingdom and international studies. The following sections are organised as follows:

- Section 9.2 analyses the influence of population densities on travel demand and choice of travel mode;
- Section 9.3 analyses the influence of intermixing of land-uses on travel demand and choice of travel mode;
- Section 9.4 analyses the influence of metropolitan forms on travel demand and choice of travel mode;
- Section 9.5 analyses the influence of neighbourhood structure on travel demand and choice of travel mode;
- Section 9.6 analyses the influence of fast-road infrastructure on development of urban areas; and
- Section 9.7 studied the scope for a land-use planning contribution in Ar-Riyadh.

9.2 The influence of population densities on travel demand and choice of travel mode

The role of population density in influencing travel behaviour has been emphasised in many United Kingdom and international studies. These are summarised briefly.

9.2.1 Evidence from United Kingdom studies

According to the report of ECOTEC, a variety of studies indicate that population density effects travel patterns in at least four ways:[3]

1. Higher population densities widen the range of opportunities for the development of local personal contacts and activities which do not require private car use;
2. Higher population densities increase the scale of local expenditure, widening the viable range of services and, reducing the need for travel elsewhere;
3. Higher density patterns of development tend to reduce distances between places of residence and the places at which services, employment or other opportunities are located; and
4. Increasing the density of population creates greater numbers of personal journeys along specific corridors, improving the potential viability of public transport. Higher densities may constraint ownership and use of private vehicles. Both of these factors have potential implications for modal choice.

In another study, Hillman and Whalley examined United Kingdom settlements based on the National Travel Survey (1978/79). They have shown how the low population density factor within a city increases car ownership and use. Figure 9-1 shows the travel characteristics (population

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[3] ECOTEC, 1993, p.33.

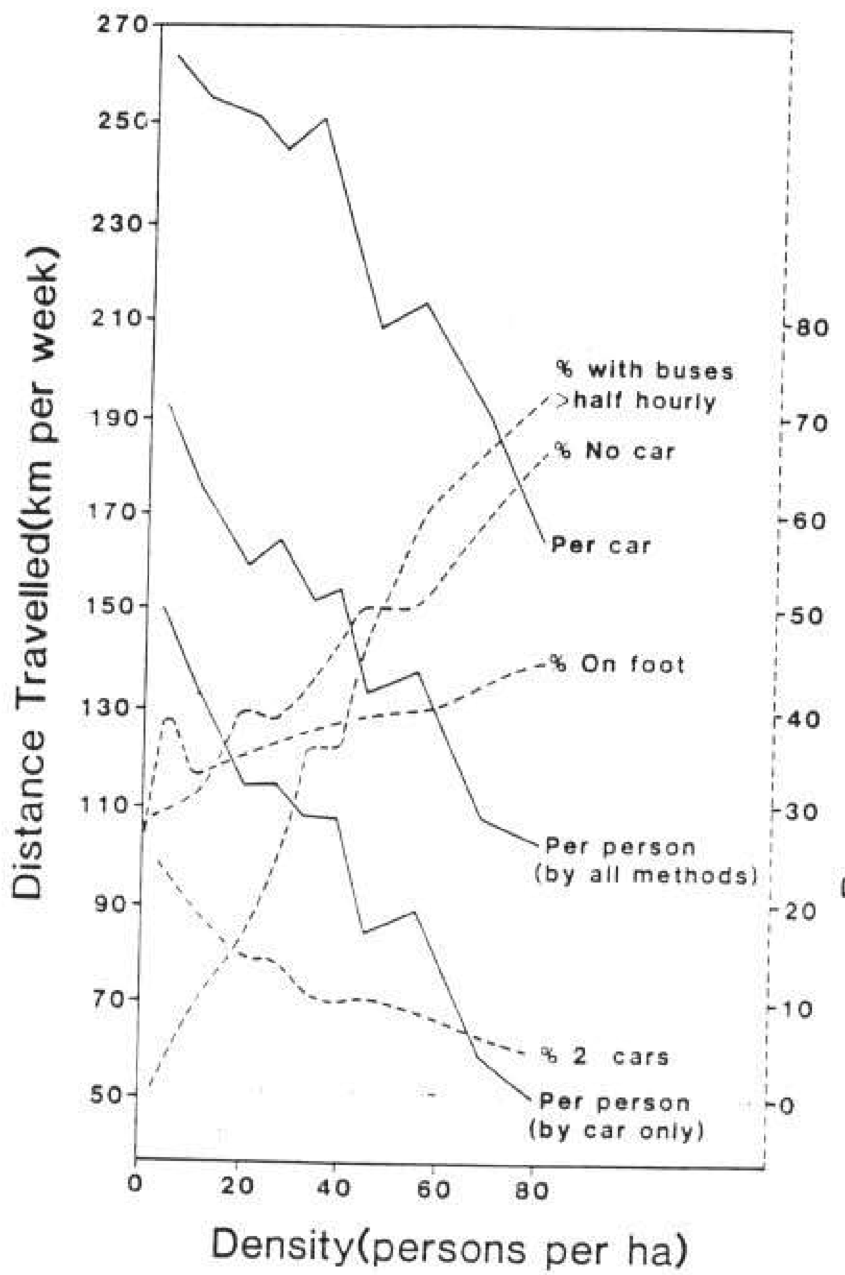
density, households and distances travelled) in the United Kingdom. The figure shows the following:[4]

1. As population density declines, there is an increase in the total distances travelled by all travel modes. People in low density areas travel almost twice as far as those in high density areas and there appears to be a break at around 30 persons per hectares. For that reason, travel distances go from around 150 km/week for 30 persons per hectares to 190 km/week for less than 10 persons per hectares areas.
2. People in low density areas travel by car 3 times as far as those in high density areas (when car travel alone is compared).
3. In a density under 20 persons per hectares, there is a remarkable increase in travel per person by car only.
4. As population density declines, car ownership increases, especially in areas with a density less than 20 persons per hectares where there are rapid increases in households owning two or more cars.
5. As population density declines, the percentage of households having a bus service more frequent than half hourly decreases considerably (the bus service becomes very poor under 30 persons per hectares).
6. As population density declines, the walking percentage decreases also.
7. In population density above 30 persons per hectares, the proportion of families with no car is more than 40 per cent, and at the maximum density range over 75 persons per hectares, 67 per cent have no car.

All earlier evidence suggest that higher population density decreases vehicular traffic and in the same time increases the choices for alternative means of transport (public transport, walking, cycling, etc.).

[4] Hillman and Whalley, 1979 and 1983, in Newman & Kenworthy, 1989, p129.

Figure 9-1: Travel characteristics by population density in UK (1978/79)



Source: Hillman and Whalley, 1979 and 1983, in Newman & Kenworthy, 1989, p130.

9.2.2 Evidence from international studies

At the international level, the influence of population density was studied by Newman & Kenworthy, in their publication Cities and automobile dependence, in 1989. The two Australian transport researchers studied car dependence of thirty-two world cities. A study of petrol consumption in these cities shows that energy consumption falls as density rises.[5] Figure 9-2 shows petrol use per capita versus population density. Low density growth is a major factor generating dependence on the car. According to the study of Newman and Kenworthy, low density areas below 20 to 30 persons per hectares create car dependence because of a combination of factors including longer distances to travel and limited choices to walk or use public transport.[6] While the above evidence supports the view that destiny plays an important role in influencing travel behaviour, future planning policies which require area-wide increases in density will cause some difficulties. Cervero has warned that area-wide density increases in any urban area would result in difficulties such as: (1) increasing traffic congestion for residents and industry; (2) increasing the costs of providing additional infrastructure to local government; and (3) imposing lifestyle that may not be acceptable to the

[5] Newman & Kenworthy, 1989, p.47.

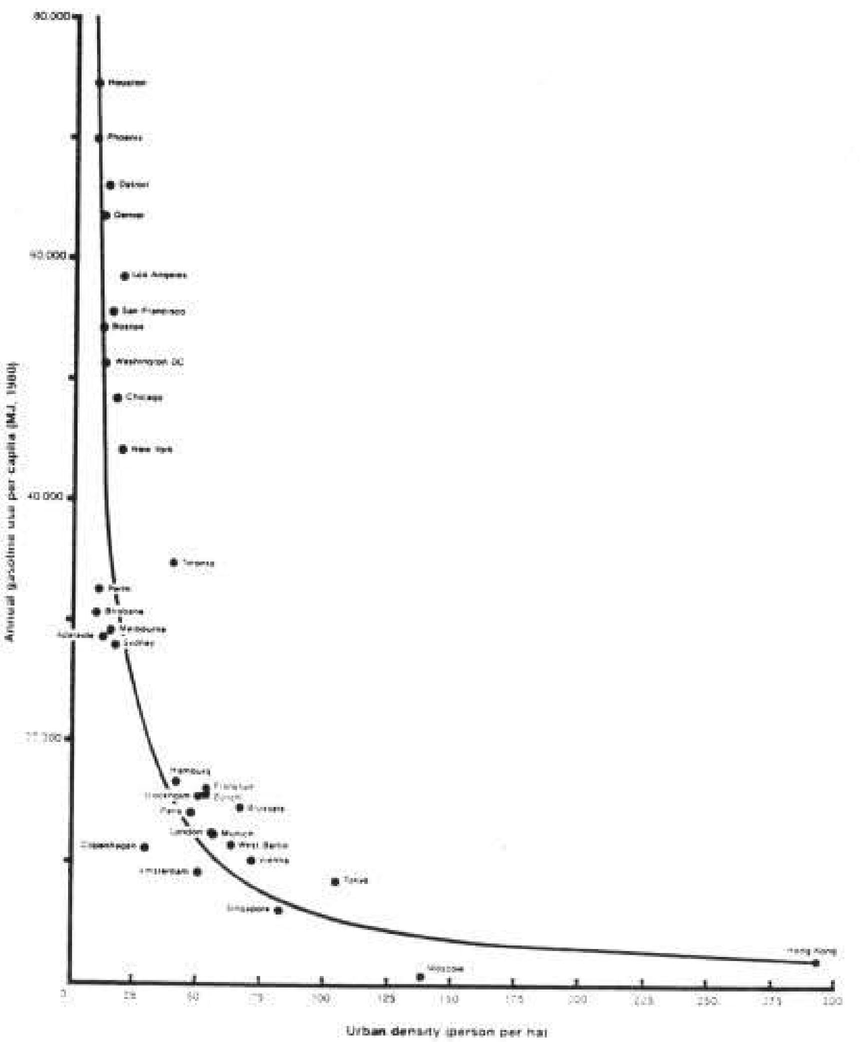
[6] Newman & Kenworthy, 1989, p.129.

majority of residents and to society. Therefore, to minimise these difficulties, density increase should target major urban centres rather than city-wide increase in density.[7] However, it is important to impose minimum density standards on city-wide development and in the same time high density development should target areas along major public transport corridors (and transit station if applicable). Higher density does not necessarily mean high-rise buildings. This can be achieved with low-rise development such as a compact individual dwellings.

In conclusion, the evidence presented in this section supports the view that higher densities in residential development (provided services and facilities are close) would both reduce travel and increase the proportion of travel demand met by alternative modes of travel. Travel demand rises quickly as density falls. However, other factors such as income, car ownership and location might influence density and travel demand relationship.

[7] Cervero, 1990 in Al-Mosaind, M., 1993, p.138.

Figure 9-2: Petrol use per capita versus population density (1980)



Newman & Kenworthy, 1989, p.48.

9.3 The influence of mixed land-uses on travel demand and choice of travel mode

9.3.1 Two opposite views

There have been two parallel streams of argument on the influence of mixed land-uses on travel demand and choice of travel mode. One view has been that mixing of residential and other land-uses reduces the need to travel. This view suggests that in large urban areas, clustering employment and services at particular locations, reduces travel demand.[8] The opposite view is that mixing of land uses has little effect on travel, might encourage car use at the expense of public transport or may lead to greater fuel consumption.[9]

Mixing of land-uses throughout the city may not reduce car use, but in limited area such as a neighbourhood scale it might work because this practice would potentially reduce average distances and encourage walking and cycling for daily uses. However, according to the report of ECOTEC:

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[8] Hemmens, G., 1967, Schneider, J. And Beck, J., 1973, in Royal Commission on Environmental Pollution, 1994, p.149.

[9] ECOTEC, 1993; Fels, M. and Munson, M., 1975, in Williams, R., 1992; Rickaby et al., 1992; Stone, P., 1973; and Webster et al. 1988 in Royal Commission on Environmental Pollution, 1994, p.149.

> "... choice or specialisation within the labour market, or in the nature of services which are sought, may mean that people do not make use of the nearest local opportunities. In this case the effect of intermixing may be to create diffuse patterns of trips which can not be served effectively by public transport."[10]

This suggests again that creating city-wide mixed land-uses dose not mean that people have to chose the nearest opportunities. If people found better jobs elsewhere they will travel by car if necessary. Patterns of work travel are unpredictable because access to work places may change. Therefore, dense housing developments along major public transport routes are very important in addition to good quality of public transport services, and work places must equally be in reach by public transport.

9.3.2 Current knowledge of the effects of intermixing land-uses on travel demand and choice of travel mode

In some studies, land-use is considered to have very little effect on travel behaviour, whereas in others, differences in travel or fuel consumption are considered to vary by as much as a factor of three between different

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[10] ECOTEC, 1993, p.43.

land-use patterns.[11] Owens mentioned also that the physical separation of activities may be a major determinant of travel demand, but within urban areas evidence suggests that the key factor is population density rather than the mixing of land-uses.[12] Population density is a very important factor which can support more mixed land-use, as Newman says:

> "Generally speaking, the denser an area the more mixed is the land-use because the sheer number of people can support a rich diversity of small businesses, shops and other activities."[13]

The simulations used in the study along with evidence from other studies mentioned in the report of ECOTEC suggest that mixing residential and employment uses in an urban area makes little difference to travel distances or modal choice.[14] Therefore, mixing is unlikely to reduce significantly car dependence in the short term. However, at a regional level, the degree of urbanisation has a major impact on travel. Whilst a balance of population, employment and other activities may promote self-containment, in theory no definitive evidence is available.[15]

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[11] Owens, Susan, 1986 in Royal Commission on Environmental Pollution, 1994, p.149.

[12] Owens, S., 1991 in ECOTEC, 1993, p.45.

[13] Newman & Kenworthy, 1989, p.14.

[14] ECOTEC, 1993, p.50.

[15] ECOTEC, 1993, p.50.

The Royal Commission on Environmental Pollution also concluded that there was no ideal land-use pattern which ensured a reduction in travel. However, some important principles are apparent. A range of settlement patterns, including compact, centralised cities and small to moderate-size towns or urban villages with a good mix of employment and services, can potentially offer efficiency, access and choice. Whilst the size of settlements and precise arrangement of land-uses can not be planned on grounds of transport alone, avoidance of travel-intensive development patterns is important.[16]

In conclusion, the data in this section suggested that mixing residential and employment uses within a particular urban zone has little effect on distance travelled or modal choice. The data also suggested that there is no single pattern of land-uses that reduce the need to travel.

[16] Royal Commission on Environmental Pollution, 1994, p.151.

9.4 The influence of metropolitan forms on travel demand and choice of travel mode

This section of the thesis draws together analyses and evidence of the role of urban metropolitan forms in influencing travel and choice of travel mode. It analyses metropolitan forms described by Lynch and current investigations of the effects of metropolitan forms on travel demand and choice of travel mode.

9.4.1 Metropolitan forms described by Lynch

This section illustrates a variety of abstract metropolitan forms described by Lynch with advantages and disadvantages of each one. Although this work was done more than thirty years ago (in 1961), it provides a good evidence on the effect of metropolitan forms on transport behaviour. Lynch has described six major hypothetical patterns of metropolitan forms. These are: (a) The Dispersed Sheet, (b) The Galaxy of Settlements, (c) The Core City, (d) The Urban Star, (e) The Ring, and (f) The Poly-centred Net. There are many other urban forms which are hypothetically feasible, as Lynch mentioned, but the six patterns illustrated suggest possible variation.[17] In the following a brief description of each one with advantages and disadvantages is presented.

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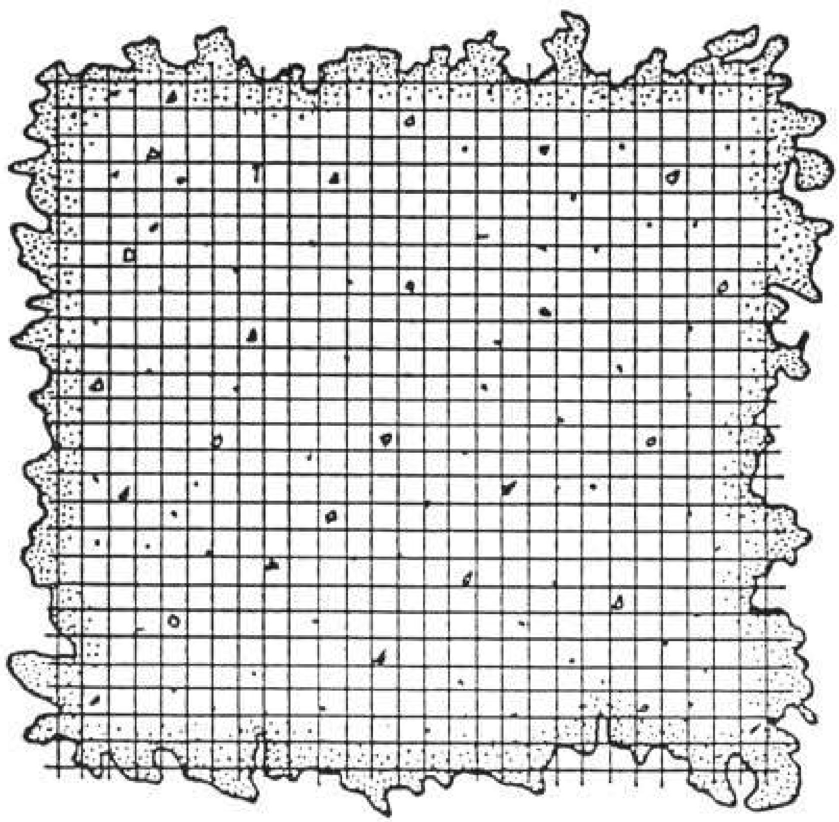
[17] Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.58.

(a) The Dispersed Sheet

Figure 9-3 shows a diagram of the "Dispersed Sheet" and Table 9-1 presents the main characters, advantages and disadvantages of the "Dispersed Sheet" as illustrated by Lynch. In this metropolitan form, the car is the main mode of transport.

Figure 9-3: The Dispersed Sheet



Source: Lynch, K., 1961, in Banerjee and Southworth, 1991, p.50.

Table 9-1: The Main characters, advantages and disadvantages of the Dispersed Sheet[18]

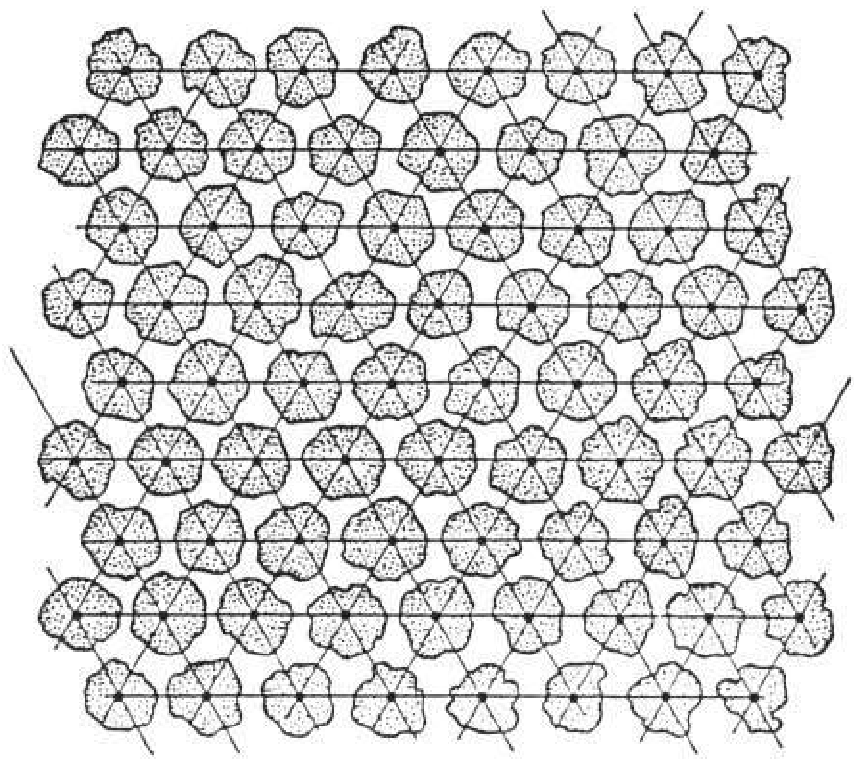
Main characters
• Low density developments and dispersion of activities; • Old centre and most sub-centre could be dissolved; • Growth controlled into an even distribution; and • The private car is the major transport mode.
Advantages
• Increasing flexibility, local participation, personal comfort, and independence to a maximum; • Solving traffic congestion through the total dispersion and balance of loads; • Good accessibility (given speeds of travel and low terminal times); and • In the end, this pattern might encourage population stability and the preservation of resources (since all areas would be favoured a like).
Disadvantages
• Long distances; • High cost; and • At the beginning, this pattern requires massive movements of the population and "extensive abandonment of equipment".

[18] After Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.49-51.

(b) The Galaxy of Settlements

Figure 9-4 shows a diagram of the "Galaxy of Settlements" and Table 9-2 presents the main characters, advantages and disadvantages of the "Galaxy of Settlements" as illustrated by Lynch. In this metropolitan form, the private car is the major transport mode, but some additional public transport would be possible especially between centres.

Figure 9-4: The Galaxy of Settlements



Source: Lynch, K., 1961, in Banerjee and Southworth, 1991, p.52.

Table 9-2: The main characters, advantages and disadvantages of the Galaxy of Settlements[19]

Main characters

- Low median densities;
- Encouraging dispersion (but with slightly different tack);
- Development is clustered into relatively small units (each with an internal peak of density and each separated form the next by a zone of low or zero structural density);
- City-wide activities concentrated at the density peak within each urban cluster (system of centres of which would be relatively equal in importance to any of the others); and
- The private car is the major transport mode, but some supplementary public transport would be feasible especially between centres.

Advantages

- Retains many of the advantages of the dispersed sheet (such as comfort, independence and stability);
- Enhances general communication through creating centres of activities;
- Presumably encourage participation in local affairs by favouring the organisation of small communities;
- The pattern provides wider range of choice than does pure dispersion; and
- Greater accessibility to open country, of the kind that can be maintained between clusters.

Disadvantages

- Works against participation and co-ordination on the metropolitan scale;
- Lost flexibility, since local clusters would of necessity have almost fixed boundaries, if interstitial spaces were preserved, and the city-wide activities would be confined to one kind of location;
- High time-distance factor, unless people could be convinced to work and shop within their own cluster;
- This pattern has a fairly local aspect and lacks the opportunities for intensive, spontaneous communication and for very specialised activities that might exist in larger centres;
- Local centres might develop a monotonous similarity, unless they were granted some specific individuality; and
- This pattern is harder to realise.

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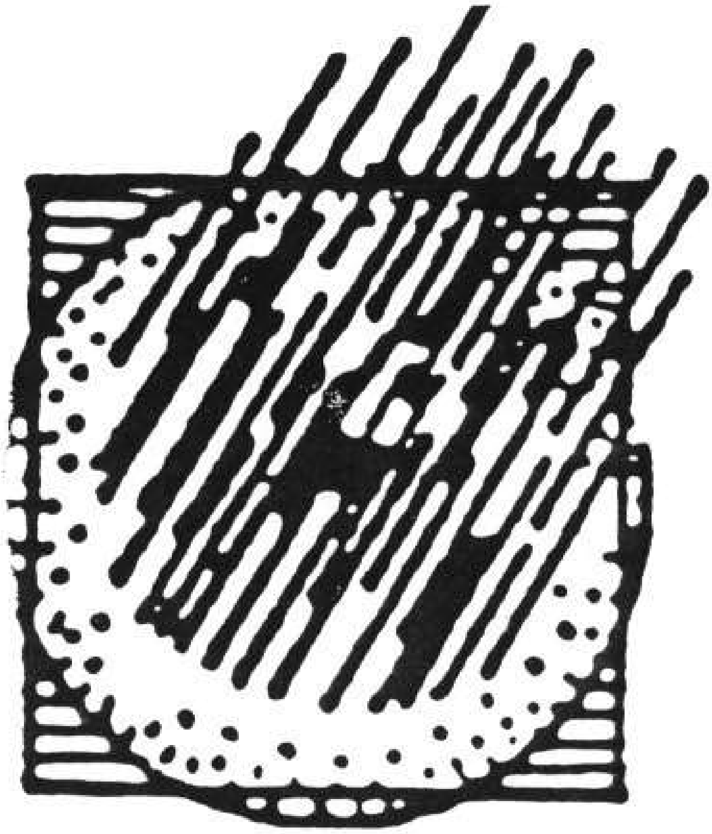
19 After Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.51-53.

(c) The Core City

Figure 9-5 shows a diagram of the "Core City" and Figure 9-3 presents the main characters, advantages and disadvantages of the "Core City" as illustrated by Lynch. In this metropolitan form, public transport is the major mode of transport, rather than private cars.

Figure 9-5: The Core City



Source: Lynch, K., 1961, in Banerjee and Southworth, 1991, p.54.

Table 9-3: The main characters, advantages and disadvantages of the Core City[20]

Main characters
• High median structural density; • Depends almost entirely on public transport, rather than private cars; and • Each family might have a second house for weekends (these houses would be dispersed throughout the countryside).
Advantages
• Very high accessibility both to special activities and the open country at the edges of the city; • Low time-distance; • Extends individual choice (due to the nearness of open country and the many kinds of special services); • Produces a strong image and contributes to a strong sense of the community as a whole; and • Discourages the segregation of social groups.
Disadvantages
• Very high initial costs; • Channels might be crowded; • The high density might increase discomfort because of noise or poor climate; • There is a level of density above which intercommunication among people begins to decline again; • High spontaneous communication (so high that it might become necessary to prevent it to maintain privacy); • Individual participation might be very difficult; and • Highly rigid solution and high cost of function change.

