The University of Sydney

Copyright in relation to this thesis*

Under the Copyright Act 1968 (several provision of which are referred to below), this thesis must be used only under the normal conditions of scholarly fair dealing for the purposes of research, criticism or review. In particular no results or conclusions should be extracted from it, nor should it be copied or closely paraphrased in whole or in part without the written consent of the author. Proper written acknowledgement should be made for any assistance obtained from this thesis.

Under Section 35(2) of the Copyright Act 1968 'the author of a literary, dramatic, musical or artistic work is the owner of any copyright subsisting in the work'. By virtue of Section 32(1) copyright 'subsists in an original literary, dramatic, musical or artistic work that is unpublished' and of which the author was an Australian citizen, an Australian protected person or a person resident in Australia.

The Act, by Section 36(1) provides: 'Subject to this Act, the copyright in a literary, dramatic, musical or artistic work is infringed by a person who, not being the owner of the copyright and without the licence of the owner of the copyright, does in Australia, or authorises the doing in Australia of, any act comprised in the copyright'.

Section 31(1)(a)(i) provides that copyright includes the exclusive right to 'reproduce the work in a material form'. Thus, copyright is infringed by a person who, not being the owner of the copyright, reproduces or authorises the reproduction of a work, or of more than a reasonable part of the work, in a material form, unless the reproduction is a 'fair dealing' with the work 'for the purpose of research or study' as further defined in Sections 40 and 41 of the Act.

Section 51(2) provides that 'Where a manuscript, or a copy, of a thesis or other similar literary work that has not been published is kept in a library of a university or other similar institution or in an archives, the copyright in the thesis or other work is not infringed by the making of a copy of the thesis or other work by or on behalf of the officer in charge of the library or archives if the copy is supplied to a person who satisfies an authorized officer of the library or archives that he requires the copy for the purpose of research or study'.

*Thesis' includes 'treatise', dissertation' and other similar productions.
ACCESSIBILITY IN SYDNEY: PATTERNS, PROFILES AND PROSPECTS

Garry Glazebrook
B. Sc.(Hons.), M. Urban and Regional Planning, M. Operations Research

A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

Urban and Regional Planning Program
Faculty of Architecture
University of Sydney

July 2004
STATEMENT OF ORIGINALITY

This thesis is my original work, and has not been submitted, in whole or in part, for a degree at this or any other university. Nor does it contain, to the best of my knowledge and belief, any material published or written by another person, except as acknowledged in the text.

Garry Glazebrook

APPROVAL OF THE ETHICS COMMITTEE

The Human Ethics Committee of the University of Sydney granted approval for the survey component of this research (Ref 00/07/18, 23 November 2000).
ACKNOWLEDGEMENTS

I would like to express my gratitude to my supervisor, Dr Peter Phibbs, who has been extremely helpful and supportive throughout, and who has been a mentor for many years.

I would also like to thank all those who have been of assistance in providing information, comment, inspiration and support. These include Martin Payne and David Hensher at the University of Sydney, and other PhD students in the Urban and Regional Planning program. Particular thanks are due to Jon Hall who helped rekindle my interest in the topic and provided much stimulating input.

This thesis would not have been possible, especially the survey component, without the financial and other assistance of the sponsoring organisations. I would like to thank in particular, Abigail Goldberg, Judith Peters and Lucinda Rigby at South Sydney Development Corporation; Phillip Tolhurst and Stephanie Darch at Liverpool Council; Jorde Frangoples and Tony Lehmann at Willoughby Council, and Alex Gooding at the Western Sydney Regional Organisation of Councils. I have also received much help in obtaining detailed travel and land use data by Frank Milthorpe, Annette Hayes and Tim Raimond at the NSW Transport Data Centre, and their assistance has been invaluable.

In addition, I would also like to express my thanks for the support of the Commonwealth's SPIRT grant, which enabled the project to proceed, in particular to help fund the survey work.

Most of all my thanks are due to my wife and children who have been tolerant and supportive throughout.
ABSTRACT

Accessibility is a key concept in helping to understand how cities function and evolve. It influences travel behaviour, housing choices, land use patterns and investment in transport systems. Increasingly, accessibility, along with sustainability and social equity, are seen as the goals of urban and transport planning. This makes it important to understand the current meaning of accessibility in our cities, the factors underlying it, and the policies which might influence it.

Conventional approaches to accessibility have been criticised for their lack of consideration of social factors, while the rise of the world-wide-web has led some to claim the demise of distance and the rise of "virtual access". This study gathered extensive original data on how different people in Sydney value access to different opportunities, what their access difficulties are, and how their travel patterns and use of time are likely to change in the Internet age. The results confirmed that there is a social dimension to accessibility, but indicated that the impacts of communications technology on lifestyles and travel patterns have been exaggerated in some quarters. It concludes that classical concepts of accessibility remain relevant.

A new measure of accessibility - equivalent travel time - was developed which is easy to interpret, robust to changes in the travel impedance function, and captures changes in land use and transport. It can be applied to any city, to changes over time in a given city, to different modes and opportunities, and to different groups in the community.

This measure was used to explore current regional patterns of accessibility in Sydney to employment, public hospitals, shopping, the population and to universities, which the survey found were representative of the five most important opportunities to which people seek access. It was also used to explore how these accessibility patterns are expected to change over time, and how they may be affected by policy changes. The analysis highlighted the patterns of relative accessibility differences across Sydney, and the factors that underpin them.

The study concluded by highlighting some of the many areas in which accessibility can be applied, and identifying future research possibilities. These range from options to use land value increments to help fund transport investment, to links between accessibility and housing affordability, the potential impacts of transport initiatives such as high speed rail services, and measures to improve accessibility at a local level.
## CONTENTS

Statement of Originality and Approval of Ethics Committee (i)
Acknowledgements (ii)
Abstract (iii)
Contents (iv)

**CHAPTER 1  INTRODUCTION**

1.1 The Importance and Role of Accessibility 1
1.2 Classic Applications of Accessibility 4
1.3 New Perspectives 6
1.4 Key Research Questions 7
1.5 Structure of the Report 9
1.6 Design and Conduct of the Survey 11

**CHAPTER 2  LITERATURE REVIEW**

2.1 Introduction 12
2.2 Defining and Measuring Accessibility 12
2.3 Accessibility and Travel Behaviour 17
2.4 Accessibility, Land Use and Housing 22
2.5 Accessibility, Activities and the Use of Time 28
2.6 Communications and "Virtual" Accessibility 33
2.7 Access Difficulties 38
2.8 Relevant Patterns and Trends 44
2.9 Summary 60

**CHAPTER 3  RESEARCH METHODOLOGY**

3.1 Introduction 67
3.2 Research Objectives and Data Availability 67
3.3 Development of Research Methodology 70
3.4 Survey Design 71
3.5 Developing Accessibility Indicators 78
3.6 Summary 87

**CHAPTER 4  ANALYSIS OF SURVEY RESULTS**

4.1 Introduction 89
4.2 Accessibility and Travel Patterns 90
4.3 Accessibility and Housing Choice 97
4.4 Accessibility, Activities and The Use of Time 114
4.5 Communications and "Virtual" Accessibility 133
4.6 Access Difficulties 146
4.7 Summary 162
# Table of Contents

## Chapter 5: Accessibility Patterns in Sydney

5.1 Introduction  
5.2 Data and Measurement Issues  
5.3 Transport Infrastructure in Sydney  
5.4 Accessibility to Employment  
5.5 Accessibility to Public Hospitals  
5.6 Accessibility to Shopping  
5.7 Accessibility to the Population  
5.8 Accessibility to University  
5.9 Mode, Location and Opportunity  
5.10 Overall Accessibility Patterns  
5.11 Summary

## Chapter 6: Applications of Accessibility

6.1 Introduction  
6.2 Urban Consolidation and the Compact City  
6.3 Employment Distribution and Centres Policy  
6.4 Distribution of Urban Services  
6.5 Transport Improvement Strategies  
6.6 Accessibility and Disability  
6.7 Summary