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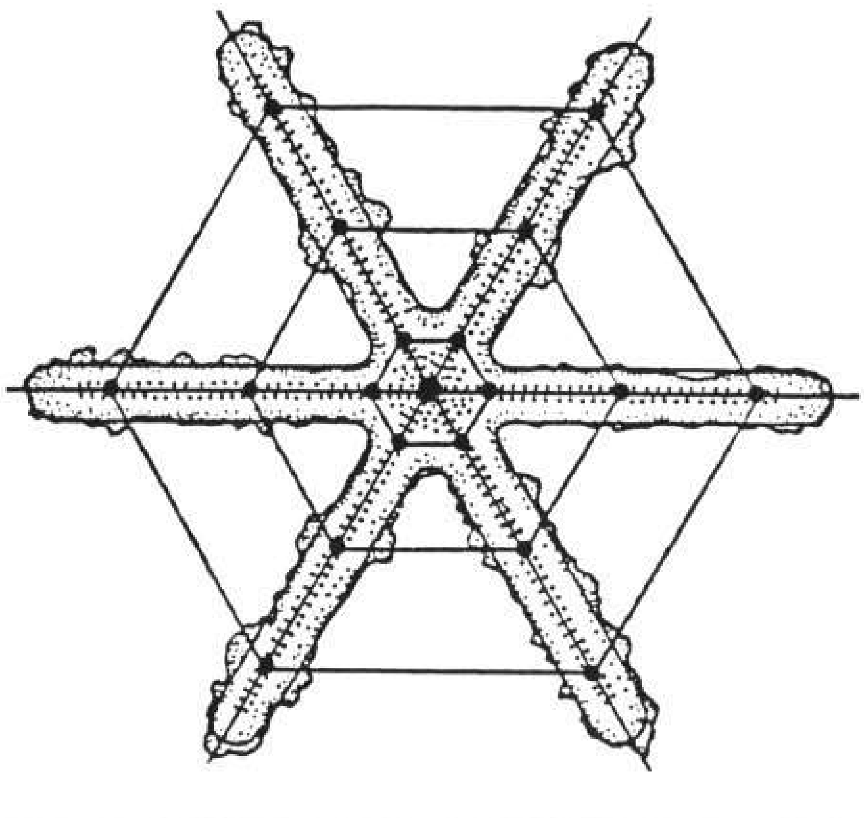
[20] After Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.53-55.

(d) The Urban Star

Figure 9-6 shows a diagram of the "Urban Star" and Figure 9-4 presents the main characters, advantages and disadvantages of the "Urban Star" as illustrated by Lynch. In this metropolitan form, an efficient public transport system could operate along the main radials and travel by private cars would be feasible in other areas.

Figure 9-6: The Urban Star



Source: Lynch, K., 1961, in Banerjee and Southworth, 1991, p.55.

Table 9-4: The main characters, advantages and disadvantages of the Urban Star[21]

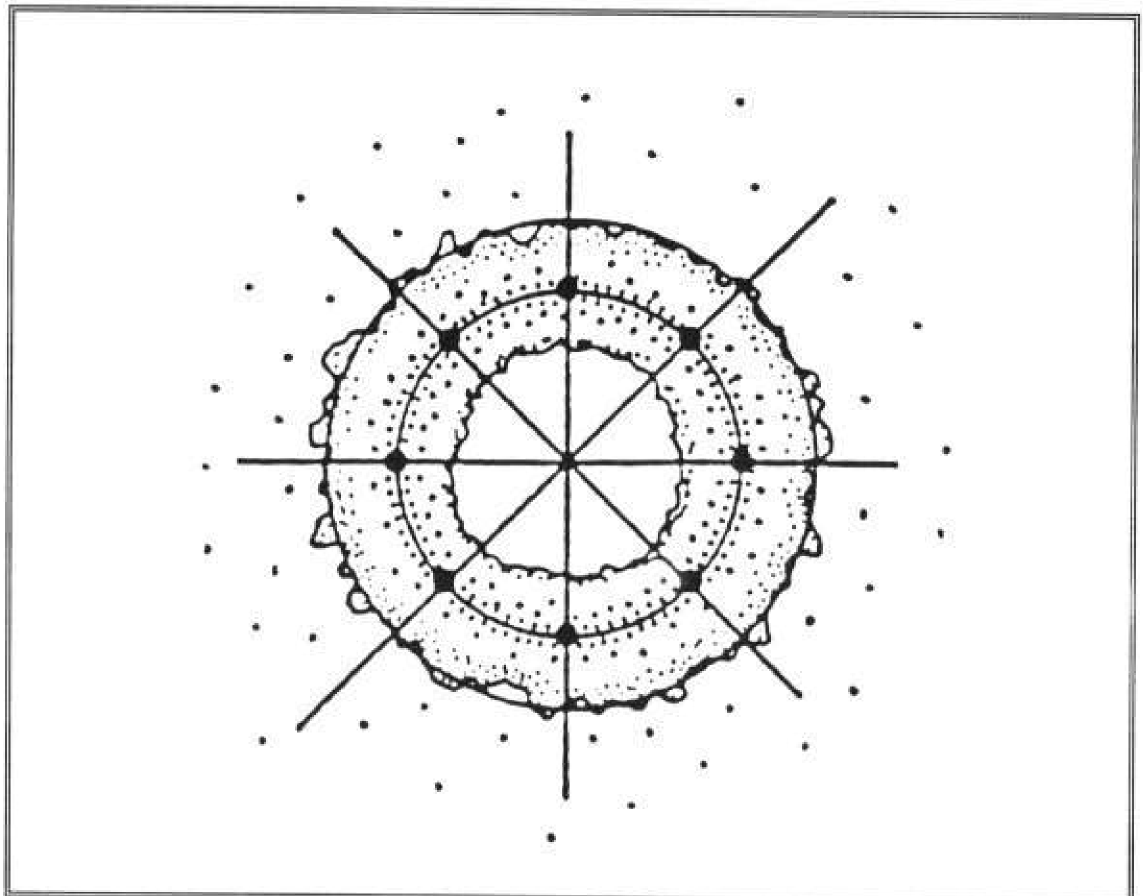
Main characters
• Density pattern that is star-shaped in the central region and linear at the peripheries; • Low-density development at the outer periphery would no longer be allowed; • Keep the dominant core surrounded by a series of smaller centres arranged along the main radials; • The lines of dense development along the radials might in time extend to other metropolitan centres (becoming linear cities between the main centres); • At moderate densities, the radial arms of a metropolis of comparable size might extend for 50 miles from its centre; • The main centre would contain the most intensive types of city-wide activities; • An efficient public transport system of high capacity could operate along the main radials and travel by private cars would be practicable in other directions; and • The rationalisation of the old metropolis in a star would work better if centre congestion could be avoided and free accessibility maintained, but this form is less and less useable as size increases.
Advantages
1. Fast and efficient movement along a sector; 2. Very strong visual image; and 3. Growth could occur radial outward.
Disadvantages
1. Terminals at the core might continue to be congested; 2. The main radials might become overloaded with continued growth; 3. Movement between sectors would be less favoured especially in the outer regions (because there distances are great, transit hard to maintain, and channels costly, since they would span long distances over land they do not directly serve); 4. Accessibility to services would be unequal between inner and outer location; and 5. Circumferential movement is the principal problem with this form (potential congestion at the core and along the main radials) and the wider dispersion of the pattern as it recedes from the original centre.

[21] After Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.55f.

(e) The Ring

Figure 9-7 shows a diagram of the "Ring" and Table 9-5 presents the main characters, advantages and disadvantages of the "Ring" as illustrated by Lynch. In this metropolitan form, public transport is well adapted, both on the ring roads and the cross radials, while private cars might be used outside the rim.

Figure 9-7: The Ring



Source: Lynch, K., 1961, in Banerjee and Southworth, 1991, p.57.

Table 9-5: The main characters, advantages and disadvantages of the Ring[22]

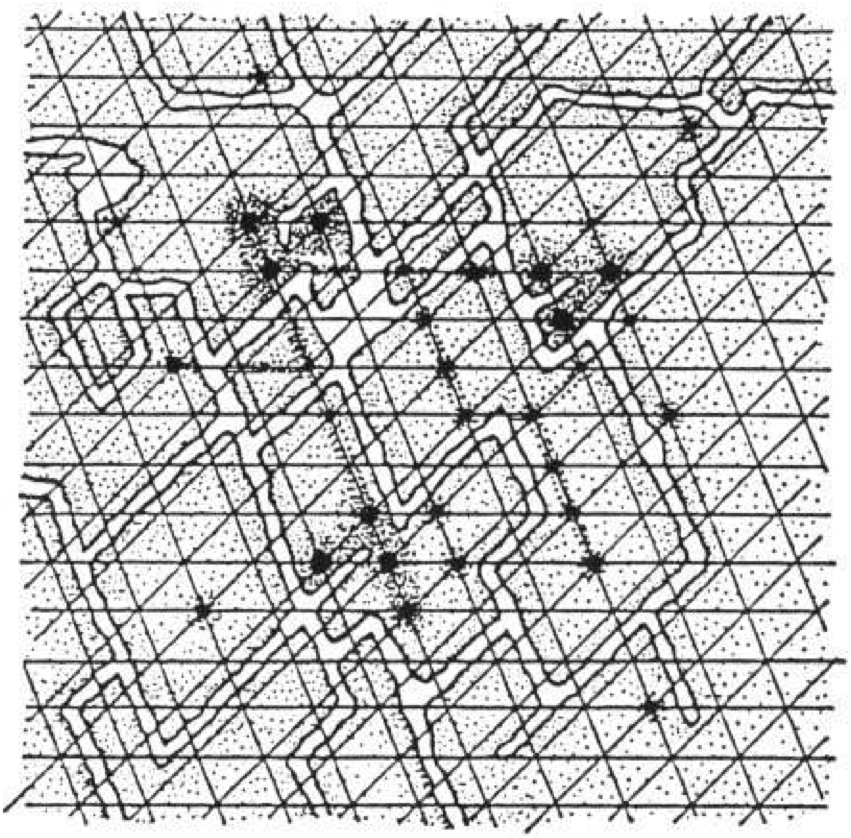
Main characters
• Centre would be kept open or at very low density while high densities and special activities surround it; • This system is well adapted to public transport, both on the ring roads and the cross radials, while individual car might be used for circulation outside the rim; • Densities within the rim would have to be high, while those beyond the rim could be low; • City-wide activities could be spotted round the rim in a sequence of concentrated centres, supplemented by linear patterns along the annular roadways; and • No single dominant centre but rather a limited number of strong centres.
Advantages
• This pattern has the linear advantages (such as a high accessibility both to services and to open land; a wide choice of home and location at any single centre is avoided, yet there is a high concentration); • The variety and strong character inherent in the specialised centres would have some hope of survival because of the relatively close proximity of those centres; • Strong visual image; and • The whole metropolis would seem almost like one community.
Disadvantages
• Growth is the most difficult problem (since much development beyond the rim would soon blur the contour and require a new transport system); • Control is another problem (how can the belts of open land or the accessible centre be kept free of development); • The ring tends to be rather rigid and inflexible as a form; and • Raises great difficulties in cost, adaptability, and continuity with present form.

[22] After Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.56-58.

(f) The Poly-centred Net

The last proposal which Lynch suggested is called the "Poly-centred Net". This pattern is a variation of the dispersed urban sheet as shown in - Figure 9-8. The main characters of this pattern as illustrated by Lynch are shown in Table 9-6.

Figure 9-8: The Poly-centred Net



Source: Lynch, K., 1961, in Banerjee and Southworth, 1991, p.63.

Table 9-6: The main characters of the Poly-centred Net[23]

Main characters
• The flow system in this form becomes more specialised and complex, assuming a triangular grid pattern that grows at the edges and becomes specialised in the core. Many types of flow would be provided for.
• Densities would have a wide range and a fine grain (with intensive peaks at junctions in the circulation system and with linear concentrations along major channels), but with extensive regions of low density inside the grid. The interstices of this network belts and tongues of open land would form another kind of grid. The general pattern would resemble a fisherman's net, with a system of dispersed centres and intervening spaces.
• City-wide activities would concentrate in clusters of density (graded in size). Special activities would be provided only in larger centres. Major centres would be highly specialised and would be arranged in a loose central cluster, each accessible to another.
• A metropolis of 20 million might have two or three clusters whose area of influence would overlap. These clusters might be so dense as to be served by transport grids organised in three dimensions. Elsewhere, the network would thin out and adapt pattern would continue to specialise and to grow perhaps in a rhythmically pulsating pattern.

(g) Conclusion and reference to Ar-Riyadh

Each of the six alternative proposals has advantages and disadvantages. For example as Lynch mentions, an extreme dispersion of metropolis (such as the Dispersed Sheet) seems to: (1) limit choice; (2) reduce natural interaction; (3) require high cost; and (4) limit a rich metropolitan image. A galaxy of small communities (such as the Galaxy of

[23] After Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.62-63.

Settlements proposal) assures better than the Dispersed Sheet, but would still be poor as regards (1) choice, (2) interaction, (3) cost, and (4) being more difficult to realise.[24] On the other hand, as Lynch mentions, a re-centralisation of metropolis with an intensive core (such as the Core City proposal) has several disadvantages in: (1) cost; (2) comfort; (3) individual participation; and (4) adaptability. The Urban Star proposal would perform better if (1) congestion in the centre could be avoided and (2) free accessibility could be maintained, but this form is less workable as a city expands. The Ring proposal has many advantages but raises great difficulties in (1) cost, (2) adaptability, and (3) continuity with existing form.[25]

All Lynch's proposals are theoretical models. Lynch mentions that all these proposals do not take into account the complications of reality. In reality, a plan for a metropolis is more likely to be a complex and mixed one whose form involves rates and ways of changes and a momentary style.[26] Nevertheless the last form suggests a concentration of population and activities along major public transport corridors forming a poly-centric net that seems to coincide with a lot of suggestions mentioned previously. The idea of concentration of population and activities along major public transport

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[24] Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.62.

[25] Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.62.

[26] Lynch, Kevin, The Pattern of the Metropolis, 1961, in Banerjee and Southworth, 1991, p.62.

corridors seems to minimise car dependence and can be used as a main concept for any development options for Ar-Riyadh.

9.4.2 Current investigations of the effects of metropolitan forms on travel demand and choice of travel mode

A recent study by Rickaby of alternative development patterns for a hypothetical city and its surrounding region found that the compact centralised city had some advantages over a pattern of development dispersed in the hinterland, reducing travel demand through shorter journey lengths by 9 to 14 percent over 25 years. In contrast, more use of the same model to simulate alternative development patterns for an archetypal town produced no significant variations in petrol use between the options.[27]

The compact centralised city emerges as one potentially transport-efficient pattern of urban development but not for a big metropolitan area. In big metropolitan area, it appears to increase average trip lengths. According to the report of ECOTEC, a range of conflicting issues are involved when considering the travel implications of centralised versus other urban structures. When journey tend to end at a centralised point it: (1) increases the possibility of multi-purpose trips; (2) potentially reduces total travel; (3) increases the viability of public transport through focusing demand on radial corridors; (4) raises the congestion and parking constraints; and (5) raises

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[27] Rickaby, 1987, in Royal Commission on Environmental Pollution, 1994, p.149f.

the costs and difficulties of car use.[28] The key findings of the report of ECOTEC regarding centralisation issue are:[29]

- at the regional level, centralisation appears to have some effect of increasing average trip lengths;
- for work travel, centralisation has strong effects of increasing the use of public transport and reducing the use of the car; and
- for non-work travel, at the regional level, centralisation has clear effects of increasing the use of public transport rather than the car.

Land-use patterns with decentralised concentrations of activities (multi-clusters of activities) may be more efficient in terms of the distance which people need to travel for particular types of activity. However, as mentioned by the report of ECOTEC, if a large number of people choose not to use their nearest centres, this potential may not be realised. The result may create a higher travel demand than overall centralisation.[30]

According to the report of ECOTEC, case studies of the travel demand implications of the location of major retail developments indicated that central locations were associated with shorter journeys and overall reductions in travel demand. However, the differences when compared with non-central

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[28] ECOTEC, 1993, p.43.

[29] ECOTEC, 1993, p.44.

[30] ECOTEC, 1993, p.43.

locations were not significant and the results were influenced by local road network setting.[31]

In conclusion, a range of conflicting issues are involved when considering the travel implications of metropolitan forms. It is clear from all the previous evidence that each urban form has advantages in some areas and disadvantages in others. However, with regard to the issue of reducing car dependence, the idea of population and activities concentration along major public transport corridors seems to be a good development strategy for urban form. This development strategy gives public transport the best possible chance to compete for commuters with the private car.

9.5 The influence of neighbourhood form on travel demand and choice of travel mode

According to the report of ECOTEC, a high proportion of all travel in UK is essentially local and a very high proportion of all trips are relatively short. Around 75 percent of all journeys are under eight kilometres in length; half are under three kilometres; and 32 percent are under 1.6 kilometres.[32] This is corroborated by the Royal Commission on Environmental Pollution

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[31] ECOTEC, 1993, p.50.

[32] ECOTEC, 1993, p.viii.

which adds that although the number and average of journeys has been increasing, almost a third are still less than a mile and almost three-quarters are less than five miles.[33]

This indicates the considerable possibility for a change to alternative travel modes, particularly walking and cycling. The review of evidence by ECOTEC indicates that:

> "proximity to local centres, the choice of available facilities and design characteristics are important factors in encouraging their use. Walking, and to lesser extent cycling, are important [travel] modes for short journeys."[34]

In addition, the survey results of ECOTEC indicate that:

> "easy access to a neighbourhood centre, with a good range of facilities, can reduce travel to major centres. Distance is a key factor determining whether people walk or use motorised transport"[35]

In conclusion, evidence in this section suggested that there are considerable potential for a shift to alternative modes of travel, particularly walking and cycling. It suggested also that easy access to a neighbourhood centre can reduce travel to major centres. However, distance is a key factor determining whether people walk or use motorised transport.

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[33] Royal Commission on Environmental Pollution, 1994, p.180.

[34] ECOTEC, 1993, p.viii.

[35] ECOTEC, 1993, p.50.

9.6 The influence of fast-road infrastructure on growth pressures

This section, considers how the provision of fast-road infrastructure influences the development of urban areas. Many studies suggest that fast-roads encourage more decentralisation of a city and increases car-dependence. For example:

- The study of Newman and Kenworthy suggests that large road systems change the nature of the city into one with more car-dependence;[36]
- The Royal Commission on Environmental Pollution suggests that building new roads around built-up areas creates a strong growth pressure;[37]
- Modelling carried out by the International Study Group suggests that provision of fast outer ring roads encourages more decentralisation of employment, particularly service and retail.[38]

Building new motorways automatically drains development (such as residence, employment, service, retail, etc.) away to the ends of these expressways. According to the report of the Urban Advisors to the Federal Highway Administrator in the USA, city transportation arrangements which adapt to high-speed car travel lead to the growth of low to medium-density residential areas, a spread of suburban neighbourhoods and the

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[36] Newman & Kenworthy, 1989, p.106.

[37] Royal Commission on Environmental Pollution, 1994, p.147.

[38] Webster, F., Ply, P. and Paulley, N., 1988 in Royal Commission on Environmental Pollution, 1994, p.147.

decentralisation of shopping, cultural activities, business and industry. On the other hand, cities which control car traffic but supply efficient public transportation are presumably more compact, with high density housing, and a more dynamic city centre.[39] This demonstrates the power of fast-road infrastructure in shaping patterns of development.

Whitelegg suggests that system speed is an important factor which encourage dispersion of the city. He mentions the consumption of space by different travel modes by saying: "whereas speed consumes distance, a travel mode occupies space -- and the faster the travel mode the more space it requires."[40] He referred to the 1985 Swiss study[41] which states that a car travelling at 40 Km/h requires over three times as much space as a car travelling at 10 Km/h. Also a single person travelling at 10 Km/h requires six times as much space as a person riding a bicycle at the same speed. Figure 9-9 shows the consumption of space by different modes of transport.

In addition to system speed, Brotchie mentions that system cost is also an important factor which encourages dispersion of the city. He says:

> "any system which increases the speed of travel, or reduces its cost, is likely to encourage people to live further away from their jobs or the other places they wish to visit fairly frequently."[42]

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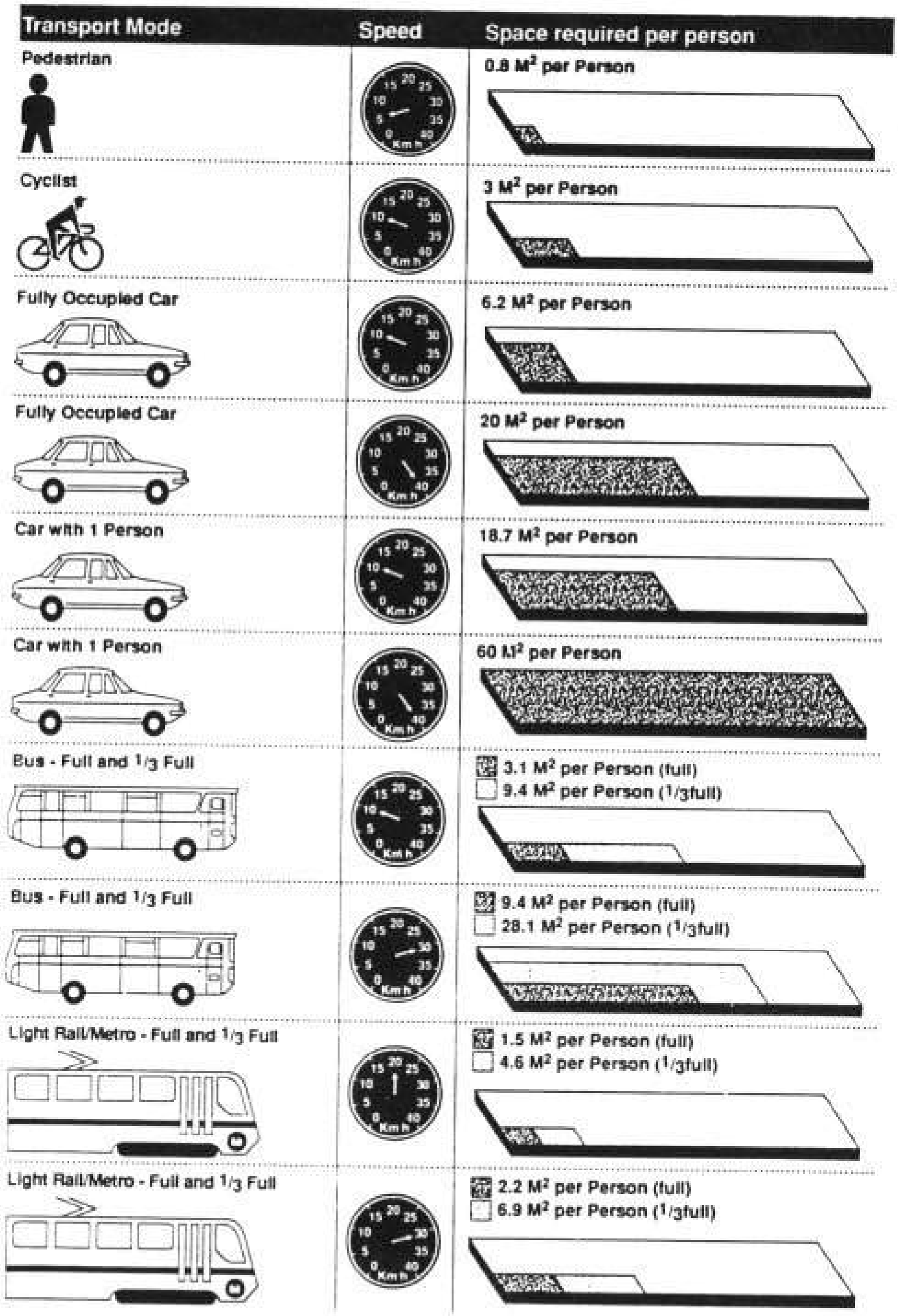
[39] The Urban Advisors to the Federal Highway Administrator, 1968, p.28.

[40] Whitelegg, 1993, p.132

[41] Navarro, 1985 in Whitelegg, 1993, p.132

[42] Brotchie, 1985, p 136.

Figure 9-9: Consumption of space by different travel modes



Source: Whitelegg, 1993, p.132.

The development of the motorway system influences the growth of urban areas. According to the report of ECOTEC:

> "The development of the motorway system has stimulated decentralisation and considerably extended the potential availability of sites with good access. Orbital routes around major urban centres can also contribute to the dispersal of economic activities and lead to travel patterns that can not easily be replicated by public transport. In contrast the construction of by-basses has had relatively minor impacts on development trends. However, new access roads for particular sites can have important localised impacts on development."[43]

Based on the evidence in this section, it is concluded that fast-roads encourage more decentralisation of employment, service and retail; create a strong growth pressure; change the nature of the city into more car-dependence; and reduce the use of public transport.

9.7 The scope for a land-use planning contribution in Ar-Riyadh

As stressed in Chapter Four, Ar-Riyadh exhibits high travel demand when compared with UK and European cities. This is probably a consequence of the high percentage of vacant lands, a relatively low overall population density, and high degree of decentralisation of population, employment, and services throughout the city. In general terms, towns and

[43] ECOTEC, 1993, p.54.

cities in Saudi Arabia are similar in density and travel demand per capita to the USA. The potential scope for land-use planning to reduce car-dependence is therefore more than that evident in, for example, the UK and Europe. The low overall population density and the decentralisation of population, employment, and services overall the city increase the contribution of land-use planning to reduce car dependence. Although most land-uses change only slowly, there is clearly substantial scope for reduced car use in Ar-Riyadh.

Land-use planning measures can not work alone to reduce travel demand without the support of the other measures. According to the report of ECOTEC, the successful reduction of travel demand must:[44]

1. incorporate technological developments;
2. integrate with economic measures, road management and regulations;
3. co-ordinate with policies for the provision of infrastructure; and
4. educate users through, for example, projects and educational initiatives about harmful effects of car use and options which are available.

9.8 Summary

This chapter investigated the inter-relationships between land-use, transport infrastructure and travel behaviour. The interrelationships between

[44] ECOTEC, 1993, p.26.

land-use patterns and travel demand behaviour are very complex. The approach to these issues has been a pragmatic one, drawing upon a wide variety of evidence from case studies, statistical analysis and current research studies from United Kingdom and international studies. This chapter analysed the influence of population densities, mixing of land-uses; metropolitan forms; and neighbourhood structure on travel demand and choice of travel mode. Also analysed the influence of fast-road infrastructure on development of urban areas.

Based on the evidence presented in this chapter, it is concluded that population densities, metropolitan forms; neighbourhood structure, and fast-road infrastructure can have positive effect on travel demand and choice of travel mode. However, the evidence suggested that mixing residential and employment uses within a particular urban zone has little effect on distance travelled or modal choice.

Although most land-uses change only slowly, the data in this chapter suggested that the potential scope for land-use planning to reduce car-dependence in Ar-Riyadh is very high due to a consequence of high percentage of vacant lands, a relatively low overall population density, and high degree of decentralisation of population, employment, and services overall the city. Examples of attempts to integrate land-use planning and transport will be presented in the next chapter.

CHAPTER 10

EXAMPLES OF ATTEMPTS TO INTEGRATE LAND-USE PLANNING AND TRANSPORT

10. EXAMPLES OF ATTEMPTS TO INTEGRATE LAND-USE PLANNING AND TRANSPORT

Integration of land-use planning and transport is a very important tool with which to reduce car dependence and to increase the choice of alternative means of travel. One of the most important alternative means of travel is public transport. In modern cities, it is difficult for public transport to run fast or far enough to keep up with low-density suburban growth. Therefore, public transport authorities need to work in conjunction with planning agencies to cluster developments (jobs, housing, facilities and services) around public transport nodes. This gives public transport the best possible chance to compete for commuters with the private car and thus change the modal splits. In the following sections, three examples of relevant experiences in different parts of the world will be presented. They have attempted to integrate land-use planning and transport to reduce reliance on the car and increase the choice of alternative modes of travel. The examples are: (1) Copenhagen as a case study of a centralised city, (2) Los Angeles as a case study of a decentralised city, and (3) reviewing some planning policy in the United Kingdom.