## Chapter 7: Conclusions

7.1 Research Questions and Hypotheses  
7.2 Conclusions from the Research  
7.3 Discussion  
7.4 Directions for Further Research  
7.5 Final Comments

## References

ATTACHMENT - Survey Instrument
LIST OF TABLES

CHAPTER 1

Table 1.1 Focus of this Study 8

CHAPTER 2

Table 2.1 Advantages and Disadvantages of Utility-Based Measures 15
Table 2.2 Measures of Accessibility 16
Table 2.3 Population Density for Australian Capital Cities, 1966 – 1986 26
Table 2.4 Planned, Impulsive and Habitual Behaviour 30
Table 2.5 Percent of those working longer hours in Australia by Occupation 33
Table 2.6 Trips by Sydney Residents by Time of Week and Time of Day, 1991-2000 45
Table 2.7 Weekday Trip Rates in Sydney, 1991-2000 46
Table 2.8 Weekday Trips (unlinked) by Mode, 1991-2000 47
Table 2.9 Time Spent Travelling (Weekdays) 1991-2000 51
Table 2.10 Morning Peak Period Trips (6:30 - 9:30am) on a Typical Weekday, 1991-2000 52
Table 2.11 Morning Weekday Peak Trips by Trip Purpose, 1991-2000 52
Table 2.12 Mode Shares by Gender, 1991 and 2000 53
Table 2.13 Issues for Research 66

CHAPTER 3

Table 3.1 Development of Research Methodology 71
Table 3.2 Characteristics of Survey Areas 74
Table 3.3 Population Trends in Selected Local Government Areas 75
Table 3.4 Initial Accessibility Measures by Zone 76
Table 3.5 Distribution of Sample by Different Measures of Accessibility 76
Table 3.6 Hypothetical Model - Inter-Zonal Travel Times 82
Table 3.7 Hypothetical Model - Alternative Land Use Scenarios 83
Table 3.8 Hypothetical Model - Alternative Impedance Functions 83
Table 3.9 Evaluation of Accessibility Indicators 84
Table 3.10 Hypothetical Model - Comparison of Accessibility Indicators 85

CHAPTER 4

Table 4.1 Information on Travel Patterns included in the Survey 90
Table 4.2 Significance Levels for Relationships between Accessibility and Participation 91
| Table 4.3 | Frequency of Visiting Activities by Level of Accessibility | 95 |
| Table 4.4 | Time Lived in Current Home by Dwelling Type | 98 |
| Table 4.5 | Hypotheses on Housing Choice | 100 |
| Table 4.6 | Importance of Accessibility in Housing Choice by LGA | 100 |
| Table 4.7 | Importance of Accessibility in Housing Choice by Type of Dwelling | 101 |
| Table 4.8 | Relationships between Travel, Socio-Economic and Land Use Characteristics | 116 |
| Table 4.9 | Assumed Factors Affecting Importance of Accessibility to Different Activities | 116 |
| Table 4.10 | Factors affecting Importance Placed on Accessibility | 131 |
| Table 4.11 | Relationships with Internet Usage | 138 |
| Table 4.12 | Listing of Access Problems by Mode and Type | 150 |
| Table 4.13 | Transport / Access Problems by Local Government Area | 155 |
| Table 4.14 | Transport / Access Problems by Public Transport Access | 155 |
| Table 4.15 | Results of Tests of Other Possible Factors | 158 |
| Table 4.16 | Summary of Major Findings | 160 |

CHAPTER 5

| Table 5.1 | Specific Opportunities and Reasons for Selecting Them | 164 |
| Table 5.2 | ETT Ranges for Accessibility to Employment by Mode (minutes) | 173 |
| Table 5.3 | Public Hospitals in Sydney Study Area | 175 |
| Table 5.4 | Key Data on Shopping Centres in Sydney: 1991 and 2001 | 179 |
| Table 5.5 | Floor-space by Category of Retail Centre (2001) | 180 |
| Table 5.6 | Other Characteristics of Retail Centres by Category (2001) | 181 |
| Table 5.7 | ETT Ranges for Accessibility to the Population by Mode (minutes) | 187 |
| Table 5.8 | Relative Weights Ascribed to Different Types of Opportunity | 196 |