10.1 Copenhagen: A case study of a centralised city

The basic concept of the Copenhagen physical plan is to focus suburban growth around nodes located along the main public transport routes. This gives public transport the best possible chance to compete with the private car for the commuters. Other cities such as Stockholm, Paris, and Toronto have adopted this same concept since the 1950s and 1960s.[1] In this section, a brief description of such a "Finger Plan" as the initial Copenhagen Plan was called will be discussed followed by a brief description of the Copenhagen regional planning after the "Finger Plan". An evaluation of the Copenhagen Plan is also presented.

10.1.1 The Finger Plan

The Copenhagen physical plan provides a good example of the strategy of concentrating growth into public transport corridors. The Greater Copenhagen Area has a population of 1.7 million, which is almost one third of the total population in Denmark and the City of Copenhagen has a

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[1] Hall, P., 1994, p.S85.

population of 465,000.[2] The first steps towards comprehensive regional planning for Greater Copenhagen Area were taken at the end of the Second World War. In the late 1940s Danish town planners noticed the effects of high levels of car ownership in other world cities. They rejected dependence on the car which elsewhere had encouraged suburban sprawl and a decline in the effectiveness of public transport. In 1948 a first proposal for a regional plan was published by the Danish Town Planning Institute. This plan was carried out on an voluntary basis and was called the "Finger Plan". Legislation supported the Finger Plan through the Town and Countryside Zoning Act of 1949. As Figure 10-1 shows, the main points of the Finger Plan proposal are:

1. Suburban growth should be focused around nodes located along the main transport lines (five fingers), which ensured that travel time to the city would be half an hour at most;
2. Suburbanisation would be restricted to the five fingers extending along rail routes, and the land between five-fingers preserved as green wedges for recreational purposes and farming; and
3. Central Copenhagen would still be the centre for production and services while local service centres would be built up around the railway stations in the fingers.

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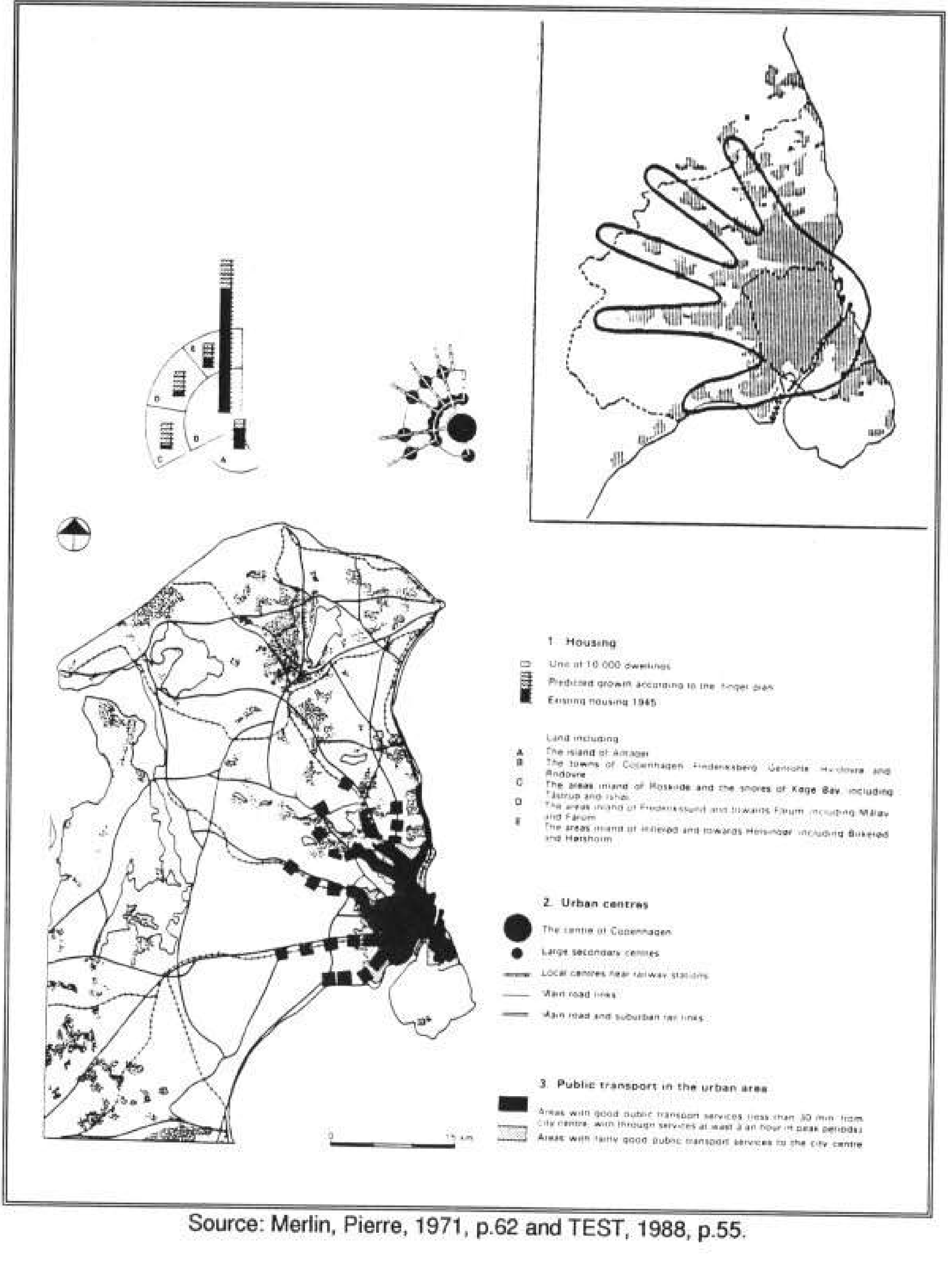
[2] Hartoft-Nielsen, Peter, in International Conference titled "The European City and its Region: How can the co-ordination of physical planning be achieved?", 1993, p.2.

Figure 10-1: Copenhagen's Finger Plan 1947



Source: Merlin, Pierre, 1971, p.62 and TEST, 1988, p.55.

The Finger Plan made it possible to divide the Copenhagen region into major built-up areas and green wedges so that growth could be contained within the core and the five fingers. The concept of the Finger Plan is similar to the Urban Star form which mentioned earlier by Lynch. According to Hartoft-Nielsen, the most important achievement of the Finger Plan was the acceptance of zoning, which has stopped undesirable urban sprawl. This is the case in spite of conflicts with and considerable changes to the original thinking about the ideal travel distance to railway stations for built-up areas.[3]

10.1.2 Regional planning after the Finger Plan

According to Gossop, the Fifties and the Sixties saw the rapid and progressive expansion of Copenhagen. The need for residential and commercial areas grew more than was foreseen in the Finger Plan. A rapidly increasing population and private cars in addition to a tendency for much of the new growth to be of relatively low density led to the fingers becoming longer and thicker than had been originally intended in the Finger Plan. Moreover, the integrity of the green wedges was further threatened by demand from expanding industrial companies looking for cheap land. The Danish Ministry of Housing alarmed by these trends set up a regional

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[3] Hartoft-Nielsen, Peter, in International Conference titled "The European City and its Region: How can the co-ordination of physical planning be achieved?", 1993, p.12.

planning office to prepare a new planning strategy for the area.[4] In the Sixties, the plan had to be supplemented with proposals for new urban areas in extended "thumb" and "index fingers".

The immediate outcome of this new Regional Plan called the Preliminary Outline Plan form 1960 was an Act in 1961 for the planning of the *Koge Bay* along the cost to south-west. In the Sixties and the Seventies, dwellings for about 150,000 inhabitants were built there.

Voluntary collaboration between the 50 local authorities in Greater Copenhagen resulted in the establishment of the Regional planning Council, which from 1967 to 1974 had the responsibility for the overall regulation of this decentralisation between authorities. Until 1973, the Council acted in an advisory capacity. The result of this Council's still voluntary work was a new regional plan for Greater Copenhagen in 1973. In this plan which was based on the expectation of rapid growth, the three northern fingers were extended so that a balance could be achieved between urban development to the north and the west of Copenhagen. The five town fingers were to be linked by transport corridor for cars and mass transport around the dense areas of Greater Copenhagen.

[4] Gossop, Chris, 1984, p.152.

In 1974, the Greater Copenhagen Council was established and was made responsible for planning in Greater Copenhagen as a whole. Besides regional planning the main task of the council was public transport in Greater Copenhagen as a whole. In 1976, the Council adopted the regional plan first proposed in 1973. In 1979, the Minister for the Environment approved an initial stage that follows the main principles for the finger plan, and this was made the first legal regional plan for Greater Copenhagen.

This regional plan was designed to control urban growth. But when the Greater Copenhagen Council took over planning for Greater Copenhagen in 1974, the job of planning had already changed character. Due to the energy crisis, urban growth came to an abrupt halt. The population in Greater Copenhagen stagnated. Construction fell to completely unexpected low levels. The new task was to stabilise the urban structure and enable some centralisation.

In 1989, the fourth regional plan for Greater Copenhagen reflects the reduced expectation of growth by focusing on a strategy for re-centralised regional location. The plan recommends that certain activities oriented towards the inner city be located there and that the functions that could just as well be located in suburbs be decentralised. This plan stresses the importance of co-ordination between transport planning and land-use planning. Like the Finger Plan, priority is given to public transport and to a higher building density around specially designated stations. Office building

and work places are to be located near transport junctions. The aim is to cultivate and refine the original city structure by using land-use planning to favour mass transport and to reduce commuting time. The strategic conclusions of the 1989 regional plan are similar to those of the Finger Plan. It can be considered a revival of the Finger Plan but it is much more complex and includes a number of new planning topics.

10.1.3 Evaluation

The Copenhagen Plan can be evaluated at different levels: physical, economic, social, and environmental. However, the main aim of this thesis is to investigate the effect of planning polices on increasing the choice of alternative modes of travel and reducing car-dependence. Although there are many factors which can affect the relationship between land-use and transport, there are four pieces of published evidence by different researchers and agencies which suggest that planning polices have succeeded in increasing the use of alternative mode of travel (modal splits) and reducing car dependence in Copenhagen. These are:

1. According to the study of Newman and Kenworthy, because of the relatively compact nature of European cities, only 44 percent use a car to

travel to work whereas 21 percent use a bicycle or walk. In Copenhagen the percentage walking or cycling is even higher with 32 percent.[5]

2. Locating offices in the city centre or near stations outside the city centre appears to reduce the amount of travelling by car. According to a survey by the Ministry of Environment in Denmark, 20 to 25 percent of the employees commute by car to the city centre, 40 percent in the residential areas immediately outside central Copenhagen, 40 to 50 percent commute to workplaces near peripheral stations whilst as many as 70 to 75 percent use a car to travel to work places far from peripheral stations.[6]
3. Since 1979 both the number of cars and the distance travelled per year have declined. According to TEST, between 1979 and 1983 the total number of cars decreased by 7% in Denmark overall. In Copenhagen, a similar decline has been noted. Table 10-1 shows that the number of residents per car fell from 17 to 4 between 1950 and 1970. However since then the number of residents per car has increased again to 6.2 in Copenhagen.[7]
4. According to the Royal Commission on Environmental Pollution, the result of transport and land-use policies in Copenhagen is reported to be 10%

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[5] Newman and Kenworthy, 1989, in Hall, P., 1994, p.S81.

[6] Hartoft-Nielsen, Peter, in International Conference titled "The European City and its Region: How can the co-ordination of physical planning be achieved?", 1993, p.20.

7 TEST, 1988, p.59.

fall in traffic since 1970 and an 80% increase in use of bicycles since 1980. About one-third of commuters now use cars, one-third public transport, and one-third bicycles.[8]

Table 10-1: Registered vehicles in Copenhagen
1954-1984

Vehicle Type	1954	1964	1974	1984
Private cars	36,236	110,157	139,063	100,460
Taxis	--	3,215	3,551	2,245
Buses and coaches	2,338 [9]	486	972	877
Vans and trucks	15,729	31,510	24,729	18,858
Motorcycles	26,138	23,769	6,700	4,078
Total	82,637	149,137	174,315	126,508
Inhabitants per car	17	6.2	4.1	6.2

Source: Copenhagen Yearbook 1955, 1965, 1975, 1985 in TEST, 1988, p.56.

In conclusion, the basic concept of the Copenhagen plan is to focus suburban growth around nodes located along the main public transport routes. This gives public transport the best possible chance to compete with the private car for the commuters.

[8] The Independent, 25 March 1994 in Royal Commission on Environmental Pollution, 1994, p.195.

[9] Buses and coaches includes taxis.

10.2 Los Angeles: A case study of a decentralised city

Los Angeles has been chosen because a generation ago it represented the situation in which Ar-Riyadh, the city at the centre of this study, is now. The experience in Los Angeles has much relevance to the problems which currently face the city of Ar-Riyadh.

In the following sections the issue of decentralisation of Los Angeles will be investigated. The old and current transportation strategies practised in Los Angeles will also be analysed. In the last part, the current urban planning of Los Angeles will be studied.

10.2.1 Decentralisation

Los Angeles, California, is considered to be the prototype of a decentralised low-density city. Its pattern of development illustrates the effect of the growth of high levels of private car ownership. Similar situations are to be found in the recently urbanised parts of North America, Canada, Sweden and Australia. Los Angeles today is the model of the "car culture", possessing highly complex motorway networks designed to meet the ever-

growing demand for road communications. It represents well the "Full Motorization Strategy" as described by Thomson.[10]

Los Angeles developed almost entirely during the era of mass car ownership. During the 1991, there were 8,000,000 cars for 12,000,000 people in Los Angeles.[11] As the volume of cars grows rapidly in Los Angeles, roads become congested, air pollution rates increase and insufficient parking spaces create even more problems especially in city centre. In 1991, the car has created environmental problems in Los Angeles such as a yellow pall over the city; visibility is reduced to 3 miles; smog fills the lungs, especially of children during summer days. Cars congest every major city in the world, and still 130,000 new cars are produced, globally, every day.[12] Figure 10-2 shows car congestion in one of Los Angeles motorways and Figure 10-3 shows thousands of newly imported cars that will soon be added to the overcrowded motorways in Los Angeles.

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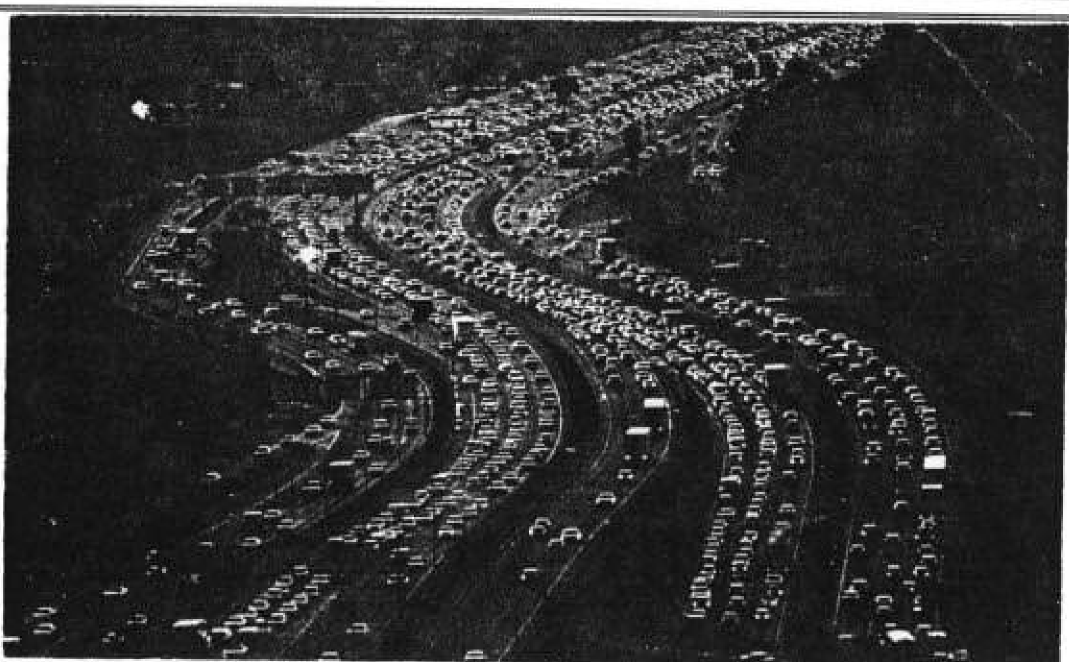
[10] Thomson, 1977.

[11] HORIZON Programme Transcript, 1991, p.3.

[12] HORIZON Programme Transcript, 1991, p.3.

Figure 10-2: Car congestion in one of Los Angeles motorways



Source: IMPACT Southern California, Post card.

Figure 10-3: Thousands of newly imported cars

Source: Cameron, R., p.29.

Low density urbanisation was encouraged by the effect of high levels of personal mobility, wealth, and a lack of serious control of urban development. This in turn had a fundamental influence upon the functional structure of land-use and transport networks. The dispersed communities and high levels of personal mobility encouraged the decentralisation of employment, schools, shops, services, and other activities throughout the city. As a result, Los Angeles city centre has declined and because of the dramatic changes in land-use in the city, alternative sub-centres have emerged. Thomson mentions that, whatever the scale of an urban region, the largest central business area can accommodate a maximum of only 150,000-180,000 car commuters, above which serious peak-hour traffic congestion is likely to arise.[13]

The structure of Los Angeles metropolitan region is poly-centric. The main city centre contains a small percentage of all jobs in the county (8% only).[14] The necessity for links between the numerous settlements within the region was met by a network of motorways that transport some of the highest traffic volumes in the world. Figure 10-4 shows Los Angeles city centre and Figure 10-5 shows an aerial-view photograph of four-level interchange near Los Angeles city centre.

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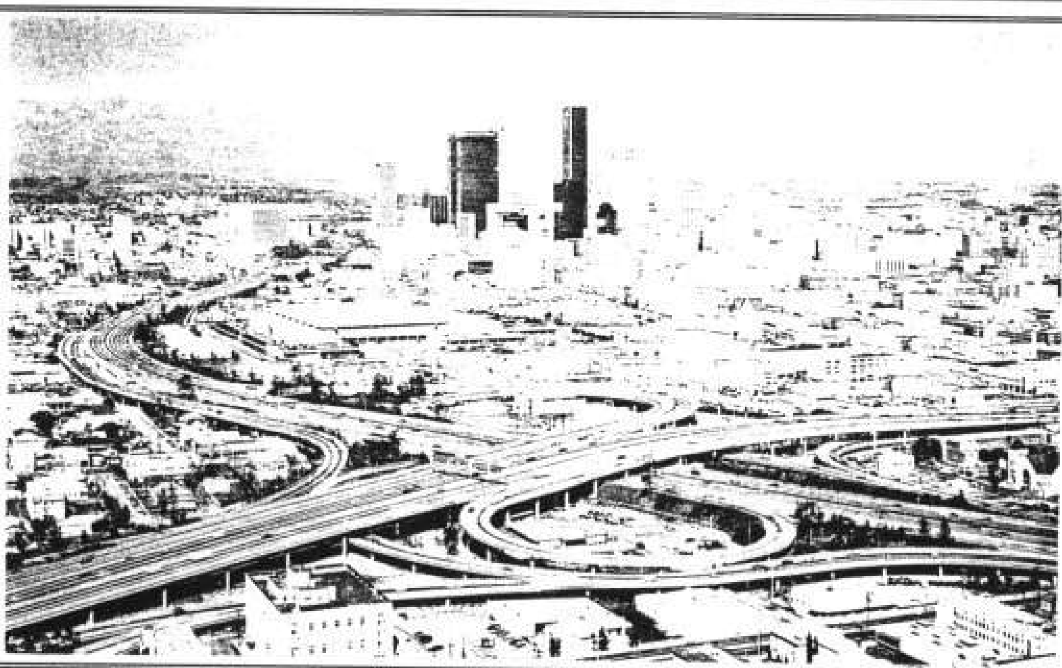
[13] Thomson, 1977, in Herbert and Thomas, 1990, p.161-163.

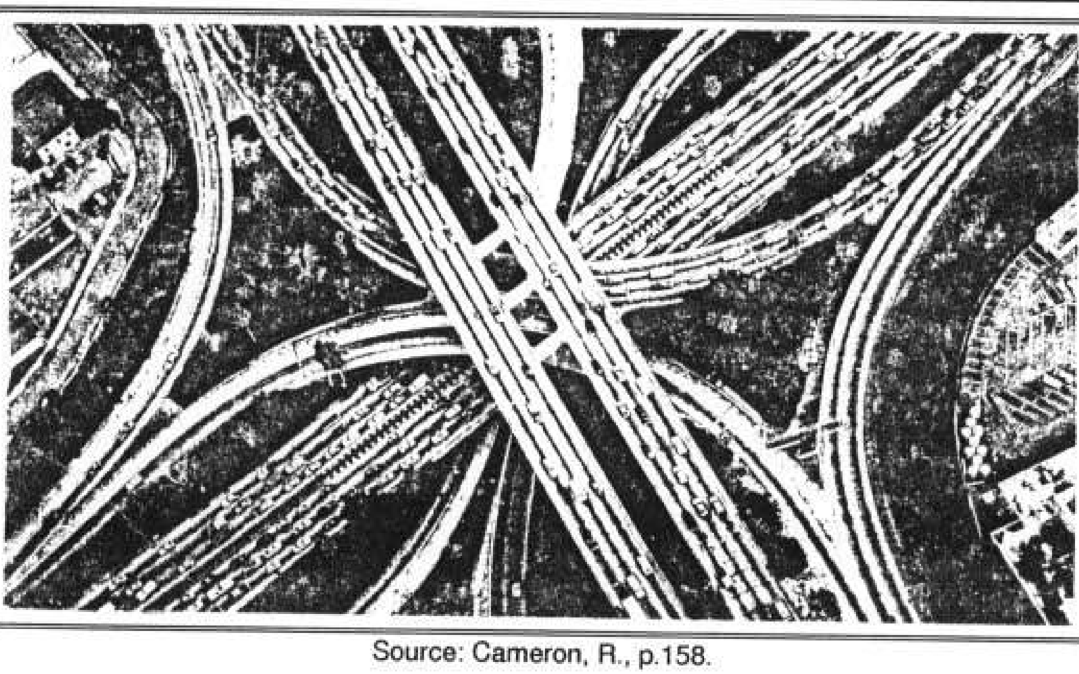
[14] Turton, Brian and Knowles, Richard, Urban Transport Problems and Solutions, in Hoyle and Knowles, 1992, p.100.

Figure 10-4: Los Angeles city centre



Source: Columbia Publishing, Post card.

Figure 10-5: A four-level interchange near centre of Los Angeles



Source: Cameron, R., p.158.

10.2.2 Transportation strategies

Two transportation strategies which practised in Los Angeles will be presented in this section: (a) the old strategy of more road and motorway construction, and (b) the current strategy of more land-use control and management.

(a) The old strategy: more road and motorway construction

In the 1940's, due to the demands of a highly car oriented culture which obligated the comprehensive development of car transportation facilities, most of the urban transportation investment in Los Angeles was directed to roads and motorways. These were increased by the construction of secondary grid-pattern roads to support the increasing traffic. In such a system as Thomson mentions, the influence of public transport has been minimal because improved facilities for car transportation diverted users from public transport. Pederson states:

> "The automobile is blamed for the problems of public transit. There is a correlation between decline in usage of public transit and increase in automobile usage. The decline began as early as 1920 in some American cities, and it is now rapid in European cities."[15]

The extensive physical impact of the car is best illustrated in the experience of Los Angeles. The influence of the car on Los Angeles has

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[15] Pederson, 1980, p.31.

been enormous. A lot of money was spent to build motorways, bridges, roads, and other traffic facilities. The results of this investment, however, have not satisfied city authorities since each improvement brings with it new difficulties. Ridley states that road improvements are soon flooded by increased traffic, car parks use up important building sites, and cars pour into town in even greater numbers.[16] Richards also states that new roads built in part of a city may produce only temporary relief to other parts of the network. They then bring in so much traffic that they too become congested, causing traffic speeds to drop.[17]

(b) The current strategy: more land-use control and management

The authorities of Los Angeles decided in the 1920's to go the way of transportation facility construction and decentralisation of activities. But recently, due to the increasing traffic problems which resulted from that planning, the emphasis in transportation planning has shifted from facility construction to transportation system management and the control of land-use with the goal of slowing down the growth in traffic congestion. According to Wachs:

> "In the late eighties, this growing movement toward management rather than facility construction has emphasised changes in land-use policy and the spatial redirection of economic growth to control

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[16] Ridley, Anthony, 1975, p.49.

[17] Richards, 1990, p.1.

traffic at its source. This represents a change in basic direction for transportation planning ..."[18]

Buchanan compares dispersed growth (as in Los Angeles) with the advantages of the compact community (as in most of the original European cities). He mentioned that dispersal is synonymous with "sprawl" and, if taken beyond a critical point, will complicate transportation problems by increasing all distances. On the other hand the advantages of compactness as Buchanan suggested are as follows: (1) In compact areas, journeys are kept to the minimum, including the all-important journeys to work and school; (2) A diversity of services, interests, and contacts is provided; (3) There is wider choice of housing, employment, schools, shops, and recreational and cultural pursuits; and (4) Secondary activities such as restaurants, specialist shops, and service industries are maintained.[19]

There are many management and regulation measures used in Los Angeles. For example, as mentioned in Chapter Eight, The Southern California Air Quality Management District adopted in 1987 Regulation 15 to encourage the car sharing as a result of a serious pollution problem. This law requires all employers of 100 or more persons to advise their workers arriving between 6:00 and 10:00 to reduce their use of private cars. These

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[18] Wachs, 1990, p.242.

[19] Buchanan, The future of the motor vehicle, in Blowers, A. et al., 1974, p.83.

big employers must submit trip reduction plans to the Air Quality Management District for approval. Regulation 15 seeks to create a regionwide average commuter car ridership of 1.5, with a target of 1.75 for downtown Los Angeles workers. Another management example is that the only new cars allowed to enter the city centre of Los Angeles by the end of the century will be electric cars.[20]

10.2.3 The current urban planning of Los Angeles

Most of the present efforts are a reaction to the legislated reduction in air pollution, car congestion, parking problems, etc. In this section, the current urban planning for Los Angeles is studied. This includes the following topics: (a) the Centres Concept of 1974; (b) the co-operative planning effort between City and Los Angeles County Transportation Commission (LACTC); (c) the current General Plan Framework for Los Angeles; (d) land-use policy overview; and (e) an evaluation of the current General Plan Framework.

(a) The Centres Concept

In 1974, the Centres Concept was adopted by the City Council as the framework for future growth and development in Los Angeles. The Centres Concept envisioned the city as a network of urban centres linked by a rail

[20] Clegg, G., 1993, p.30

transit system. Centres would be self-contained communities where many types of services, jobs, and housing would be available and accessible. The Centres Concept called for concentrating growth in these urban centres to avoid invasion of unwanted commercial development or higher densities while protecting the city's predominant single-family pattern of residential development.[21] Figure 10-6 shows Los Angeles Centres Concept of 1974.

(b) Co-operative planning effort between City and LACTC

In the Eighties and the Nineties, the citizens in the County of Los Angeles adopted sales tax measures to fund an extensive regional transportation system integrating rail, bus and highway improvements. The planned system includes over 300 miles of rail transit to be built in the next ten years. This integrated rail transit and bus system creates a unique opportunity for the city of Los Angeles to address the challenges of providing for local growth, improving local air quality, relieving traffic congestion and reducing dependence on the car.[22]

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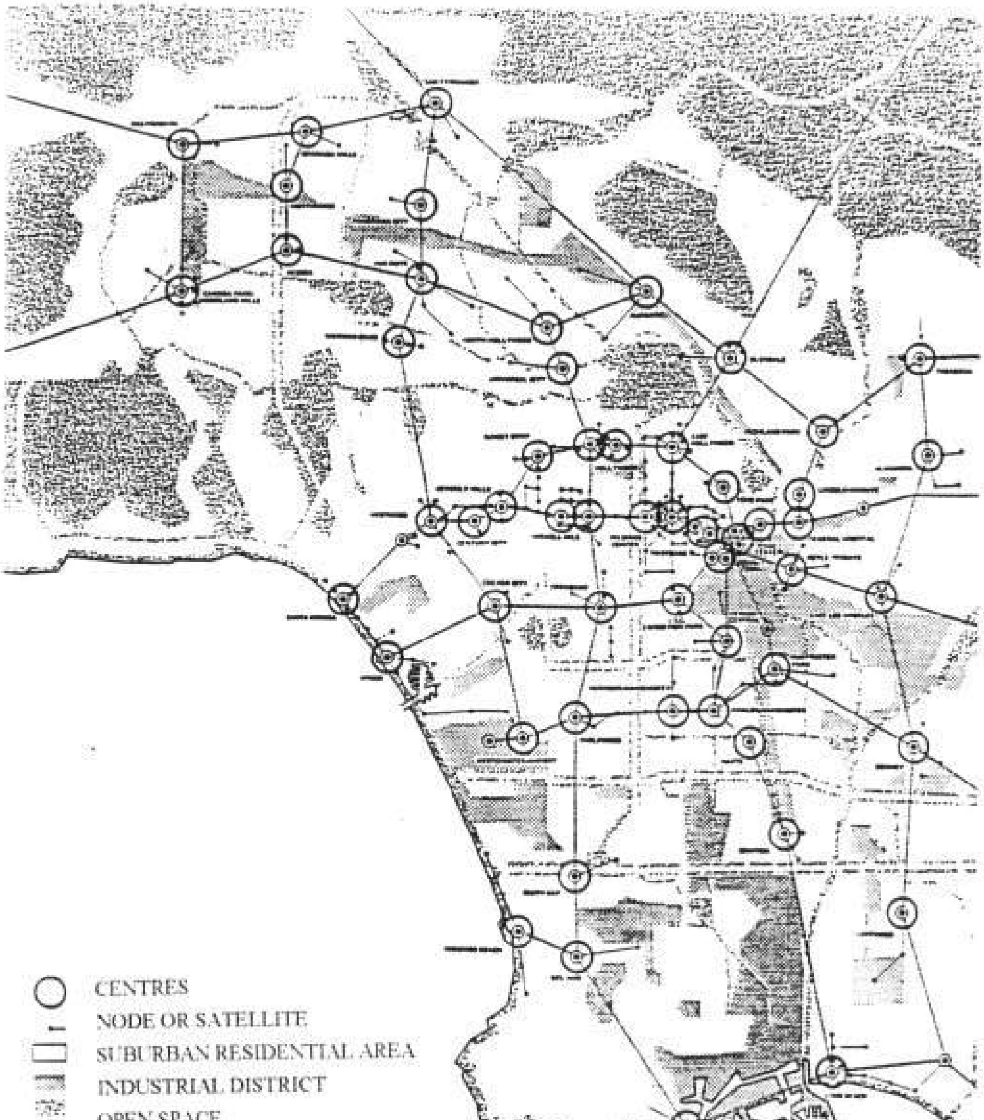
[21] Los Angeles Department of City Planning, February 1994, p.3.

[22] Staff of the city of Los Angeles et al., June 1992, p.i.

Figure 10-6: Los Angeles Centres Concept of 1974



Source: Staff of the city of Los Angeles et al., June 1992, p.iv.

A co-operative planning effort was initiated by the City of Los Angeles and the Los Angeles County Transportation Commission (LACTC) to develop an integrated policy addressing land-use, transportation and air quality issues related to the regional transportation system currently being planned and constructed by LACTC. The mission of this policy is to focus development and establish an efficient urban pattern arising form a new inter-dependence of transit and land-use.[23]

The Land-use and Transportation Policy in Los Angeles is intended to address both transit station areas which include the vicinity surrounding a subway, light-or commuter-rail station; or the intersection of major bus lines and corridors which include the route of a subway, light -or commuter- rail line or major bus line.[24]

(c) Current General Plan Framework

During the Seventies and the Eighties, the Centres Concepts guided the department's preparation of the current General Plan, which consists of 35 community plans and a variety of citywide elements. The community plans collectively comprise the land-use element.[25]

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[23] Staff of the city of Los Angeles et al., June 1992, p.i.

[24] Staff of the city of Los Angeles et al., June 1992, p.3.

[25] Los Angeles Department of City Planning, February 1994, p.3.

The integration of land-use and transportation planning for the city of Los Angeles relates directly to the development of a revised General Plan Framework which will guide the long-range implementation of the City's Community Plans. The current General Plan Framework is based on the Centres Concept of 1974, and envisage regional transit connecting higher-density centres surrounded by single-family houses in residential neighbourhoods. While currently being re-examined, transit planning decisions to date have been made in support of the City's Centres Concept.[26] Figure 10-7 shows the new rail transit routes for Los Angeles and Figure 10-8 shows map of regionwide rail transit system for Los Angeles. The Citywide General Plan Framework is a comprehensive plan that will direct future revision for all city general plan elements. The current plan, adopted in 1974, is being revised to reflect new policy directions. The thirty-five Community Plans set policies and programs for transportation and land-uses at a neighbourhood level.[27]

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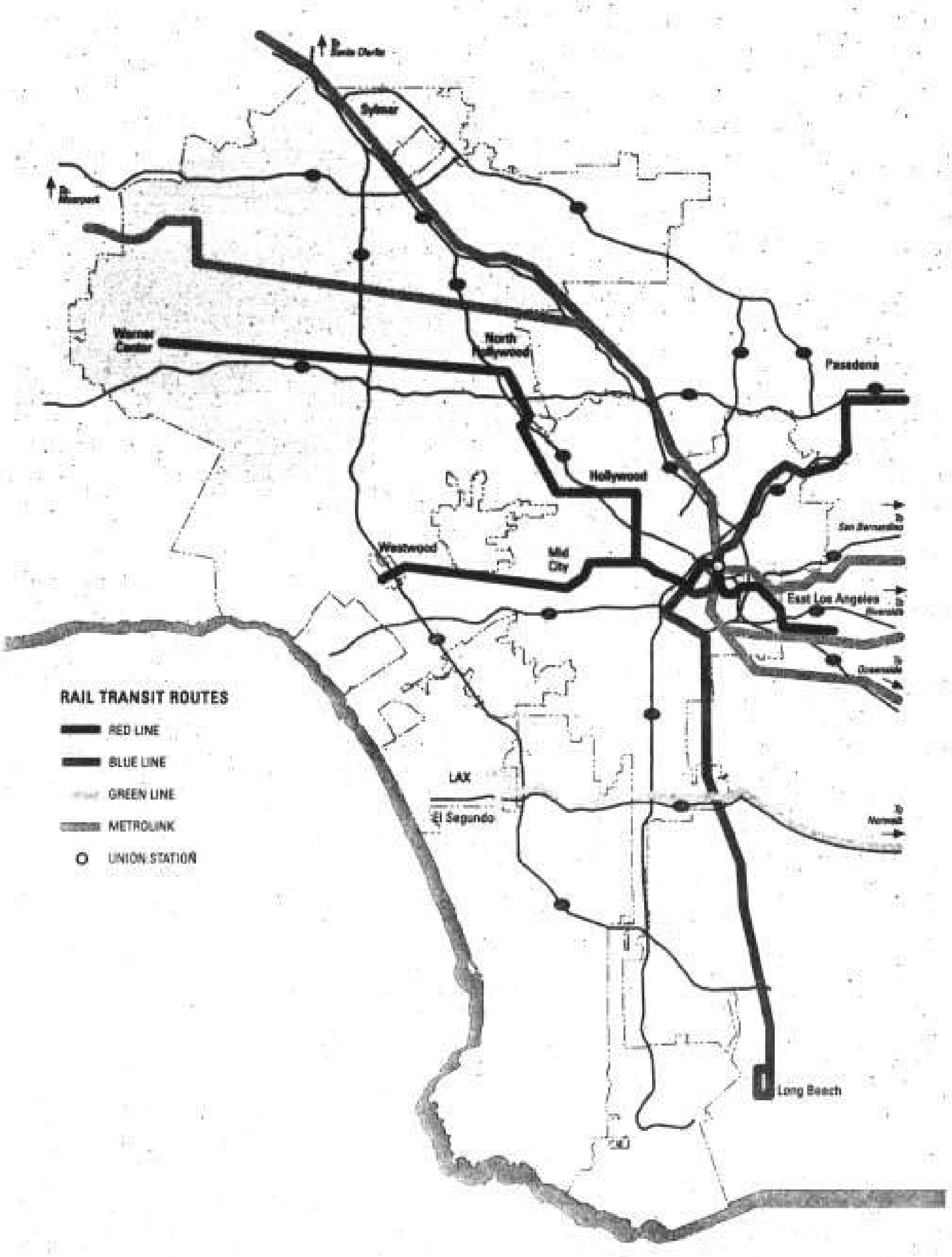
[26] Staff of the city of Los Angeles et al., June 1992, p.i.

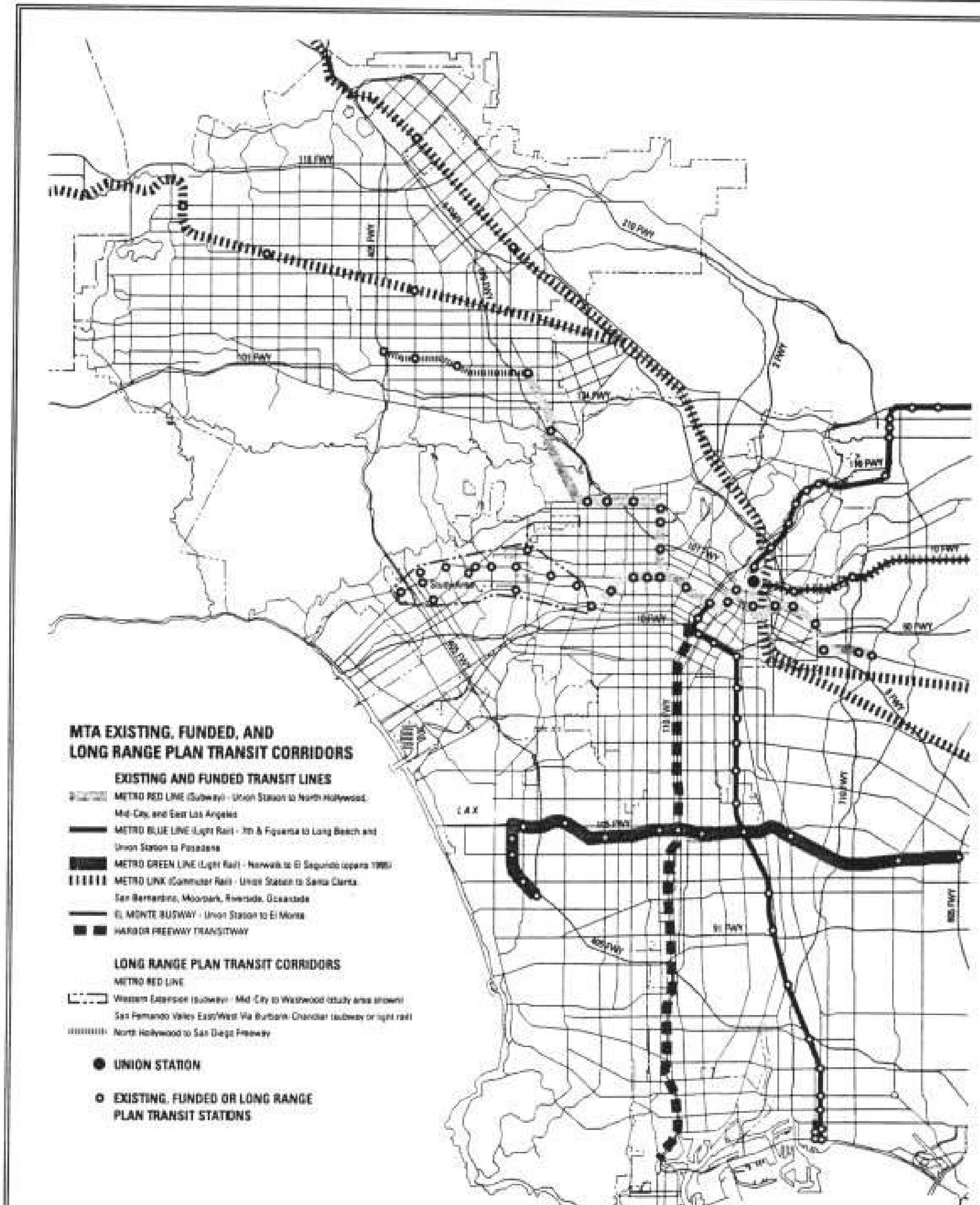
[27] Staff of the city of Los Angeles et al., June 1992, p.2.

Figure 10-7: The new rail transit routes for Los Angeles



Source: Los Angeles Department of City Planning, February 1994, p.11.

Figure 10-8: Map of regionwide rail transit system for Los Angeles



Source: City of Los Angeles, Department of City Planning, October 1994, p.42.

(d) Land-use policy overview

According to the Discussion Paper, current planning and zoning practices in Los Angeles are not transit-oriented. With the exception of the central city and Hollywood community plans, no other current policies or code requirements encourage appropriate land-use and densities directly related to the regional transportation system. With the substantial public investment in the regional system, it is important that land-uses should be focused to match the transportation infrastructure and converted over time.[28]

One important point to be noticed is that in many European cities, public transport was never neglected as much as it was in the Los Angeles, because the degree of car-dependence was always much lower. The narrow geometry of historical European cities did not lend itself to the space-demands of cars. For that reason, historically, European cities in general have grown around public transport and transport planners have always had to face the problem of cars because there was not enough space to accommodate them especially in city centres.

[28] Staff of the city of Los Angeles et al., June 1992, p.7.

The land-use policy put forward in the Discussion Paper for Los Angeles is an affirmation of a constructive and interactive relationship of local land-uses with the regional transportation system and contains the following goals:[29]

1. In order to encourage people to live, work and shop near stations, compact mixed land-use should be planned to create neighbourhoods comprising housing, retail and commercial outlets, and employment opportunities,
2. developments should be redirected and focused around stations and along public transport routes,
3. The development of station areas should be orientated towards the transit user whilst maximising opportunities for development,
4. Strategies for in-fill, reuse, revitalisation and rehabilitation including conservation of historic structures should be encouraged,
5. The role of the station area as a centre of activity for its neighbourhood should be recognised and strengthened,
6. The scale of appropriate development should vary depending on the distance from the station; approximately 1/4 mile around the station there is a primary influence area and there is also a secondary influence area which includes the area around stations as well as along transit corridors;
7. There should be a threshold level of density in the primary influence area which will encourage long-term investment, both public and private in the areas adjacent to the transit station;
8. Opportunities for employment development in station areas and along transit corridors appropriate to the character of the area should be facilitated by land-use decisions;
9. There should be a balance between regional growth in employment and the development of housing near and along the transportation system.

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[29] Staff of the city of Los Angeles et al., June 1992, p.7.

(e) An evaluation of the current General Plan Framework

It is not clear how far this current General Plan Framework has been tested to show what change in modal split (away from the car and towards public transport) might be achieved. However, it takes a long time for the effects of the integration of land-use with transport planning to become evident. According to the Discussion Paper, the new proposals have planning, economic, mobility, environmental, and housing advantages:[30]

(i) Planning Advantages

By linking land-use and transportation decisions, it is possible to accommodate both regional growth and local growth around local transit stations. As the regional transportation system develops, future developments can be accommodated with minimal impact on existing residential neighbourhoods.

(ii) Economic Advantages

Co-ordination of land-use and transportation planning decisions provides both regional and local benefits through two types of economic

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[30] Staff of the city of Los Angeles et al., June 1992, p.i and ii.

opportunities: private sector business and project development, and public sector value capture of economic benefit. Not only can a transportation system improve regional access it can also stimulate economic development by retaining and attracting businesses, and creating opportunities for employment.

(iii) Mobility Advantages

Land-use and transportation planning should be linked so that use of transit stations can be maximised. The success of a regional transit system will be determined by its ability to encourage more people to use it. If station areas provide for daily requirements as well as cultural and local amenities, then daily car trips will be reduced whilst mobility is increased by use of public transport.

(iv) Environmental Advantages

Linking land-use and transportation planning can reduce the environmental impacts of development. An increase in transit passengers and reduction of car use will reduce local oil and petrol consumption thus reducing pollution from nitrogen oxides and carbon monoxide emissions.

(v) Housing Advantages

Population growth can be contained by concentrating new houses around stations and along public transport routes. This will reduce the impacts of the region's expanding population growth on existing residential areas. When housing is located near to station areas along with appropriate amenities then the need for daily car journeys can be reduced by increased use of public transport. In other cities, more than fifty percent of residents who live close to a transit station have indicated that the convenience of travel is a consideration in their choice of home. In addition, many developers believe that building properties close to transit stations or along public transportation corridors actually adds to the desirability and value of their properties.

In conclusion, as mentioned earlier, the experience in Los Angeles has much relevance to the problems which currently face the city of Ar-Riyadh. Today, Ar-Riyadh is following the same steps as Los Angeles at the beginning of this century by going the way of transportation facility construction and decentralisation of the activities. Ar-Riyadh may learn lessons from the experience of Los Angeles to improve problems caused by the car traffic in the future especially as a result of land-use planning. The main lesson to be learnt form the experience of Los Angeles is the importance of the integration of land-use and transportation planning.

10.3 Planning policy in the United Kingdom[31]

There are many sources of information covering different parts of the planning policy in the United Kingdom. However, Planning Policy Guidance (PPG 13) (which was published by the Department of the Environment and Department of Transport in 1994) founded to be the most recent and comprehensive source of information. Planning policy guidance notes set out government policy on planning issues and provide guidance to local authorities and others on policies and the operation of the planning system. PPG 13 provides advice on how local authorities should integrate transport and land-use planning. According to the report, the most important aim of the guidance is to ensure that local authorities achieve their land-use policies and transport programmes in ways which help to:[32]

1. reduce growth in the length and number of motorised trips;
2. encourage alternative means of travel which have less environmental impact; and
3. reduce dependence on the private car.

Under the structure of the guidance, there are four main sections presented which provide advice on the integration of land-use and transport

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[31] All information for this section adapted from the Department of the Environment and Department of Transport, PPG 13, 1994, p.5-7.

[32] Department of the Environment and Department of Transport, PPG 13, 1994, p.1.

policies. The most important section related to land-use planning is the one regarding the location of development. According to the report:

> "the location and the nature of development affect the amount and method of travel; and the pattern of development is itself influenced by transport infrastructure and transport policies. By planning land-use and transport together in ways which enable people to carry out their everyday activities with less need to travel, local planning authorities can reduce reliance on the private car and make a significant contribution to the environmental goals." [33]

The following section provides guidance to local authorities regarding location of development in order to reduce the need to travel. The main recommendations listed in the report are:[34]

(1) Housing

Structure plan policies should aim to:

- allocate the maximum amount of housing to existing larger urban areas where they are or can be easily accessible to facilities (such as local shops, schools, work places, places of entertainment etc.) and to a range of transport provision, with particular priority placed on the reuse or conversion of existing sites and properties;
- in so far as needs cannot be met in central locations in larger urban areas, promote land for housing in locations capable of being well served by rail or other public transport;
- avoid any significant incremental expansion of housing villages and small towns where this is likely to result largely in car commuting to urban centres and where the travel needs are unlikely to be well served by public transport;

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[33] Department of the Environment and Department of Transport, PPG 13, 1994, p.2.

[34] Department of the Environment and Department of Transport, PPG 13, 1994, p.5-7.

- avoid sporadic housing development in the open countryside, but promote appropriate development within existing communities which can help to sustain local services and employment;
- avoid the development of small new settlements (broadly those unlikely to reach 10,000 dwellings within 20 years) especially where they are unlikely to be well served by public transport and are not designed to be capable of being largely self-contained.

Local plan policies should aim to:

- provide for housing development in central location within existing urban areas or rural centres, including on vacant, derelict or under-used land or through conversion, improvement or redevelopment of existing stock;
- concentrate higher-density residential developments near public transport centres, or alongside corridors well served by public transport and close to local facilities;
- set standards to maintain existing densities and where appropriate increase them; and
- juxtapose employment and residential uses, where feasible, through mixed-uses development and by releasing adequate housing land on suitable sites within central urban areas to make it easier for people to live near their work.

(2) Employment

Structure plan policies should aim to:

- aim, so far as practical, to move towards a better balance between employment and population, both within existing urban areas and in rural communities, in order to enable people to live near their work;
- focus the opportunities for development of travel intensive uses (such as offices) in urban areas in locations already well served, or with the clear potential to be well served, by public transport;
- provide opportunities for development suitable to the scale of rural centres, readily accessible from local housing; and
- avoid major developments in locations not well served by public transport or otherwise readily accessible to a significant local residential work force.

Local plan policies should aim to:

- move towards achieving a better balance in employment and housing levels within the urban or rural areas;
- focus activities attracting large numbers of trips in areas very close to major public transport facilities and in locations easily reached from local housing, by public transport, cycle or walking;
- allocate sites unlikely to be served by public transport solely for uses which are not employment (or travel) intensive;
- reallocate accessible land designated for activities which are not employment (or travel) intensive to more intensive uses;
- provide for the juxtaposition of employment and residential uses so that people have increasing opportunities to work near their homes; and
- facilitate home working and the provision of facilities for small groups of employees to work together locally.

(3) Freight

Structure and local plan policies should aim to:

- designate sites for distribution and warehousing, particularly of bulk goods, which, although avoiding direct access onto the trunk road network, are both readily accessible to it and served or with the potential to be served from wharves, harbours or railway sidings; and
- maximise the proportion of materials moved by rail or water, through discussion with extractors and rail and water operators, through appropriate planning obligations and conditions on permissions, and through the encouragement of local facilities for the landing by sea and distribution of aggregates.

(4) Retail

Structure plan policies should aim to:

- promote the vitality and viability of existing urban and suburban and rural centres. Shopping should be promoted in existing centres such which are

more likely to offer a choice of access, particularly for those without the use of a private car.

Local plan policies should aim to:

- maintain and revitalise existing central and suburban shopping centres by enabling development to take place there and by policies which improve the quality and competitiveness of those areas;
- encourage local convenience shopping by promoting the location of facilities in local and rural centres, and ensuring such areas are attractive and readily accessible on foot or by bicycle;
- where suitable central locations are not available for larger retail development, seek edge-of-centre sites, close enough to be readily accessible by foot from the centre and which can be served by a variety of means of transport;
- avoid sporadic sitting of comparison goods shopping units out of centres or along roads corridors; and
- provide for both local shopping and residential uses in large new developments, where feasible.

(5) Leisure, tourism and recreation

Local plan policies should aim to:

- concentrate facilities in town centre and other locations well served by public transport;
- provide town centre locations for cinemas and theatres to give vitality in the evenings;
- maintain and encourage the provision of local leisure and entertainment facilities; and
- make provision for attractive and accessible local play areas, public open space and other recreational facilities.

(6) Education and other public facilities

- facilities with wide catchment areas attracting large numbers of people should be located so that they are well served by public transport and as

accessible as possible for those who need to use them. Such facilities include and further education establishments, conference centres, hospitals, main libraries and principal offices of local authorities;

- Universities provide particular opportunities for the sustainable location of facilities. Plans should seek to maximise the potential of urban locations for universities and should enable accommodation to be provided with ready access to the university site; and
- Policies should encourage the location of other facilities which need to be near their clients in residential areas or local centres so that they are accessible on foot or by bicycle. Such facilities include schools, health centres, branch libraries and local offices of the local authorities and other service providers (such as local offices of the utilities).

In conclusion, this planning policy indicated a clear shift of policies in the United Kingdom towards integration of land-use and transport. Integration of land-use planning and transport are very important tools with which to reduce car dependence and to increase the choice of alternative means of travel.

10.4 Summary

This chapter reviewed the ways in which planners and urban designers have attempted to integrate land-use planning and transport planning to increase the choice of alternative modes of travel in different parts of the world. All examples investigated are going the same way: higher density around public transport nodes; proximity of land-uses; and improving public transport services.

In Copenhagen, the basic concept of the physical plan is to focus suburban growth along the main public transport corridors. This policy has started already in the late 1940's and is again pursuing this plan in the later legislation development to concentrate along public transport corridors. In Los Angeles, because of enormous environmental, health and congestion problems, is now discussion planning legislation that will result in the concentration of higher-density development and mixed-uses around transit station. In the United Kingdom, the Government Recommendations are of today following the Copenhagen by suggesting the concentration of use with high travel along public transport corridors and in city centre rather than periphery areas. This planning policy indicated a clear shift of policies in the United Kingdom towards integration of land-use and transport.

Ar-Riyadh may get message from these experiences to improve problems caused by car traffic in the future especially as a result of land-use planning. The main lesson to be learnt form these experiences is the importance of the integration of land-use and transportation planning. This is a clear massage for planning in Ar-Riyadh.

CHAPTER 11

THE IMPLICATIONS FOR LAND-USE POLICY IN AR-RIYADH

11. THE IMPLICATIONS FOR LAND-USE POLICY IN AR-RIYADH

As described in the previous chapters, the analysis has examined the historical development and formal planning of Ar-Riyadh, analysed key trends in travel behaviour and land-use patterns of Ar-Riyadh, considered the impact of cars on the development of some international cities, assessed the environmental impact and economic cost of increasing car-use in major industrialised countries, considered the possible approaches to reducing car-dependence, analysed the inter-relationships between land-use transport infrastructure and travel behaviour, and finally examined case studies of attempts to integrate land-use planning and transport.

This chapter addresses major alternative planning and urban design strategies with the objective to find out how urban development of this city could be directed in order to prevent Ar-Riyadh to end up with the same serious traffic and environmental problems which Los Angeles has today. It is fully understood that any such alternative strategy will not present practical short-term solutions for the city of Ar-Riyadh. They represent explorations of ways open for planning and urban design and of the potential consequences of any such long-term strategy for the city form and structure.

This chapter discusses the following topics:

Section 11.1 presents an exploration of alternative land-use policies for Ar-Riyadh;

Section 11.2 considers planning measures relevant to Ar-Riyadh to reducing motorised travel demand for different purposes;

Section 11.3 considers some planning tools;

Section 11.4 examines two growth options for Ar-Riyadh; and

Section 11.5 examines neighbourhood form and centre hierarchy.