CHAPTER 6

| Table 6.1 | Evidence for Compact City Claims Related to Social Equity | 208 |
| Table 6.2 | Impacts of Four Processes of Housing Change | 209 |
| Table 6.3 | Scenarios for Future University Enrolments | 218 |
| Table 6.4 | Key Transport Improvements in Action for Transport 2010 | 221 |
| Table 6.5 | Comparison of Equivalent Travel Times for Current and Improved Public Transport Scenario (using current ETT public transport scale) | 225 |
| Table 6.6 | Comparison of Equivalent Travel Times for Current and Improved Public Transport Scenario (using current ETT car scale) | 226 |
LIST OF FIGURES

CHAPTER 1

Figure 1.1  Transport, Land Use and Accessibility  4
Figure 1.2  Cause and Effect of Urban Travel Patterns  6

CHAPTER 2

Figure 2.1  Journey to Work in Four Australian Cities, 1981  20
Figure 2.2  Energy Consumption by Public Transport Accessibility  20
Figure 2.3  Activity Duration and Travel Times  31
Figure 2.4  Household Incomes and Household Car Ownership, Sydney, 1986  41
Figure 2.5  Change in Population, Travel and Gross State Product, Sydney, 1991-2000  45
Figure 2.6  Trips by Purpose (Weekday Travel), 1991-2000  46
Figure 2.7  Mode Shares for Different Trip Purposes, 2000  48
Figure 2.8  Change in Mode Share by Trip Purpose, 1991-2000  48
Figure 2.9  Reasons for Travelling to Work by Car or Public Transport  49
Figure 2.10  Trip Lengths by Trip Purpose, 1991-2000  50
Figure 2.11  Trip Lengths by Mode, 1991-2000  50
Figure 2.12  Trip Times by Trip Purpose, 1991-2000  51
Figure 2.13  Mode Share by Age Group (2000, weekday unlinked trips)  53
Figure 2.14  Change in Mode Share by Age Group, 1991-2000  54
Figure 2.15  Reasons for Recent Movers Choosing an Area  56
Figure 2.16  Reasons for Choosing their Area (for Sydney)  57
Figure 2.17  Growth of Computers and Internet Access at Home  58
Figure 2.18  Computer and Internet Usage, Australia, 1998  59

CHAPTER 3

Figure 3.1  Travel Zones Selected for the Survey  73
Figure 3.2  Concept of Equivalent Travel Time  81
Figure 3.3  Hypothetical Model - Travel Times from Zone 1  82
Figure 3.4  Hypothetical Model - Robustness of RAV and RTT  86

CHAPTER 4

Figure 4.1  LGA Accessibility by Workforce Participation  91
Figure 4.2  Frequency of Working by Public Transport Accessibility  92
Figure 4.3  Mode for Journey to Work by LGA Accessibility  93
Figure 4.41 Usage per Month by Gender
Figure 4.42 Hours Per Week Using the Internet by Gender
Figure 4.43 Hours Per Week Using the Internet by Personal Income
Figure 4.44 Average Number of Times Internet was Accessed Last Month (Users)
Figure 4.45 Has the Internet Made a Difference in Making Friends / Social Communications?
Figure 4.46 Impact of Internet on time on other activities around the home
Figure 4.47 Type of impact for those for whom there is an impact
Figure 4.48 Percent who feel use of Internet impacts on time for Indoor Activities by qualification and LGA
Figure 4.49 Impact of Internet, Email and Computers on Travel and Ways to Access
Figure 4.50 Likely Impact of Internet on Travel Patterns by Trip Purpose
Figure 4.51 Problems with Walking
Figure 4.52 Problems with Using a Bicycle
Figure 4.53 Problems with Using Mass Transit
Figure 4.54 Problems with Using Taxis
Figure 4.55 Problems with Using Cars
Figure 4.56 Most Common Problems / Difficulties and Relevant Modes
Figure 4.57 Problems with Accessing Main Place of Study
Figure 4.58 Problems Accessing Shops
Figure 4.59 Overall Feelings about Transport and Access in Sydney
Figure 4.60 Transport / Access Problems versus Household Car Availability
Figure 4.61 Transport / Access Problems versus Disability – Related Difficulty
Figure 4.62 Transport / Access Problems versus Personal Income Group
Figure 4.63 Transport / Access Problems versus Personal Income
Figure 4.64 Transport / Access Problems versus Age
Figure 4.65 HH Cars Available by LGA
Figure 4.66 Age by LGA
Figure 4.67 Average Level of Access Problems by LGA