11.1 Exploration of alternative land-use planning policies for Ar-Riyadh

Land-use and transport policy issues are closely linked as has been discussed earlier. The purpose of this part of the thesis is to draw out the main implications of the study's findings for planning policies in Ar-Riyadh. This section considers the implications relevant to those land-use factors which can potentially influence travel behaviour including: (1) population density, (2) metropolitan forms, (3) neighbourhood form, (4) responses to the development pressures caused by fast-road infrastructure, and (5) key factors which would increase the proportion of public transport in Ar-Riyadh.

11.1.1 Population density

Chapter Nine concluded that higher residential densities usually lead to a reduction in travel demand to access facilities and encouragement shifts towards using alternative modes of travel. However, such an effect is complicated by factors such as location, income, car ownership, etc. The data also revealed that if high density is required to reduce the travel demand then planning policies are required to ensure that high population densities do not result in a deterioration in the quality of urban life.

In Chapter Four, the analysis of key trends in land-use patterns of Ar-Riyadh concluded that the overall gross and net residential densities of Ar-Riyadh are relatively low compared with world-wide net residential densities. The gross residential densities indicated that there is an average of 3 dwelling units per hectare (19 persons/ha) citywide. The net residential densities indicated that there is an average of 34 dwelling units per hectare city-wide. These figures are typical of relatively low-density development which tends to increase the demand for motorised travel. Planning policies in Ar-Riyadh can encourage higher densities by:

- imposing minimum density standards on new development in some areas such as new development within major public transport corridors (e.g. changing building height codes by allowing more than two stories high in these areas);

- controlling urban growth of Ar-Riyadh by enforcing the current policy of "Urban Growth Limit" by introducing boundaries to development such as the Green Belts schemes; and
- encouraging development within existing urban areas close to newly planed public transport nodes (corridors or stations) where almost 64% of land in Ar-Riyadh is currently vacant.

11.1.2 Metropolitan form

The data revealed in Chapter Nine that centralisation of employment and other trip-generating activities has some advantages over other patterns of development: it increases the possibility of multi-purpose trips; potentially it reduces total travel; it increases the viability of public transport through focusing demand on radial corridors; and potentially it reduces the use of the private car. At the same time, a centralised pattern has some disadvantages: it raises the congestion and parking constraints; it raises the costs and difficulties of car use; and at the regional level, centralisation appears to have some effect of increasing average trip lengths. That means high levels of centralisation and concentration of land uses are associated with long journeys which generate high overall travel. On the other hand, the data revealed that land-use patterns with decentralised concentrations of activities (multi-clusters of activities) may be more efficient in terms of the distance which people need to travel for particular types of activities. However, if a large number of people choose not to use their nearest

centres, this potential may not be realised. The result may be a higher travel demand than overall centralisation.

In Chapter Four, the analysis of key trends in land-use patterns of Ar-Riyadh concluded that rapid urban growth in Ar-Riyadh has led to extensive dispersal of developments, segregation of land-use, and decentralisation of different land-uses throughout the city (residential, commercials, industrial, manufacturing, governmental and administrative offices, public service and other activities). This practice has led to an increasing demand for travel between different uses because in most cases people do not use their nearest activities. As a result, people depend more on motorised transport throughout the city. Planning polices in Ar-Riyadh can strongly influence the urban form and so create a reduction in car dependence by:

- focusing trip-generating activities at high density in the central areas of the city or within major public transport corridors (as in the Finger Plan of Copenhagen). It is particularly helpful if development is linked to public transport nodes, such as transit stations (as the new proposal for Los Angeles);
- distributing new services and provisions which are daily needed to be easily reached within walking-distances of major residential areas;
- providing a choice for people to walk, cycle or catch public transport rather than drive between homes and such facilities;
- encouraging growth balance of employment and population within communities; and
- encouraging the retention and development of hierarchies of centres within urban areas, so as to enhance accessibility to local services.

Section 11.4 suggests two growth options for Ar-Riyadh.

11.1.3 Neighbourhood form

In Chapter Nine, the data showed that a high percentage of all trips in the UK is local, that a high percentage of all journeys are relatively short, and that walking accounts for over one-third of all passenger journeys. This illustrates the importance of walking in providing access to a variety of destinations. Moreover, the review of evidence indicates also that if local centres were located within neighbourhoods, then the length of journeys would be reduced and walking and cycling would become more realistic as neighbourhoods became more self-contained. However, proximity to local centres and characteristics of their design are two important factors in encouraging their use.

In Chapter Three, the historical development of Ar-Riyadh concluded that Doxiadis' Master Plan in 1968 proposed a hierarchy of communities and centres based on their population. There were seven classes within the hierarchy. The higher the class and population size, the more facilities such as shops, schools, mosques and parks would be created. To facilitate this, one important policy in the Master Plan is the provision of adequate land for community buildings, public facilities and open spaces, especially in the new development areas.

However, in Chapter Four, the analysis of key trends in land-use patterns of Ar-Riyadh concluded that rapid urban growth in Ar-Riyadh has

led to an imbalance in the distribution of some public uses. Moreover, within most neighbourhoods there has been practically no development of neighbourhood centres as envisaged by Doxiadis. The shortage of basic public facilities and imbalance of distribution (location) have contributed to the increasing demand for travel by car. Another problem with the present layout design of neighbourhoods in Ar-Riyadh tends to reflect the grid of wide roads. This arrangement is usually dangerous in traffic terms especially for children. Planning policies can have a strong influence on neighbourhoods in Ar-Riyadh, particularly if they are linked with positive measures to influence investment in public transport facilities and amenities. Planning policies could encourage the reduction of car dependence by:

- strengthening existing local centres which offer a range of everyday community shopping and employment opportunities;
- encouraging the development of local centres in all neighbourhoods and encouraging the development of high density residential areas in the surroundings of these local centres;
- locating public services in local centres to minimise overall associated travel;
- encouraging the provision of local services in parallel with new residential development; and
- improving existing neighbourhood subdivision by restructuring communities to better accommodate pedestrians (especially women and children) and the provision of safe and convenient access for pedestrians and cyclists with high quality design and environmental standards.

These measures have an important role to play in encouraging trips to be undertaken by non-car modes especially by women and children in Ar-

Riyadh. One solution has already been developed for the Master Plan of the city of Jeddah, Saudi Arabia, which could be applied for Ar-Riyadh with some modifications. Section 11.5 shows neighbourhood form and centre hierarchy which includes an abstract service hierarchy, and an improvement to existing neighbourhood subdivision.

11.1.4 Growth pressures caused by fast-road infrastructure

The analysis in Chapter Nine on the impact of fast-road infrastructure has concluded that new transport infrastructure could enable people to extend their choice of housing location, improve the market prospects for development in particular locations, and influence the relative accessibility of peripheral locations as opposed to central areas. Based on the evidence from the studies regarding the influence of fast-road infrastructure on growth pressures, it is concluded that fast-roads encourage more decentralisation of employment, service and retail; create a strong growth pressure; change the nature of the city into more car-dependence; and reduce the use of public transport.

In Chapter Four, the analysis of key trends in land-use patterns of Ar-Riyadh concluded that there has been much investment in motorways and fast-road networks to meet the overwhelming demand of cars in Ar-Riyadh. The data shows that more than 60 percent of the streets in Ar-Riyadh are high speed roads (freeways, expressways, and major arterial roads). To

obviate the effect of these factors on increased car dependence, planning policies in Ar-Riyadh need to be developed to include:

- limiting the development of fast-road infrastructure and encouraging the development of facilities for alternative means of travel;
- locating major generators of travel demand in existing centres or new centres which are highly accessible by alternative modes of travel; and
- concentrating development in locations benefiting form improvement in public transport infrastructure and services.

11.1.5 Key factors which would increase the proportion of public transport in Ar-Riyadh

In Chapter Five, performance of public transport in Ar-Riyadh was reviewed. A summary of the passenger profile data indicated that the percentage of Saudis passengers in the SAPTCO was very low. The data also revealed that female, children under 16, and old people passengers in the SAPTCO were very low. The data suggests that existing public transport is unacceptable especially to women passengers, children under driving age, and old people. It is not possible to plan public transport in Ar-Riyadh without further research. However, in the following, nine factors are suggested which would improve public transport services and increase the proportion of passengers carried by public transport in Ar-Riyadh:

1. **More attractive services:** The data in Chapter Five revealed that since the Saudi Arabian Public Transport Company (SAPTCO) began operation in 1979, they have experienced an increase in passengers, as

a result of increases in the number of services, quality of the buses and service efficiency. Therefore, if public transport becomes a better, cheaper and faster alternative, the use of it would increase. With the introduction of an even more attractive service such as mass transit, the modal split can be expected to swing further in favour of public transport.

2. **More arrangement for female and children passengers:** The data in Chapter Five revealed that the Saudi Arabian regulation prohibits women from driving cars and also the data suggested that existing public transport is unacceptable to women passengers. The data revealed that in 1987, only 9 percent passengers in the SAPTCO were female, about 4 percent were children under 16 years of age. Therefore, more convenience and maximum privacy for female passengers in public transport is needed. Segregated public transport for female passengers is one option. To improve women's mobility and maintain maximum female privacy, exclusive public transport for female passengers is recommended. Moreover, special arrangements for child passengers in the public transport is also needed (to create for example more services between homes and schools for students).

3. **Integration of land-use planning and transport:** The data in Chapter Ten revealed that integration of land-use planning and transport are very important tools with which to reduce car dependence and to increase the choice of using public transport. In modern cities, it is difficult for public

transport to run fast or far enough to keep up with low-density suburban growth. Therefore, public transport authorities need to work in conjunction with planning agencies to cluster developments (jobs, housing, facilities and services) around public transport nodes. This gives public transport the best possible chance to compete for commuters with the private car and thus change the modal splits.

4. **Coincide passenger's desire lines:** Pederson[1] mentions the "desire lines" connection between origins and destinations. In a city with a dominant city-core, many of the passengers' desire lines coincide or nearly coincide. In dispersed cities with employment, public service, and shopping centres dispersed in many locations, few passengers' desire lines correspond. The larger the correspondence of passengers' desire lines, the more practicable is public transportation. Public transport must carry a large number of passengers from similar points of origin to similar destinations to financially succeed. In a city with a dominant centre many workers and shoppers have similar origins and destinations. This is in contrast with Ar-Riyadh' pattern. Therefore, focusing housing and trip-generating activities at high density in the central areas of Ar-Riyadh or within major public transport corridors would coincide many passengers' desire lines.

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[1] Pederson, E. O., 1980, p.34 - 37.

5. **Controlling the use of the private car:** To encourage people to make more use of public transport, direct restraint of the private car is needed. Some restrictive policies are needed to encourage car users to use public transport. Chapter Eight provided the possible approaches to control the use of the private car.

6. **Public transport priority:** Granting some priority to public transport over the private car can improve public transport services. This can be utilised by, for example, reserving road space for buses, manipulating traffic signals for buses, and by fiscal measures to limit the private car use.

7. **Public transport management:** High standards of public transport management is a very important factor which can improve public transport services (e.g. encouraging the integration of different public transport services, improving information for passengers, introducing new fares structures, etc.)

8. **Information technology:** Using the latest information technology for public transport operations (e.g. closed circuit television cameras) can also improve public transport services.

9. **Public transport environment:** Improving the environment on public transport and stations is very important element to increase the proportion of passengers carried by public transport (e.g. security, cleanness, no smoking regulations, quality of spaces, services, shops,

etc.). Public transport nodes may become also nodes for retail establishments, work places, services such as in Munich.

11.2 Planning measures relevant to Ar-Riyadh to reducing motorised travel demand for different purposes

Whilst there has been considerable growth in overall motorised travel demand in Saudi Arabian cities, motorised travel for different purposes has increased at different rates. Accordingly the potential for planning to influence motorised travel demand for different purposes varies markedly. It is likely to be most influential in relation to travel to work, school, shopping, and for health purposes. Individual planning measures can be relevant to reducing travel demand for more than one purpose, and the combination of planning measures will be necessary to encourage reductions in car dependence. However, as mentioned in Chapter Nine, some researchers suggested that reduction in travel for one particular purpose may be associated with an increase for another purpose. Nevertheless, it is helpful to consider the main planning measures relevant to different travel purposes.

11.2.1 Trips to work

The data in Chapter Five show that trips to work accounted for 24% of the total daily trips in Ar-Riyadh. As mentioned in Chapter Four, government employment accounts for almost 40 percent of the total working age population in Ar-Riyadh. Saudis predominate in government employment, accounting for almost 70 percent of the employees of the Saudi Government. A comparison between government land-use and other land-uses, in Chapter Four, reveals that government land-use is located outside major housing, retail and service areas. As a result, the majority of government employees and users travel by car to get to their workplaces. This practice causes traffic congestion in the morning and afternoon and also parking problems around most government-offices. The following planning measures would be helpful in encouraging reduction in travel demand:

1. focusing employment uses in centres and locations already well served, or with the clear potential to be well served, by public transport and avoiding major employment uses in sites with inadequate public transport access;
2. concentrating high-density residential developments in major pubic transport corridors to provide employees the choice to use public transport;
3. encouraging employees to use alternative modes of travel particularly walking and public transport;
4. maximising the possibilities for households to locate close to their places of work or close to major public transport corridors to achieve a better

balance between employment and population, in order to enable people to live near their work; and

5. encouraging the provision of housing projects by the employers (ministries, big company, etc.) for the employees close to employment places.

11.2.2 Trips to school

As mentioned in Chapter Five, there is a relatively high percentage of daily trips to school (21.2%) in Ar-Riyadh. This could be due to the unbalanced distribution of schools especially in the new areas. Polices to extend choice in the consumption of public services and to increase financial efficiency in their provision could be associated with increases in travel demand for those purposes. Planning measures in Ar-Riyadh could make a significant contribution to reducing car dependence associated with travel for schools, for example by:

1. ensuring that location of education establishments involve considerations of the overall travel demand implications;
2. encouraging the provision of schools (for both boys and girls) in parallel with residential development; and
3. encouraging design and road configurations that promote accessibility to schools on foot and bicycle or by using public transport.

11.2.3 Shopping and health trips

Travel for shopping, particularly in the non-food sector, and for health care purposes has grown strongly. As mentioned in Chapter Five, shopping trips accounted for 8.2% and medical trips accounted for 2.4% of the total daily trips in Ar-Riyadh. As mentioned in Chapter Nine, policies to extend choice in the use of public services and to increase financial efficiency in their provision could be associated with increases in travel demand for those purposes. Planning measures in Ar-Riyadh could make a significant contribution to reducing car dependence associated with travel for shopping and medical care, for example by:

1. encouraging the provision of shopping and health services in local convenience centres or in district centres;
2. encouraging the arrangement for shopping and health services in parallel with large new residential development where feasible;
3. maintaining and revitalising existing central and sub-urban shopping and health services which are accessible by other modes of travel; and
4. ensuring that the location of shopping and health services include considerations of the overall travel demand implications;

11.3 Planning tools

In the following, two planning tools are suggested to encourage development in the central area or in areas within corridors well-served by public transport.

11.3.1 Charges on vacant lands

As mentioned in Chapter Four, the data showed that 64 percent of Ar-Riyadh's area are vacant lands which should be considered. Alskait suggests two measures to deal with the problem of existing vacant lands: (1) to impose certain charges on these vacant lands, and (2) to prevent commercial development on areas outside Urban Growth Limit boundaries. He mentions that although there could be legal obstacles to the former, it does hold some promise.[2] This seems a good measures to encourage development within the urban area of Ar-Riyadh and to stop the growth dispersal. It is recommend that priority of charges should be imposed on vacant lands in central area or in areas within corridors well-served by public transport. In addition, a certain number of years (for example five years from

[2] Alskait, K., 1993, p.239.

the time of land purchased) may be suggested before imposing any charges to allow time for development on that vacant land.

11.3.2 REDF as a powerful planning tools

As mentioned in Chapter Four, the urban growth in Ar-Riyadh has been influenced by some factors which served to generate low density, rapid urban growth. One factor largely resulted from an unusual level of residential development, which was promoted by government housing subsidies through the Real Estate Development Fund (REDF). The objective of this policy was first to assist the development of private-sector housing, by providing interest-free loans to Saudi citizens to construct their own houses; and secondly to provide investment loans to individuals and corporations for commercial purposes. Many households took advantage of these personal interest-free loans. A large number benefited from the loan because there were very simple qualification conditions as shown in Appendix (A).

Jenaideb suggests that it would be possible to use the REDF loans to shape the urban structure of the city by controlling its use. Currently the control mechanism of the REDF is to adjust the housing market by manipulating the time it takes to grant a loan to prospective developers. He suggests that the interest-free loan granted through the REDF provides policy makers in Saudi Arabia with a powerful planning tool which is under-

exploited.[3] Application of housing and planning polices as a basis of criteria for granting loans could control development more effectively. To implement some of the policies suggested in this thesis regarding development location, it is recommended that loans from the REDF be classified on the basis of location. Priority would be given to those wishing to build in the central area or in areas within corridors well-served by public transport, by for example reducing the time that it takes to approve loans for building in these locations (at present it can take more than five years) or by giving more discount for those wishing to build in appropriate locations.

11.4 Development options for Ar-Riyadh

It is clear form all the previous evidence that a range of conflicting issues are involved when considering the travel implications of metropolitan forms. Each urban form has advantages in some areas and disadvantages in other areas. However, as mentioned before, with regard to the issue of reducing car dependence, the concentration of population and activities along major public transport nodes (corridors and transit stations) seems to be a good development strategy for urban form. This development strategy gives public transport the best possible chance to compete for commuters

[3] Jenaideb, Abdullah, 1993, 255.

with the private car. In addition, the findings of the case studies in Chapter Ten, indicate also that the concentration of housing, employment and other trip-generating activities on public transport corridors or around transit station has the effect of increasing the use of public transport and hence reducing overall car dependence. Also Lynch's last urban form proposal, "the Poly-centred Net", discussed in Chapter Nine seems to coincide with a lot of suggestions mentioned above.

Based on this evidence, two abstract development options for Ar-Riyadh are proposed which could provide a base for further detailed research into urban form of the city of Ar-Riyadh:

(1) **Growth Option One**: concentrated development primarily along public transport corridors and secondarily in centres; and

(2) **Growth Option Two**: concentrated development primarily in centres and secondarily along public transport corridors.

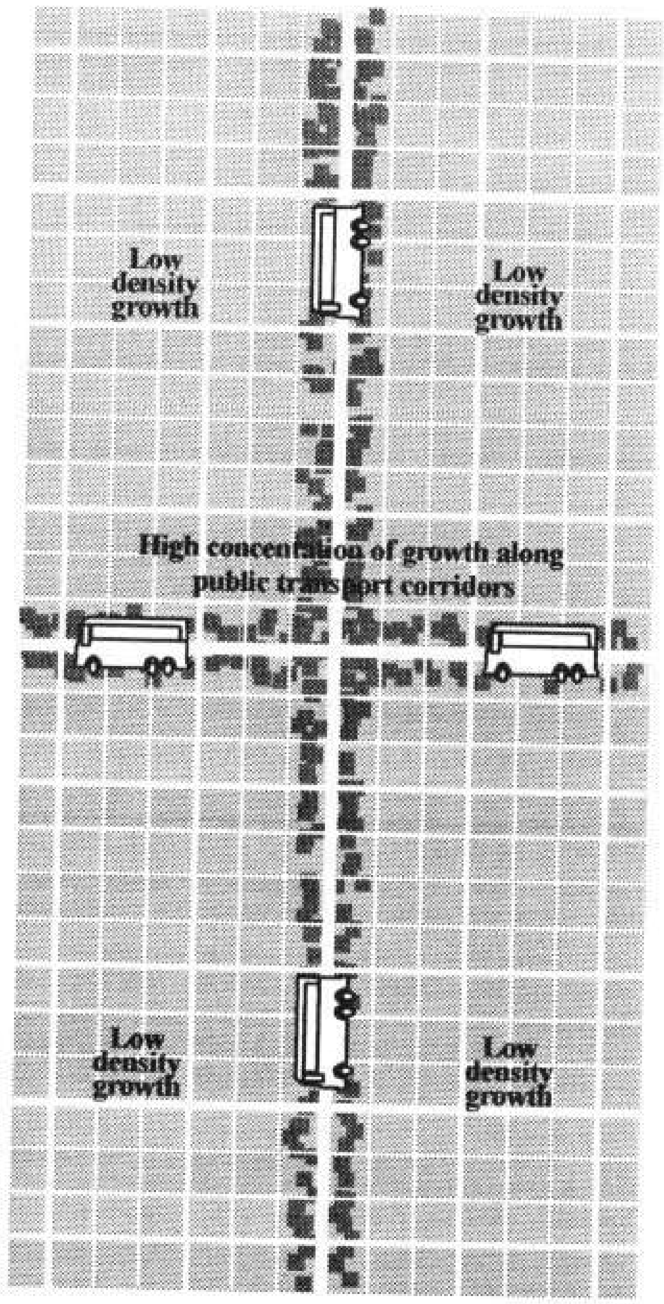
The objective of both options is to focus Ar-Riyadh's new development into main public transport corridors or in centres at rail transit stations for two reasons: (1) to reduce daily trips by car through locating housing near commercial, business, facilities, and administrative functions; and (2) to minimise the car-dependence by providing alternative means of travel. In the following, a brief distribution of each option will be presented.

11.4.1 Growth Option One: concentrated development in spine corridors

Growth Option One for Ar-Riyadh is based on the strategy of linear development and concentration of growth into main public transport corridors similar to the "Finger Plan" of Copenhagen. The main idea of this strategy is to concentrate high density residential, commercial, business and administrative functions in certain major public transportation routes. This gives public transport the best possible chance to compete with the private car for commuters. The concept of concentrating growth into public transport corridors is illustrated in Figure 11-1.

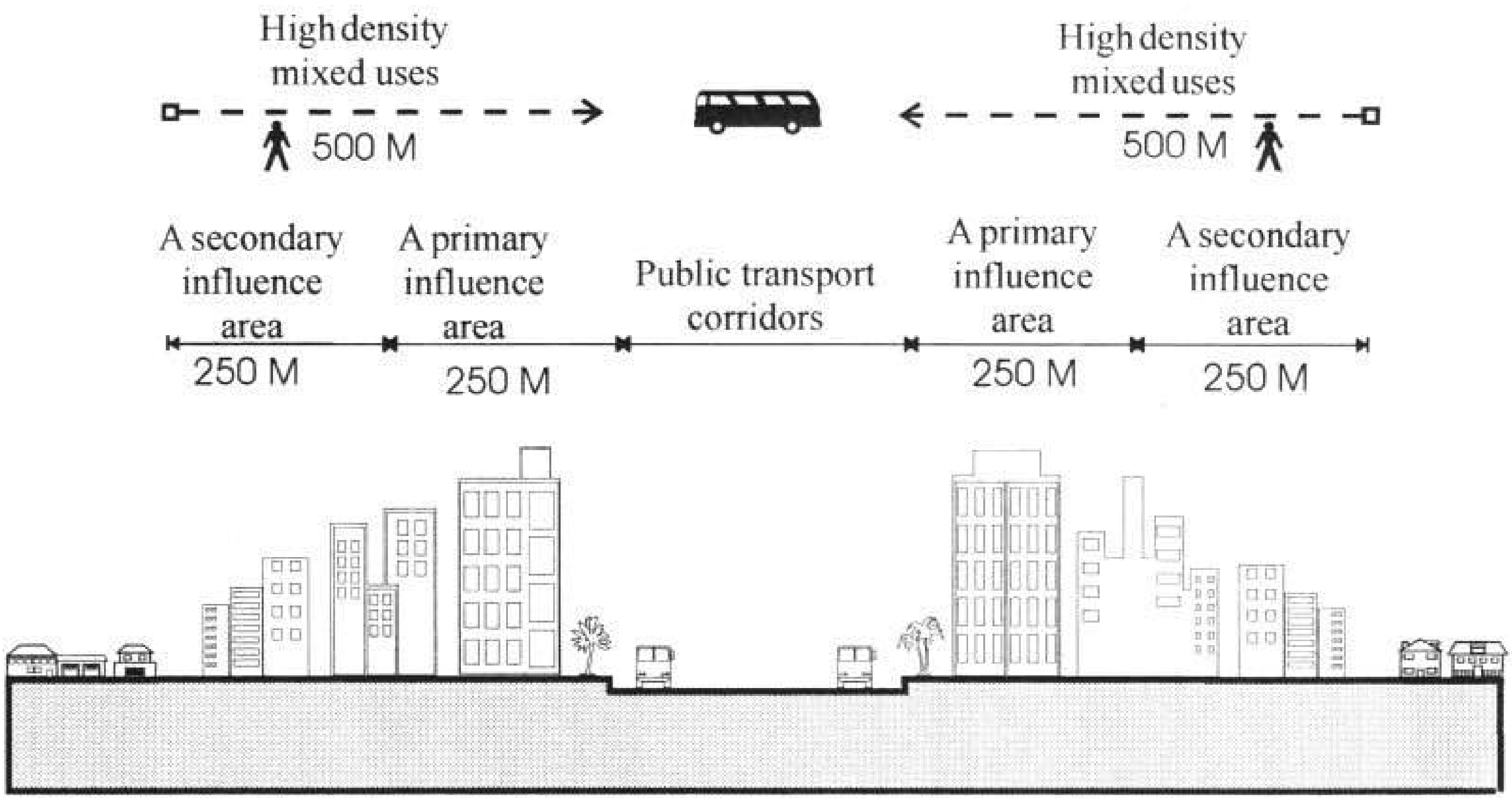
Figure 11-2 shows, an appropriate scale of development proposed within the two identified public transport influence areas: (1) a primary influence area with the width of approximately 250 metres on both side along major public transport routes and (2) a secondary influence area with a width of approximately 250 metres outside the primary influence area along major public transport corridors (maximum walking distance 500 metres to public transport).

Figure 11-1: The concept of concentrating growth into public transport corridors



Source: Author.

Figure 11-2: An appropriate scale of development (concentrated development in corridors)

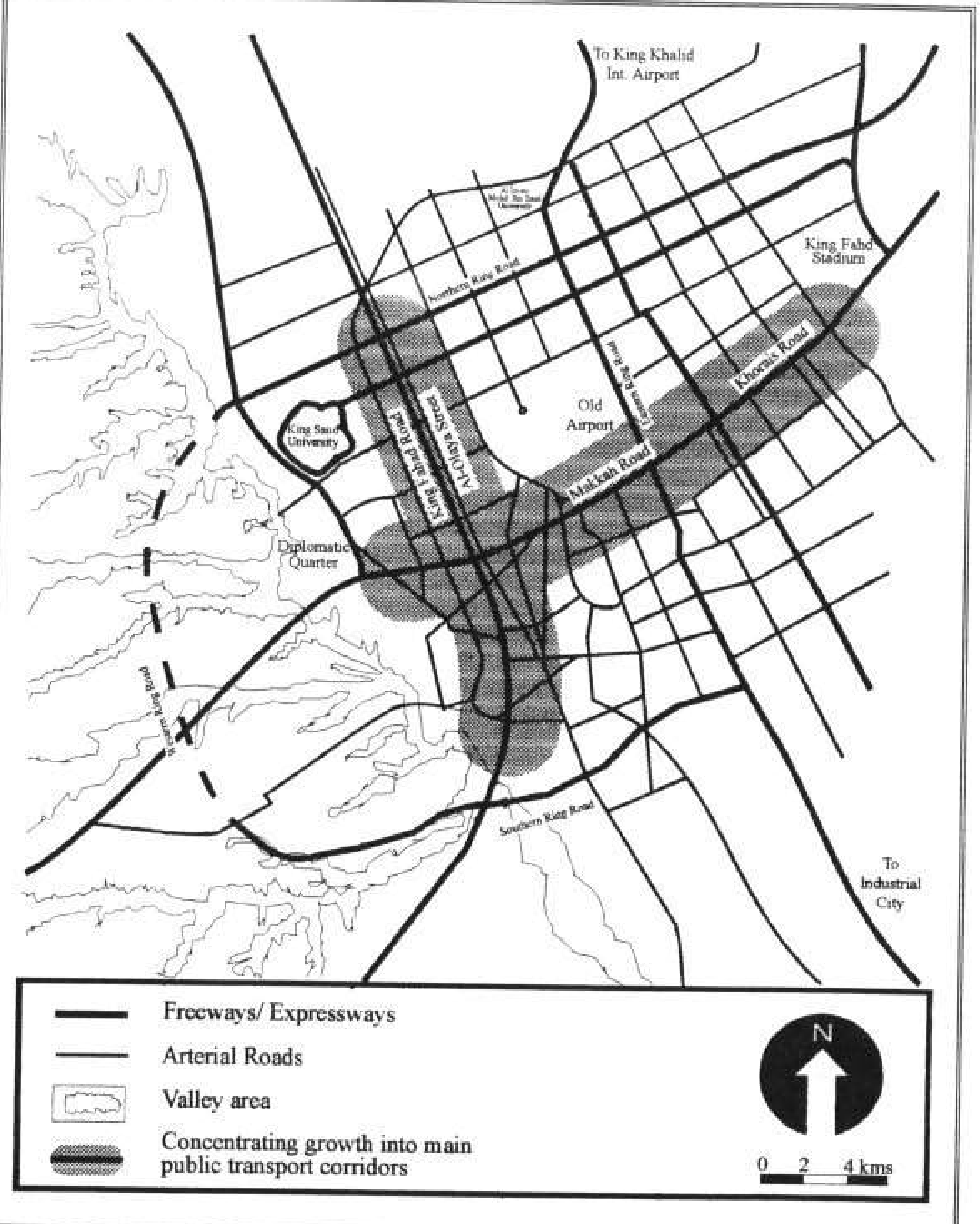


Source: Author.

The analysis of key trends in land-use patterns of Ar-Riyadh in Chapter Four showed a clear concentration of current growth in two directions: (1) north-south axis between King Fahad Road and Al-Olaya Street and (2) east-west axis along Makkah Road and then Khorais Road. Figure 11-3 shows these two axes resulting from the superimposition of the clustering of dwelling units (Figure 5-5), the clustering of retail establishments (Figure 5-8), and the clustering of service establishments (Figure 5-9).

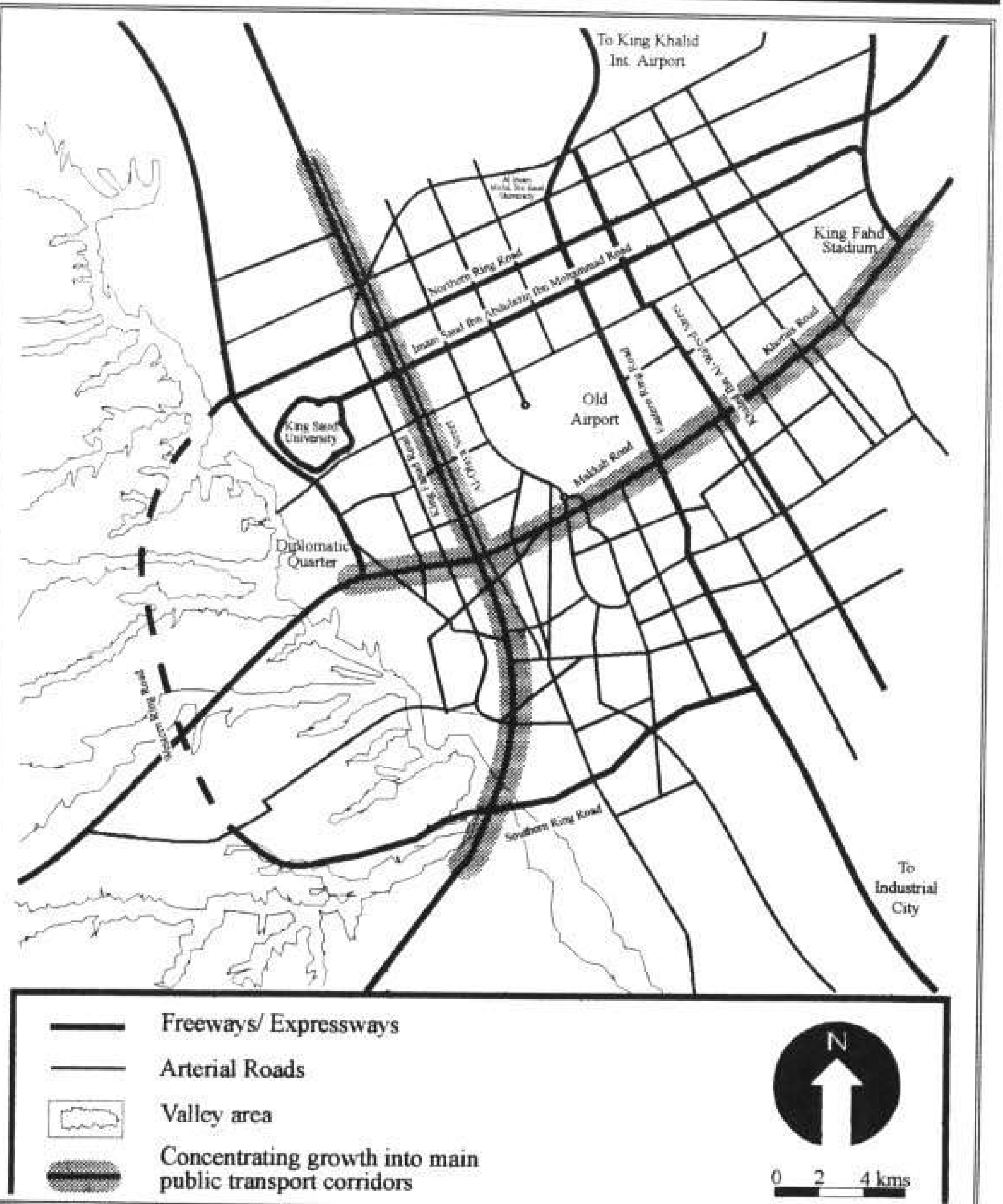
Growth Option One for Ar-Riyadh is an attempt to integrate the "linear development concept" with the existing patterns of development. Growth Option One has two Phases. Phase I, illustrated in Figure 11-4, proposes two spines: (1) a north-south corridors between King Fahad Road and Al-Olaya Street and (2) an east-west corridors along Makkah Road and then Khorais Road taking up and reinforcing current concentration of development. These spines are proposed to be high density zones of commercial, business and administrative functions. The areas on either side of the two spines are suggested to be densely populated.

Figure 11-3: Concentration of current growth in Ar-Riyadh



Source: Author.

Figure 11-4: Growth Option One for Ar-Riyadh (Phase I) (concentrated development in corridors)



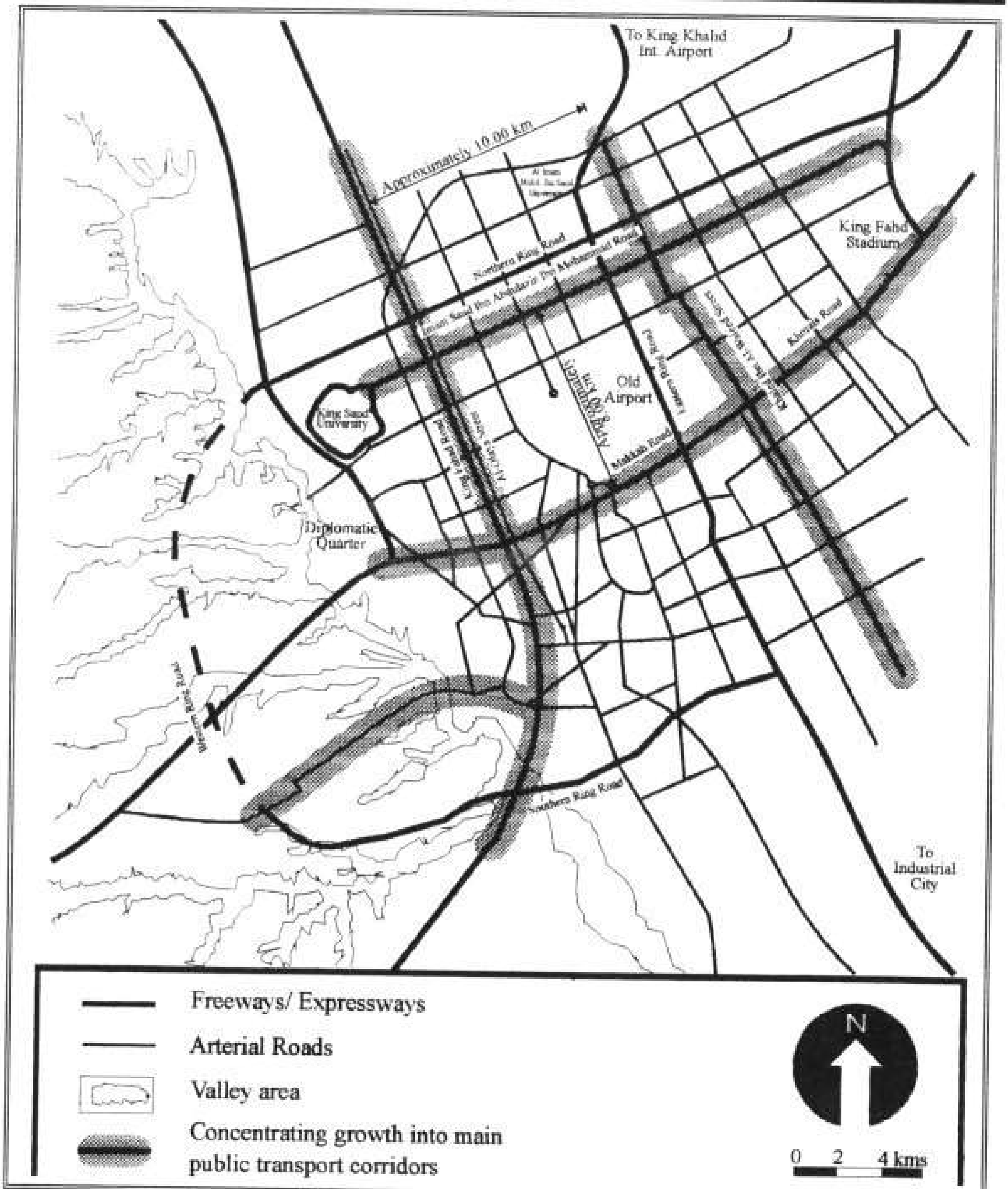
Note: this is a draft concept which gives only a general idea; the number and the location of these major public transport corridors needs further detailed research.
Source: Author.

It is worth mentioning that in 1968, the northern part of the north-south corridor was proposed to be the major spine for the city in the first Master Plan for Ar-Riyadh by Doxiadis Associates International. Currently, the strip between King Fahd Road and Al-Olaya Street (located in the centre of the north-south corridor) accommodates major businesses and is now considered to be one of the most expensive areas in Ar-Riyadh. In most parts of Ar-Riyadh a maximum building height of two stories is allowed but in this linear area companies are allowed to build multi-stories buildings.

Since Ar-Riyadh city is undergoing rapid growth and change, it might need more than two corridors. Phase II, illustrated in Figure 11-5, proposes therefore an expansion of the spines to five: two north-south corridors and three east-west corridors cover most of the city. As the figure shows, the distance between the north-south corridors is approximately ten kilometres and the distance between the major east-west corridors is approximately eight kilometres.

If the distance to the spines and the major concentration of work places is too long to be practical, most people will go by car and the spine will be inundated by cars. Therefore, as Figure 11-6 and Figure 11-7 show, a secondary public transport system is considered essential and is recommended to be introduced to link most district centres (and possibly some neighbourhood centres) to the nearest spine. The type and the location of this secondary public transport need further detailed research.

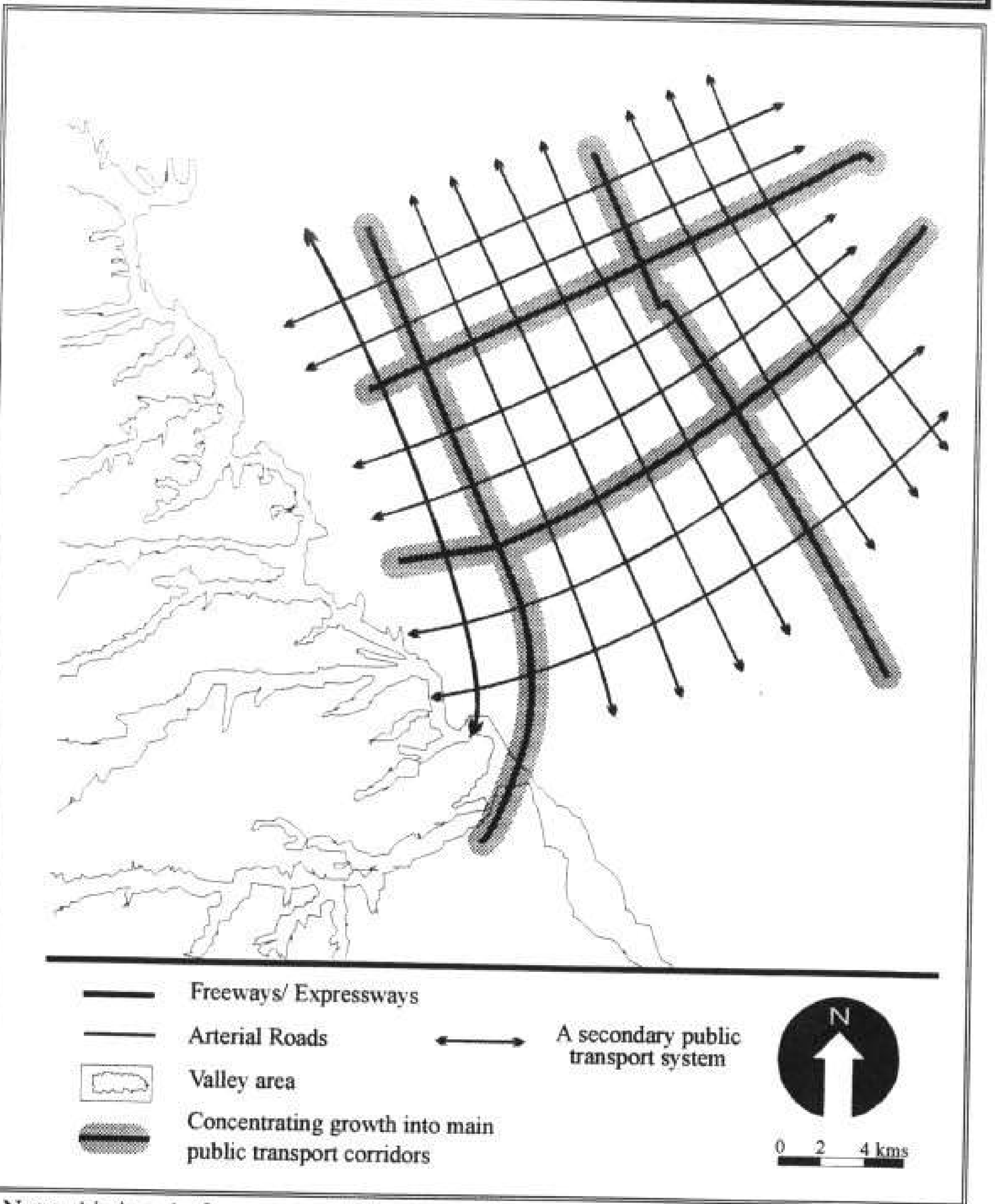
Figure 11-5: Growth Option One for Ar-Riyadh (Phase II) (concentrated development in corridors)



Note: this is a draft concept which gives only a general idea; the number and the location of these major public transport corridors needs further detailed research.

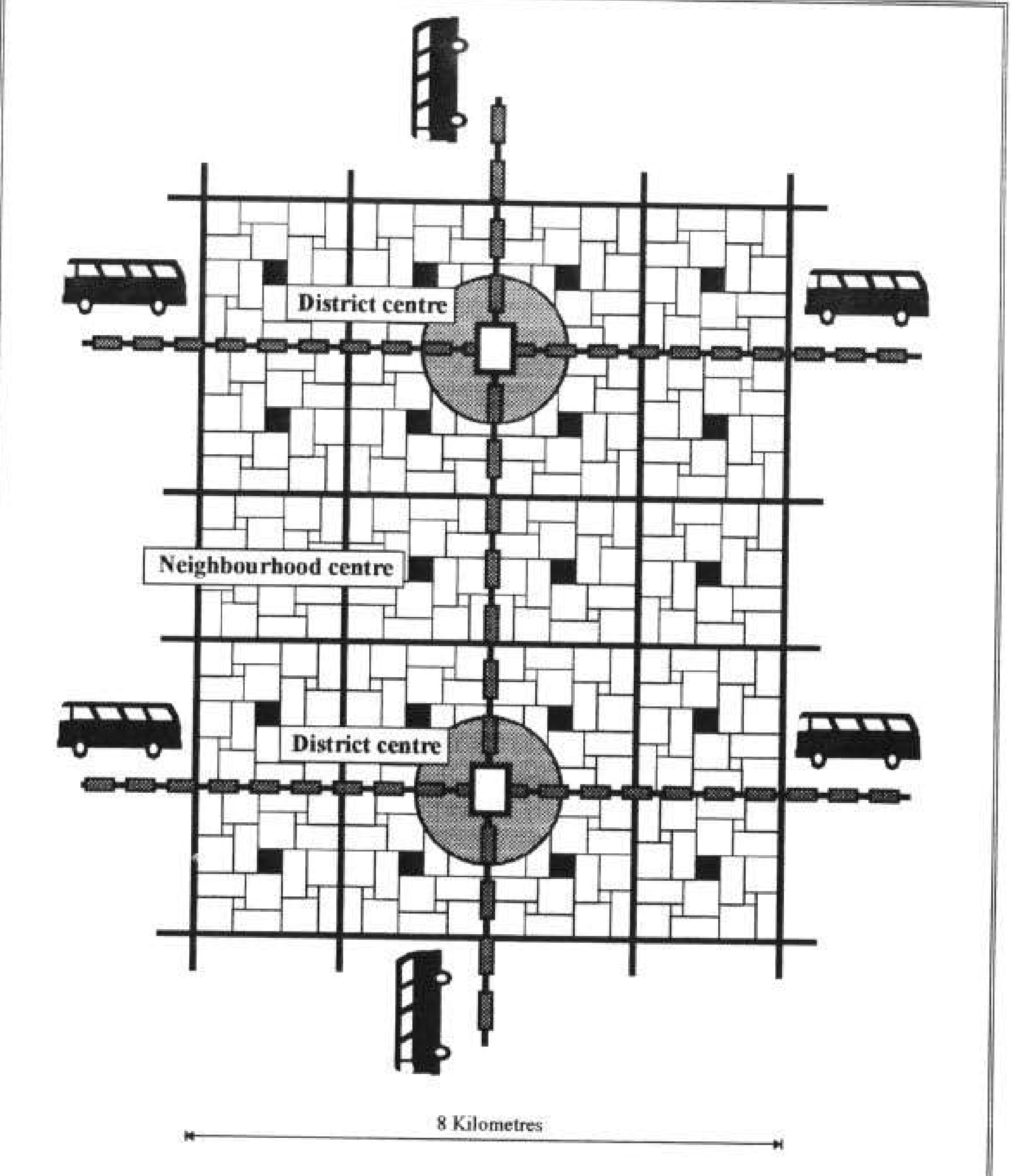
Source: Author.

Figure 11-6: A secondary public transport system to link most parts of the city to the nearest spine



Note: this is a draft concept which gives only a general idea; The type and the location of this secondary public transport need further detailed research.
Source: Author.

Figure 11-7: linking most district centres to the nearest spine



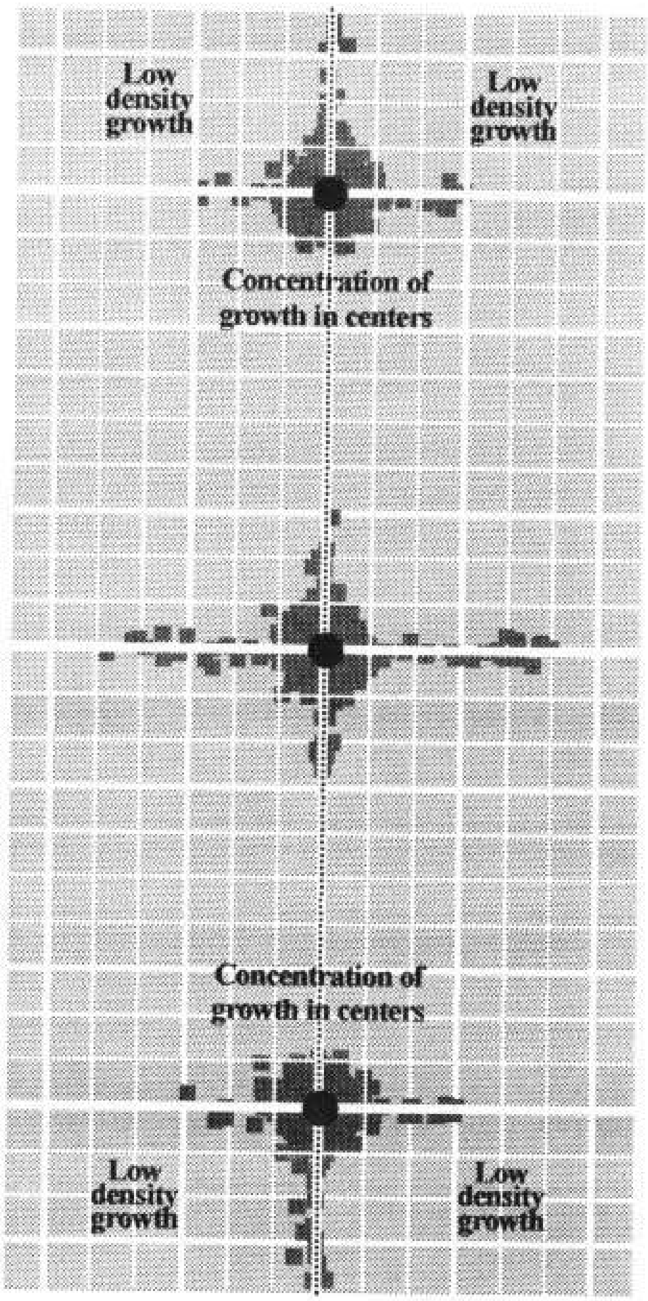
Note: this is a draft concept which gives only a general idea; The type and the location of this linkages need further detailed research.
Source: Author.

11.4.2 Growth Option Two: concentrated development in centres

Growth Option Two for Ar-Riyadh emphasises in the concentration of growth primarily in centres linked by public transport and secondarily along the public transport corridors. It is based on the strategy of focusing development near transit stations (as in the City Centres Concept of LA).

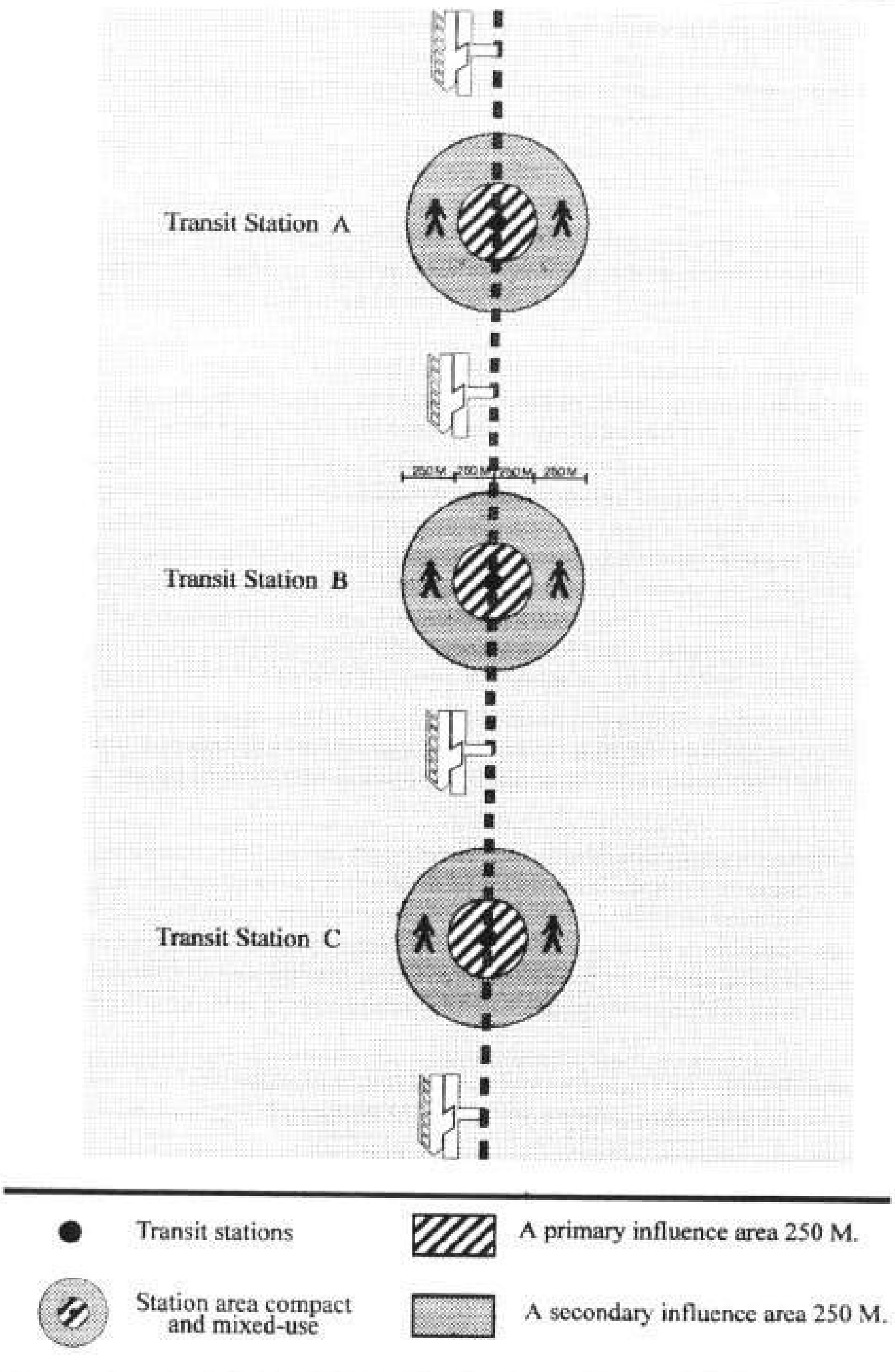
The concept of linking centres and concentrating development near transit stations is illustrated in Figure 11-8. The abstract plan shows transit stations surrounded by high density of mixed land-uses (residential, commercial, business and administrative functions). As in the Growth Option One, Figure 11-9 shows an appropriate scale of development proposed within the two identified transit station influence areas: (1) a primary influence area of approximately 250 metres radius surrounding the transit station and (2) a secondary influence area of approximately 250 metres outside the primary influence area. The main idea of Growth Option Two for Ar-Riyadh, illustrated in Figure 11-10, is to link existing centres of concentration (e.g. governmental offices, airport, universities, sports, hospitals, etc.) by fast public transport. The second step is reinforcing centres by concentrating high density housing, commercial, business and administrative functions around transit stations in the core of these centres. This system may have expanded if new centres are developing.

Figure 11-8: The concept of focusing development near transit stations



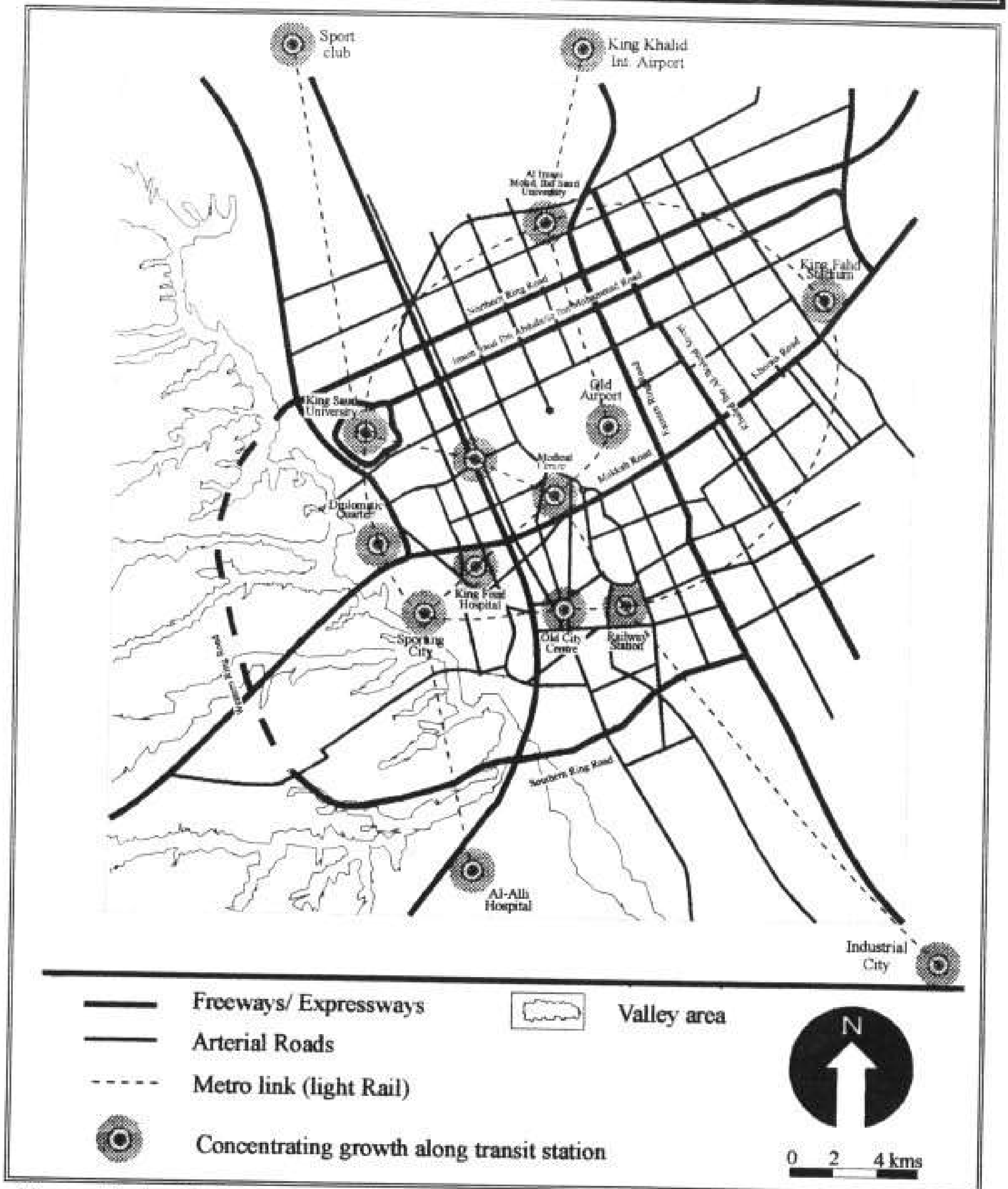
Source: Author.

Figure 11-9: An appropriate scale of development (concentrated development in centres)



Source: Author.

Figure 11-10: Growth Option Two for Ar-Riyadh (concentrated development in centres)



Note: this is a draft concept which gives only a general idea; the type and the location of these transit stations need further detailed research.
Source: Author.

11.4.3 Benefits of the proposed Growth Options

It is important to mention that land-use and transportation planning should be linked in both Growth Options so that use of public transport corridors and transit stations can be maximised. The success of a public transport system will be determined by its ability to encourage more people to use it. If public transport nodes (corridors and stations) provide for daily requirements as well as cultural and local amenities, then daily car trips will be reduced whilst mobility is increased by use of public transport especially by women and children. Some advantages of both Growth Options will be presented as follows:

1. The Growth Options can accommodate both regional development and local growth along public transport corridors and around local transit stations. As an efficient public transport system develops in Ar-Riyadh, future developments can be accommodated with minimal impact on the city;

2. The Growth Options can contain population growth in Ar-Riyadh by concentrating new houses along public transport routes and around stations. This will reduce the impacts of the region's expanding

population growth on the city. When housing is located along public transport routes or near to station areas along with appropriate amenities then the need for daily car journeys can be reduced by increased use of public transport and women's mobility can also be increased; and

3. The Growth Options can reduce the environmental impacts (pollution, car accidents, traffic congestion, and car parking). An increase in public transport passengers and reduction of car use will reduce petrol consumption thus reducing pollution from nitrogen oxides and carbon monoxide emissions, reducing car accidents, reducing traffic congestion, and reducing the need for car parking.

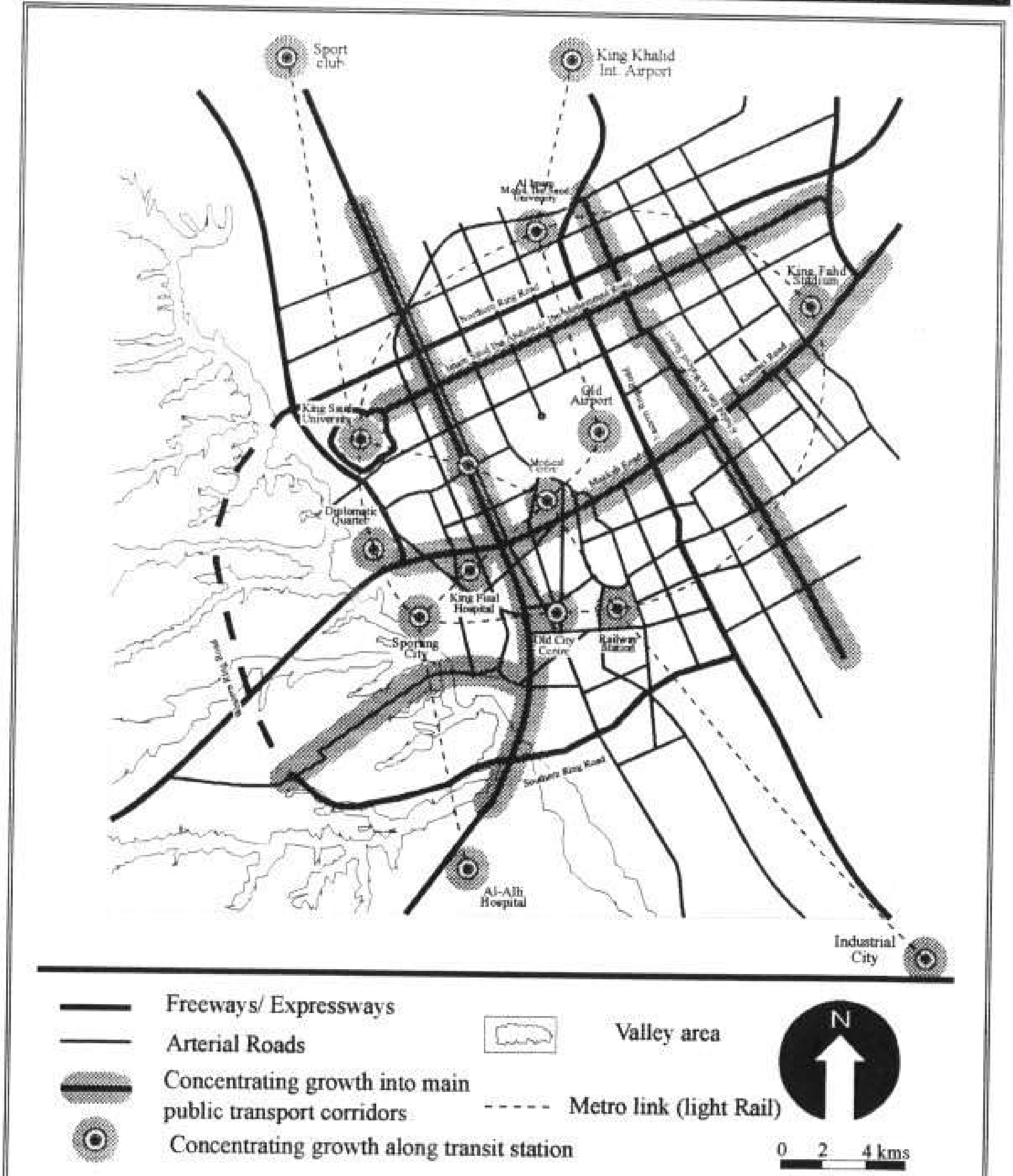
11.4.4 Assessment of the proposed Growth Options

There are many criteria for evaluating any alternative development strategies such as accessibility, efficiency, ease of implementations, responds to development pressure, expansion, and flexibility to change. However, most of these criteria are hard to evaluate because the two Growth Options for Ar-Riyadh are first draft concepts and need more detailed research on the appropriate location of major public transport corridors, location of housing and employment, location of activities and services,

location of motorways, location of pedestrian and bike ways, type of public transport and the appropriate design criteria and layout needed for urban form. This research cannot be carried out in this context because no detailed information of Ar-Riyadh is available now with the author. It is also not the objective of this thesis to generate anything like sort-term solutions.

In general, the Growth Option One (concentrated development in spine corridors) is based on long term strategy of implementation. It requires the relocation of existing governmental offices, housing, services, and retail establishments towards the proposed spine corridors, and this takes a long time. The Growth Option Two (concentrated development in centres) allows to respond to uses in locations outside spines and is therefore more flexible and adaptable. Figure 11-11 shows a combination of Growth Option One and Growth Option Two

Figure 11-11: Combination of Growth Option One and Two (concentrated development in corridors and centres)



Note: this is a draft concept which gives only a general idea; the number and the location of these major public transport corridors and the type and the location of these transit stations need further detailed research.

Source: Author.

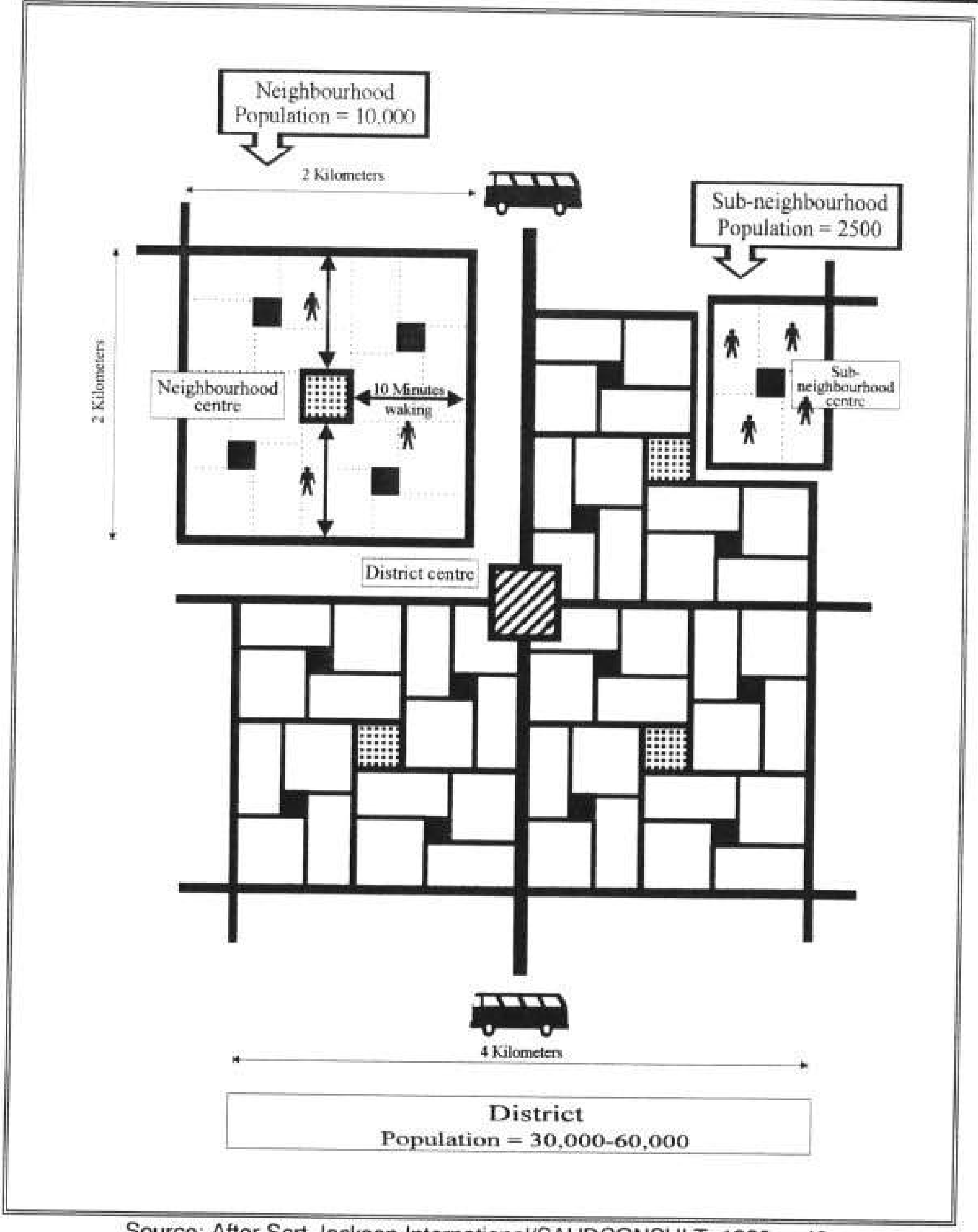
11.5 Neighbourhood form and centre hierarchy

As mentioned before, the findings of this study indicate that the quality of neighbourhood layout and the availability of neighbourhood facilities can make a contribution to reducing car dependence in so far as they encourage walking and cycling. Therefore, in this section, an abstract neighbourhood form and service-centre hierarchy will be presented (in terms of sizes of different facilities and their resultant catchment areas) which would formed a base for further research into an appropriate neighbourhood layout and service-centre hierarchy for the city of Ar-Riyadh. Most information in this section is taken from the Jeddah Action Master Plans (Jeddah is the second largest city in Saudi Arabia after Ar-Riyadh). The general pattern of neighbourhoods in Jeddah is similar to that in Ar-Riyadh.

The Master Plan of Jeddah has examined the service catchments for a number of residentially based facilities (such as schools, health clinics, etc.). In consequence, an ideal hierarchy of services has been developed which is compatible with the sizes of facilities currently administered by different service ministries. This abstract service hierarchy is presented in Figure 11-12.[4] It is important to mention that service hierarchy is combined with road hierarchy also.

[4] Sert Jackson International/SAUDCONSULT, 1980, p.46f.

Figure 11-12: Abstract centre hierarchy



Source: After Sert Jackson International/SAUDCONSULT, 1980, p.48.

11.5.1 Abstract service hierarchy

According to the report, the abstract service hierarchy effectively comprised different catchment areas related to different levels of service. This abstract service hierarchy is defined in the following sections:[5]

1. "**Residential Unit**": The smallest unit within a residential unit is the dwelling. A group of 50 to 100 houses form a cluster. A series of some 5 to 10 clusters form a residential unit (or sub-neighbourhood) with a population of 2,500. A residential unit is served at its centre with a mosque, a kindergarten with children's playground, a mail box and telephone booth and corner shops. Access to the centre is on foot, with minimal need for the pedestrian to cross any service road. A residential unit centre is illustrated in Figure 11-13.

2. "**Neighbourhood Unit**": Four residential units aggregate to form a neighbourhood (population of 10,000) which is served by a neighbourhood centre with a community centre, Friday Mosque, boy's and girls' elementary schools, police station, dispensary and post office, ornamental gardens, games areas with playgrounds, shops and offices. Access to the centre is primarily on foot. A neighbourhood centre is illustrated in Figure 11-14.

3. "**District Unit**": Three to six neighbourhoods aggregate to form a residential district (population 30,000-60,000) served by a secondary or a

[5] Sert Jackson International/SAUDCONSULT, 1980, p.47-49.

district centre. These centres contain higher order functions such as intermediate and secondary schools, shopping centre, fire station, municipal office, post and telegraphs office, workshops and service yards, and child care centre, health centre, public areas, play areas, gardens and a sports complex. A district centre is illustrated in Figure 11-15. According to the report, the preferred catchment size for the district centre is 55,000 to 65,000 (average 60,000). This population should fit within a grid of primary roads, thus avoiding the necessity for local residents and school children who have no access to a car, to cross major roads.[6]

4. **Metropolitan service functions** such as hospitals, special schools, institutes or stadium, will be located in such a way as to serve a number of districts. According to the report, from inspection of facilities and their catchment areas, it is proposed that some 40 hectares of land should be made available in total for each city "quarter" of 200,000 population, with a further 10 hectares of land per "quarter" allocated to serve the city as a whole.[7]

Appendix (B) illustrates examples of centre design for the city of Jeddah (local centre, neighbourhood centre, and district centre).

As mentioned before, different kinds of public transport may link these centres, otherwise the essential question of linkage would be lift open and cars will be used.

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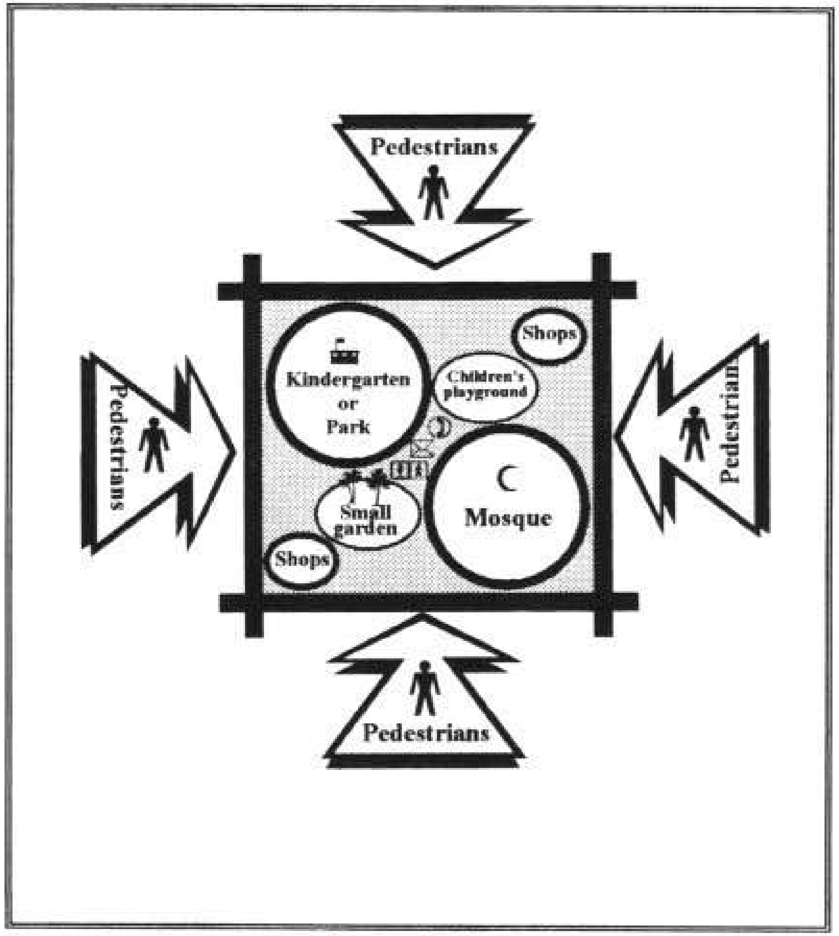
[6] Sert Jackson International/SAUDCONSULT, 1980, p.161.

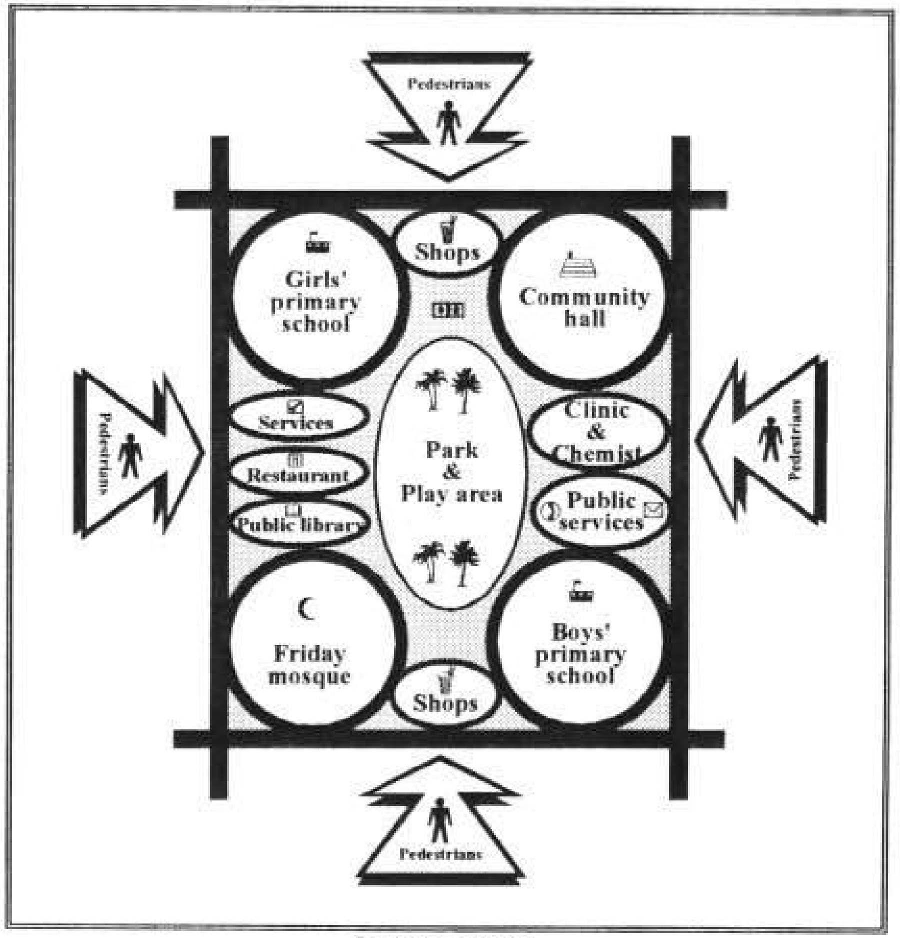
[7] Sert Jackson International/SAUDCONSULT, 1980, p.49.

Figure 11-13: Abstract local centre



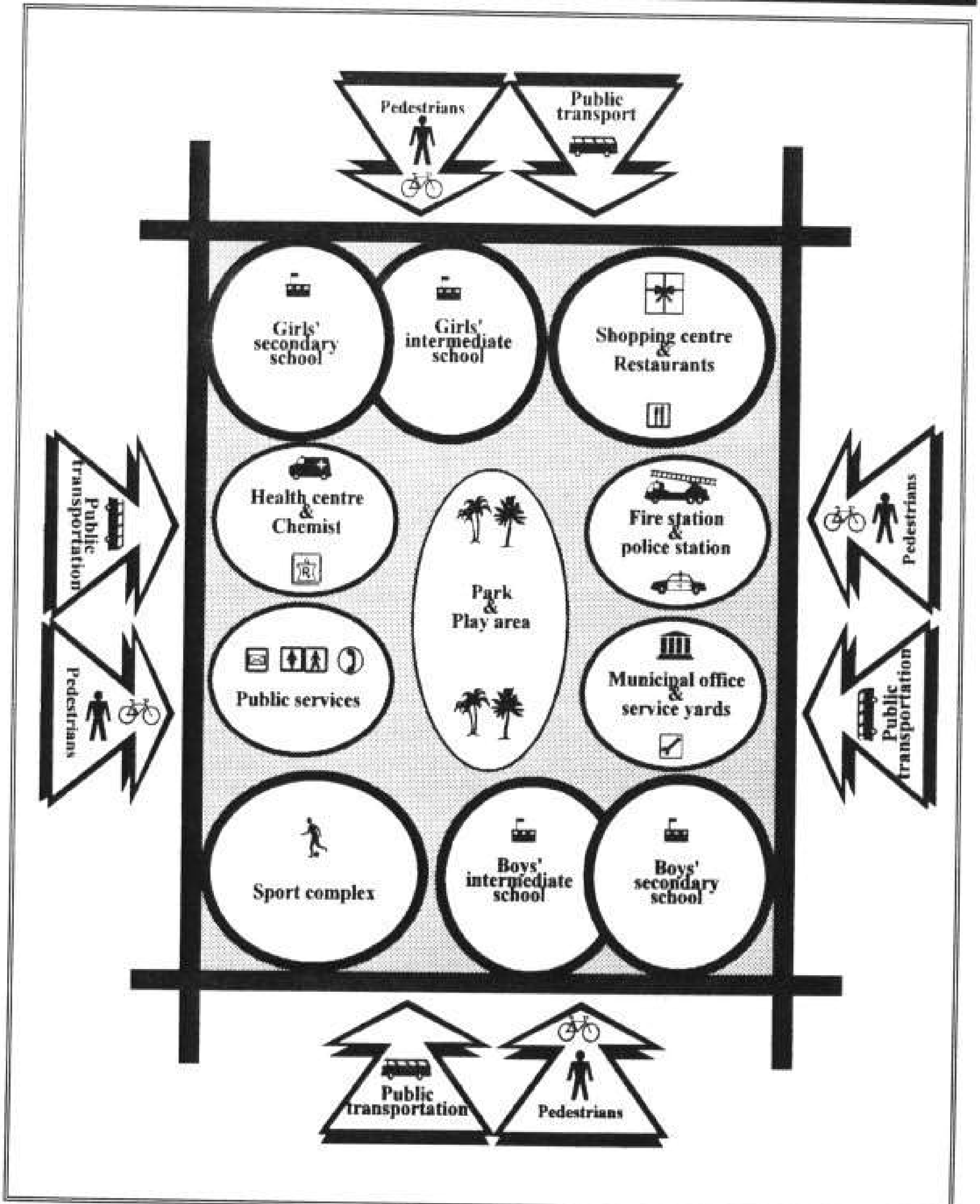
Source: Author.

Figure 11-14: Abstract neighbourhood centre



Source: Author.

Figure 11-15: Abstract district centre



Source: Author.

11.5.2 Improvement to existing neighbourhood subdivision

The existing layout design of neighbourhoods in Ar-Riyadh tends to reflect the grid of wide roads which allow fast car traffic to pass through. This arrangement is quite dangerous in traffic terms especially for children. The Jeddah Action Master Plans suggest that relief and interest could be created in conjunction with a traffic arrangement scheme involving the closure of certain roads and their use for community benefit as in Figure 11-16. The Master Plans also suggest that more encouragement needs to be given to comprehensive estate layout, where the landowner not only sells a land title, but, if required, a building and a serviced environment to go with it. This would result in higher quality of design lacking in current developments.[8]

Figure 11-17 and illustrates the improvements that would be achieved with such an estate layout; evidently many other forms and approaches are possible. Therefore, it would be helpful to do further research on the appropriate design criteria and layout needed for Ar-Riyadh's neighbourhoods especially regarding land subdivision, activities, spaces, pedestrian ways, landscaping, and street furniture.

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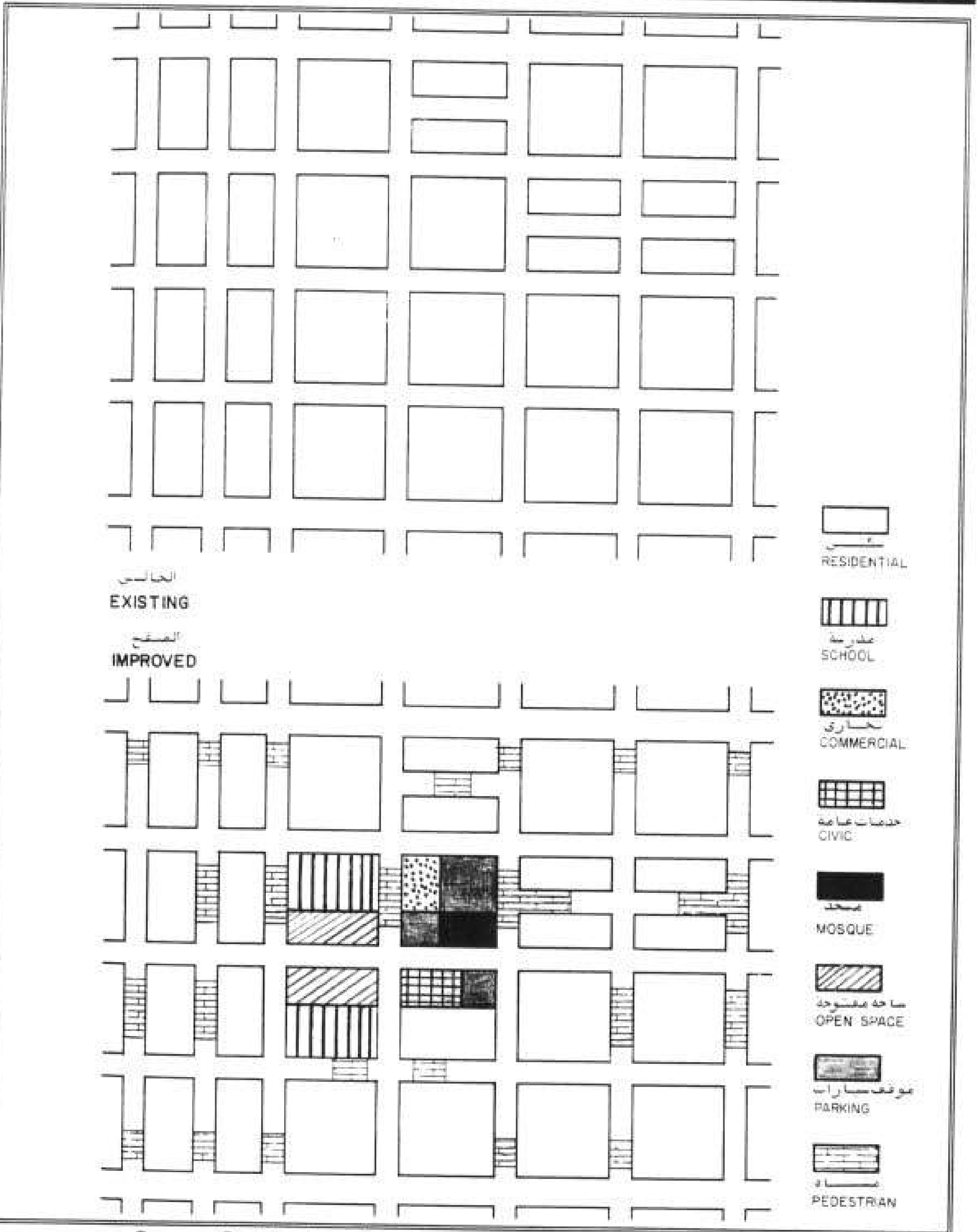
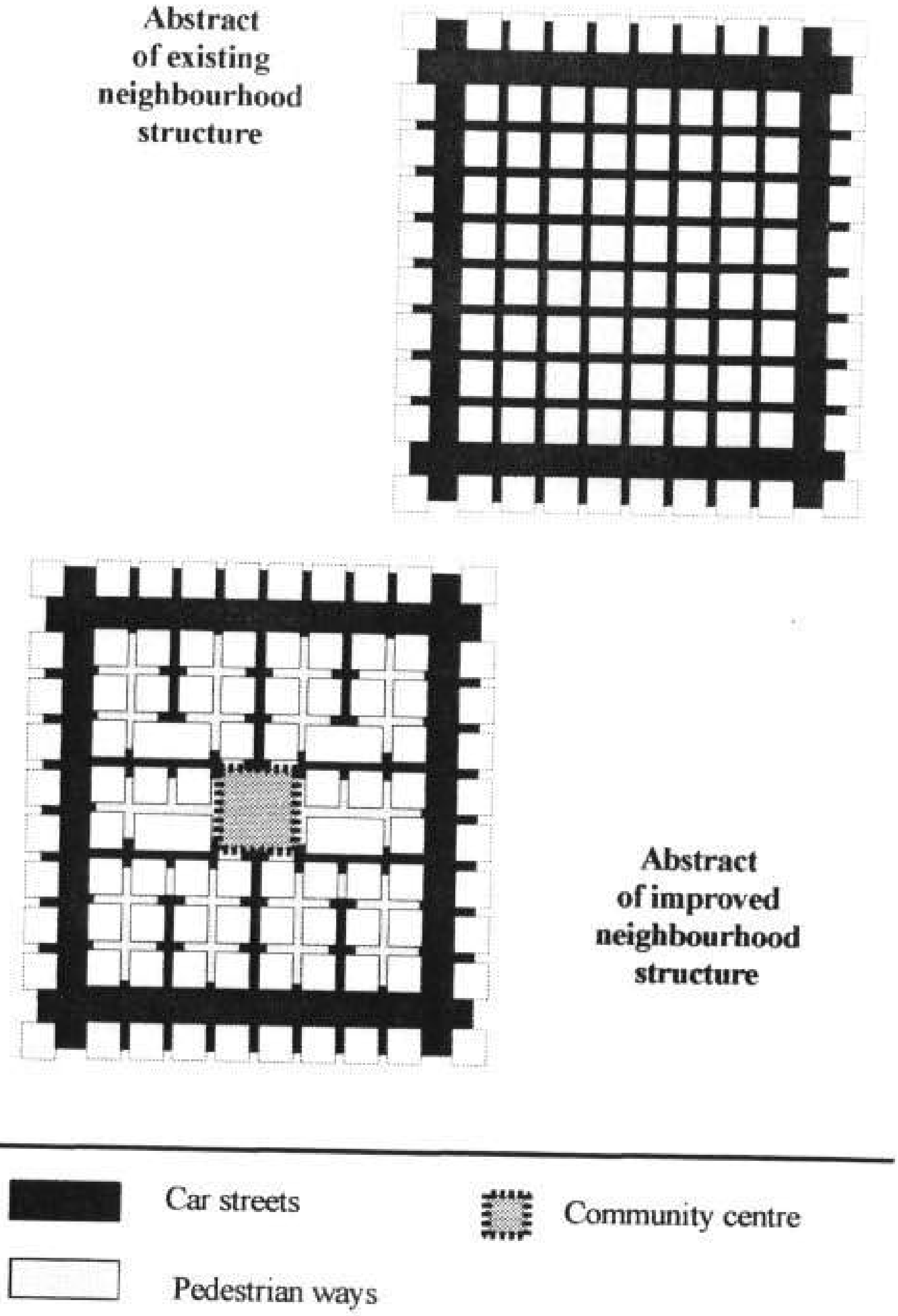
[8] Sert Jackson International/SAUDCONSULT, 1980, p.217.

Figure 11-16: Example of improvement to existing neighbourhood subdivision of Jeddah



Source: Sert Jackson International/SAUDCONSULT, 1980, p.219.

Figure 11-17: Example of abstract subdivision layout



Source: Author

11.6 Summary

Ar-Riyadh development could be influenced by land-use policies. This chapter considered the implications relevant to those land-use factors which can potentially influence travel behaviour and reduce motorised travel demand. These factors included: population density; metropolitan forms; neighbourhood form; responses to the development pressures caused by fast-road infrastructure; and public transport improvement.

A range of conflicting issues are involved when considering the travel implications of different urban forms. It is clear from all the previous evidence that the concentration of population and activities along major public transport nodes (corridors and transit stations) seems to be a good development strategy for urban form to minimise car dependence. Based on this evidence, a first draft growth options for Ar-Riyadh are proposed which could form a base for further detailed research into urban form of the city of Ar-Riyadh.

To implement some of the policies suggested in this thesis regarding development location, some planning tools suggested to encourage development in the central area or in areas within corridors potentially well-served by public transport in Ar-Riyadh such as imposing certain charges on these vacant lands and the loan granted through the REDF could be classified on the basis of location.

CHAPTER 12

CONCLUSIONS AND RECOMMENDATIONS

12. CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

This study investigated the role which land-use planning potentiality can play in reducing car-dependence in Ar-Riyadh city, the capital of Saudi Arabia. The purpose of this final chapter is to draw together the main conclusions reached and make some recommendations for future studies.

This study considered the ways in which land-use planing can influence reliance on the private car by:

1. reducing the need to travel in motorised transport;
2. reduce growth in the length and number of motorised journeys;
3. increasing the accessibility and practicability of using non-motorised modes of travel; and
4. increasing the quality and availability of alternative means of travel (modal choice) which have less environmental impact.

The impact of land-use planning measures determined in this thesis have to be seen from a long-term perspective because land-uses change relatively slowly. The data in Chapter Eight suggested that although most land-uses change only slowly, the potential scope for land-use planning to

reduce travel demand and encouraging use of alternative modes of travel in Ar-Riyadh is high due to a consequence of high percentage of vacant lands, a relatively low overall population density, and high degree of decentralisation of population, employment, and services overall the city. The ways in which land-use planning can control dependence on the private car are considered to be through influencing: (1) the urban density, (2) urban form and the location of development, (3) the neighbourhood structure, and (4) transport infrastructure. The evidence of the study indicates that, in overall terms, the planning policies most pertinent to the objective of reducing travel demand and encouraging use of alternative modes of travel are:

1. increasing development and population density in specific areas such as public transport corridors and major centres. This practice will influence the viability of public transport as well as walking and cycling;
2. focusing both housing and facilities, with wide catchment areas attracting large numbers of people, along major public transport corridors;
3. encouraging the development of neighbourhood and district centres which offer a range of everyday community shopping, education, health etc. in addition to improving existing neighbourhood subdivision by restructuring communities to better accommodate pedestrians; and
4. limiting the development of fast-road infrastructure and encouraging the development of facilities for alternative means of travel and locating major generators of travel demand in existing centres or new centres which are highly accessible by alternative modes of travel.

In Saudi Arabia, there are no simple measures that can have direct and major effects on the car use. This is because the guiding principles in the current decision making process assume no limitation of car ownership and

guarantee the freedom of mobility for business and distribution purposes. Given the importance of the car in Saudi Arabia, substantial limitation on its use requires fundamental measures capable of influencing people's travel demand and people's choice of mode through land-use planning. Evidence in this study suggested that in the long term, land-use planning can be used to minimise car dependence.

The data in this thesis revealed that economic measures such as road pricing, central area pricing system (area licensing), car pricing and taxation, high charges for parking meters and parking fines, increasing fuel prices, and other legislative measures, can have an important impact upon travel demand and modal choice. However, such measures are not the focus of this thesis, but land-use measures that might reduce travel demand and increase the choice of alternative means of travel. However, land-use measures by themselves can only provide opportunities for reducing growth in travel demand and choice of mode of travel. Therefore, they need to be supported by other measures in order to be effective such as economic measures, management and regulation measures, and improving alternative means of travel.

12.2 Recommendations for Further Researches

This thesis has been able to draw upon a wide range of existing research studies. The new evidence assembled has also thrown light on some of the complex relationships that exist between land-use planning and transport. There are however other areas of inquiry that could usefully be further researched. There remain many areas of uncertainty concerning the complex relationships between land-uses and transport planning. The following are some examples of research problems that draw the aim for future investigations:

1. **Research into improving travel of women in Saudi Arabian cities:** travel for women is restricted in Saudi Arabian cities. There would be merit in undertaking research that identified the effects of these restrictions on overall women-travel patterns and the best way to improve women's mobility within the bounds of socio-cultural considerations, especially now that it is evident there will be high demand for travel by women in the future. Some further treatment is needed considering the sensitive nature of this issue regarding its social, cultural and religious implications.

2. **More research into improving public transport in Saudi Arabian cities:** the study findings indicate that the availability and quality of public transport is important in reducing car dependence in so far as good public transport encourages people to use it. Many factors affect the availability and quality of public transport in Saudi Arabian cities such as high income, car ownership, development densities, culture, and climate. Although some key factors have been suggested in Chapter Eleven which might improve public transport services and increase the proportion of passengers carried by public transport in Ar-Riyadh, it would be useful to examine in more detail the extent to which public transport facilities can create the conditions to improve travel options for women and children. Social acceptability of public transport is a very important factor to be considered especially in the Saudi culture where male-female segregation is practised. In addition, a detailed investigation of public transport systems and appropriate public transport corridors and nodes would be useful.

3. **Research on short-distance trips in Saudi Arabian cities:** world wide evidence suggests that many trips are for short distance and they make a significant contribution to the issue of car dependence. However, there is relatively little specific data available on personal travel patterns in Saudi Arabian cities especially with regard to short-distance trips and the extent to which they can be influenced by planning policies. It would be helpful

therefore to improve data availability generally in this area and to undertake focused research to help assess the contribution that planning policies might make to encourage walking. This may improve the mobility of women, children, and people who have no access to the car in Saudi Arabian cities.

4. **More research into the appropriate neighbourhood layout:** the study findings indicate that the quality of the neighbourhood layout and the availability of neighbourhood facilities can make a contribution to reducing car dependence in so far as they encourage short trips and walking and cycling. Although an abstract neighbourhood form and centre hierarchy have been suggested in Chapter Eleven, it would be helpful to do further research on the appropriate design criteria and layout needed for neighbourhoods with regard to land sub-division, activities, spaces, pedestrian ways, landscaping, and street furniture.
5. **Research into the appropriate pedestrian-friendly walkways:** the findings of this study indicate that walking and cycling can make a contribution to reducing car dependence in so far as they encourage the use of alternative means of travel. It is not clear, however, how to develop effective sustainable urban forms at local, sub-regional and regional scale also the design of walkways in response to Ar-Riyadh's climate. It would be helpful therefore to do further research on that mater both theoretical and empirical.

6. **Design measure for high standards housing along public transport corridors:** one essential consequence of higher density housing in public transport corridors is the loss of living in detached houses for some Saudis families. So, alternative forms of high density dwellings need to be introduced to make living in such higher concentrations attractive. It would be helpful to do further research on the appropriate design criteria for high standards housing along public transport nodes.

7. **More research into urban and architectural design frameworks and guidelines:** there would be merit in undertaking research on qualitative aspects related to the compatibility of these planning procedures with the social cultural context, as well as architectural aesthetic quality within the regional framework and give the city and its buildings identity and image.

Since all Saudi Arabian cities and towns have the same car-dependence problem and since Ar-Riyadh is the capital of Saudi Arabia and is representative of all other cities, it is possible to generalise the implication of land-use planning and urban design which is mentioned in this thesis to be applied in all Saudi Arabian cities to minimise the effect of car-dependence.

Appendix A
Real Estate Development Fund (REDF): Conditions and Stipulations[1]

According to the Real Estate Development Fund (REDF) guidebook for private loans, the REDF is empowered to offer loans under the following stipulations:

1. Private loans are available only to those citizens who are males 21 years or older (unless married); divorced or widowed females and unmarried females over 40 years old, and single persons under 18 years or a group of siblings under 21 years old whose parents are deceased.

2. The recipient of the private loan should not own a private house by him/herself (unless it is an unsuitable or uninhabitable older house, and the owner is willing to demolish it to build a new one), and should hold a title to a plot of land which he or she intends to build, as sanctioned by the local municipality.

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[1] Source: Abdulaziz Al-Saati, Residential Satisfactions in Subsidised Housing: An Evaluation Study of the Real Estate Development Fund Program in Saudi Arabia, A Ph.D. Dissertation, University of Michigan, 1987. Cited in Telmesani, Abdullah, 1989, p.173.

3. The building which will be constructed by the private loans should be built in the place of residence (city/town) of the loan recipient.

4. The private loan is strictly a one-time offer, and previous recipients of REDF (both private and investment) shall not be granted a second loan.

5. Those who are qualified for the loans have to apply to local banks (either the National Commerce Bank or Riyadh Bank) with legal documents needed, such as proof of Saudi citizenship, land deed and building permit. Accordingly, application forms (including the specifications sheet) will be issued to be filled out by the applicants and then approved by the responsible government agencies before submitting them back to local band for final process.

6. Funding payments will be made on a periodic basis through the local bank. Each payment will be issued after certification by the REDF inspectors (civil engineer of architect). The first payment is 10 percent of the loan, and will be issued after signing the contract. The second payment is 40 percent of the loan and will be issued after the completion of the roofs and the structural skeleton of the building. The third payment will be 40 percent of the loan and will be issued after the completion of the exterior finishing, bathrooms and floor tiles. The last payment will be 10 percent and will be issued after the completion of the interior finishing, doors, windows, and the rest of the construction work.

7. In case of any reduction in the amount of work or changes that do not comply with the original specifications (which is the base form on which the total amount of the loan was calculated), payments will be adjusted according to the completed specification.

8. The recipient of the loan should start the construction work upon receipt of the first payment. Request for the second payment should be made within a period that should not exceed the eight month limit form the day

he signed the contract with REDF. Request for the remaining payments should made within a period that should not exceed the twenty-four months limit from the day he signed the contract and no payment will be allowed after that date.

9. Requests for REDF inspectors to visit the site to issue a certification should not be made unless the recipient was to ascertain that all required work had been completed. Any violation will be subject to a fine of SR. 200 per visit.

10. The land deed and building will be held by the REDF mortgage, and the recipient has no right to sell, relinquish, transfer the ownership, or change the status of the property until redemption of the mortgage has been made or the last payment of loan is made.

11. The recipient of the private loan should repay the loan back to the REDF on twenty-five annual instalments. The first payment is due two years after the signing of the contract with REDF. Each payment is due a year after the previous one.

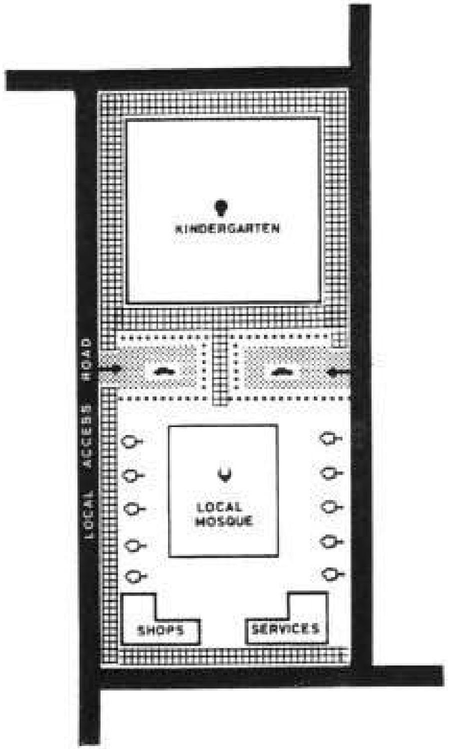
12. A twenty percent discount from each instalment will be rewarded to recipients who pay within two months of their due date. Those who fail to pay instalment on the due date will be exempt from the discount on that particular instalment.

13. Recipient who repay the loan back (the remaining instalments) in a lump sum will be rewarded a thirty percent discount on all instalments which are not due.

14. Failure to repay the loan or any instalments on the due date will give REDF the right to sell the mortgage by whatever price it is worth in the market in order to collect all or part of the remaining payments.

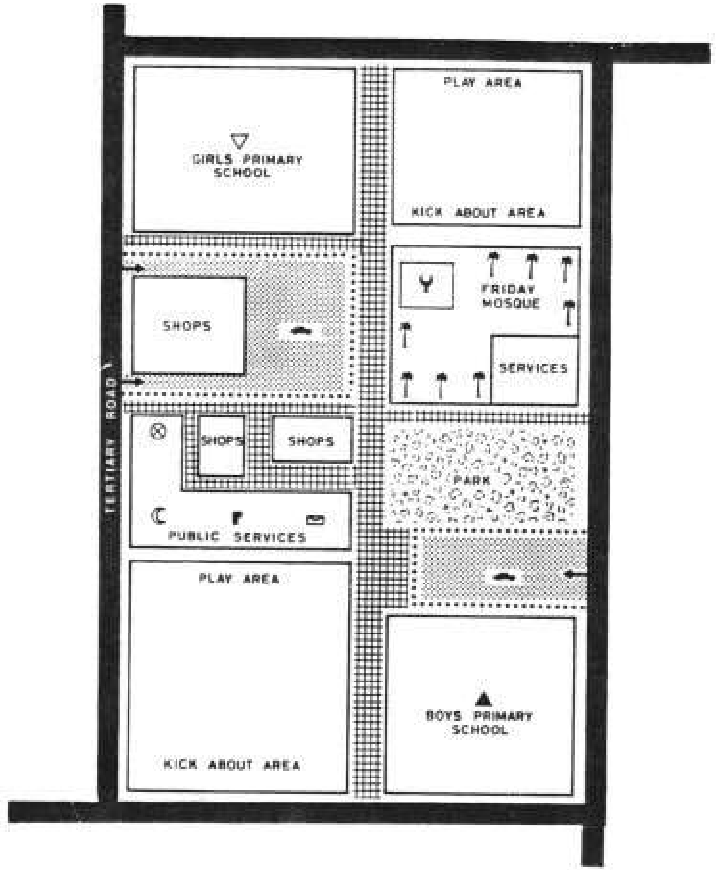
Appendix B
Examples of centre design for the city of Jeddah

Figure B-1: Local centre



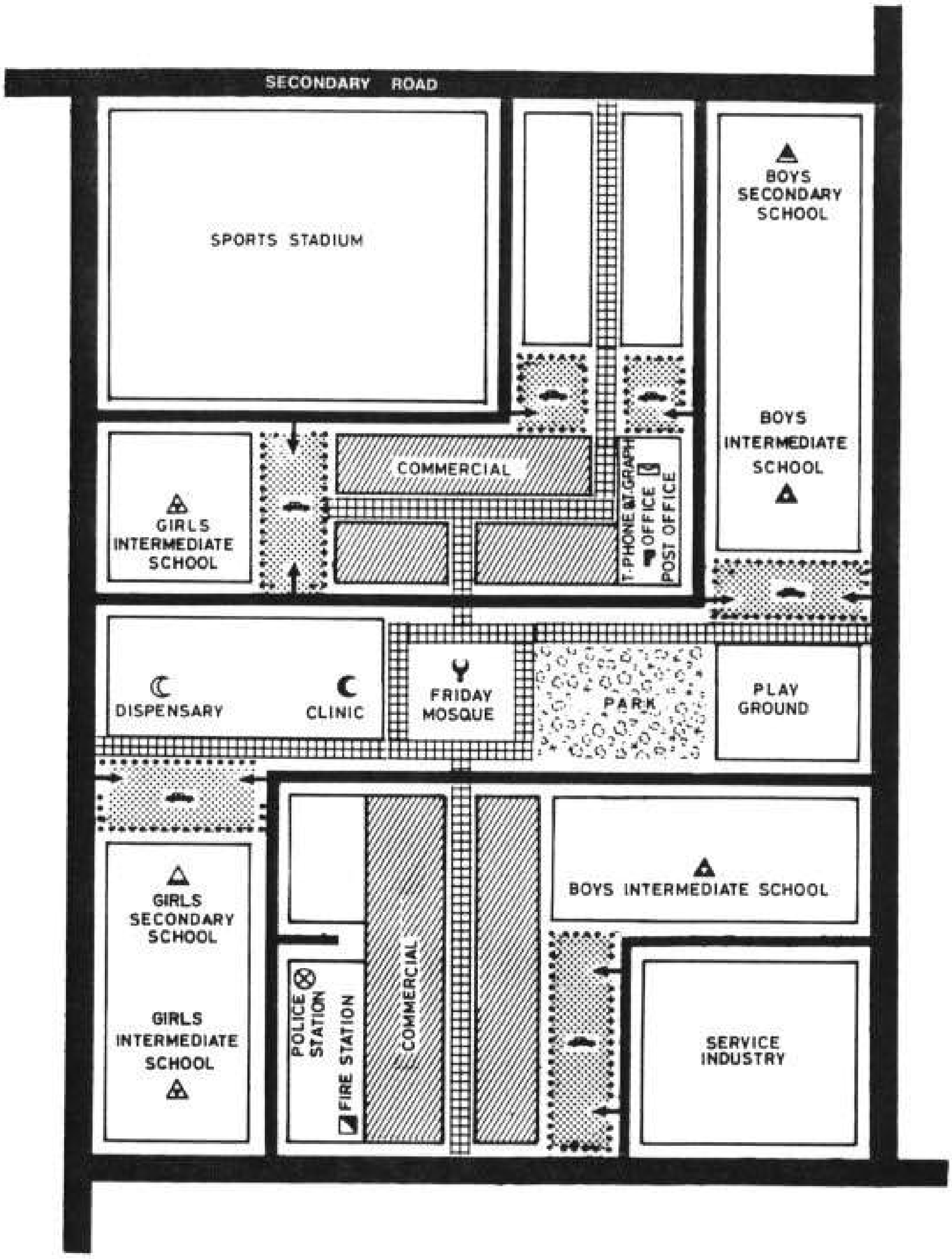
Source: Sert Jackson International/SAUDCONSULT, 1980, p.167.

Figure B-2: Neighbourhood centre



Source: Sert Jackson International/SAUDCONSULT, 1980, p.166.

Figure B-3: District centre



Source: Sert Jackson International/SAUDCONSULT, 1980, p.162.

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The research sources for the materials from which this thesis was assembled are those primarily given in the footnotes. Besides these, however, a number of books and articles proved to be particularly influential in expanding the researcher's knowledge and background in this field.

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