CHAPTER 5

Figure 5.1 Relative importance of accessing different opportunities
Figure 5.2 Trips in Sydney by Time of Day, 1991 and 2000
Figure 5.3 Major Road Infrastructure in Sydney
Figure 5.4 Rail Infrastructure in Sydney
Figure 5.5 Employment Distribution in Sydney, 2001
Figure 5.6 Accessibility to Employment by Car, 2001 (ETT, minutes)
Figure 5.7 Accessibility to Employment by Public Transport, 2001 (ETT, minutes)
Figure 5.8 Accessibility to Employment by Public Transport, 2001 (car scale)
Figure 5.9  Relative Modal Accessibility to Employment, 2001 (ETT Public Transport / ETT Car)  
Figure 5.10  Public Hospital Characteristics by Type of Facility, 2001  
Figure 5.11  Distribution of Public Hospital in Study Area, 2001, by Number of Separations  
Figure 5.12  Accessibility to Public Hospitals by Car, 2001 (ETT, minutes)  
Figure 5.13  Accessibility to Public Hospitals by Public Transport, 2001 (ETT, minutes)  
Figure 5.14  Accessibility to Public Hospitals by Public Transport, 2001 (car scale)  
Figure 5.15  Relative Modal Accessibility to Public Hospitals, 2001 (ETT Public Transport / ETT Car)  
Figure 5.16  Retail Floor-space by Category of Centre, Sydney, 2001  
Figure 5.17  Car Parking Provision Per1000 sq. m. of Retail and Other Floor-space  
Figure 5.18  Distribution of Retail Centres in Study Area by Retail and Other Floor-space, 2001  
Figure 5.19  Accessibility to Shopping by Car, 2001 (ETT, minutes)  
Figure 5.20  Accessibility to Shopping by Public Transport, 2001 (ETT, minutes)  
Figure 5.21  Accessibility to Shopping by Public Transport, 2001 (car scale)  
Figure 5.22  Relative Modal Accessibility to Shopping, 2001 (ETT Public Transport / ETT Car)  
Figure 5.23  Population Distribution in the Study Area, 2001.  
Figure 5.24  Accessibility to the Population by Car, 2001 (ETT, minutes)  
Figure 5.25  Accessibility to the Population by Public Transport, 2001 (ETT, minutes)  
Figure 5.26  Accessibility to the Population by Public Transport, 2001 (car scale)  
Figure 5.27  Relative Modal Accessibility to the Population, 2001 (ETT Public Transport / ETT Car)  
Figure 5.28  University Enrolments by Institution and Campus, 2001  
Figure 5.29  Distribution of University Enrolments by Campus, 2001  
Figure 5.30  Accessibility to University by Car, 2001 (ETT, minutes)  
Figure 5.31  Accessibility to University by Public Transport, 2001 (ETT, minutes)  
Figure 5.32  Accessibility to University by Public Transport, 2001 (car scale)  
Figure 5.33  Relative Modal Accessibility to University, 2001 (ETT Public Transport / ETT Car)  
Figure 5.34  Average ETT Scores for Inner, Middle and Outer Ring Suburbs by Mode and Opportunity  
Figure 5.35  Ratio of ETT Scores between Public Transport and Car for Inner, Middle and Outer Ring suburbs by Opportunity.  
Figure 5.36  Standard Deviation of ETT Scores by Mode and Opportunity  
Figure 5.37  Overall Accessibility by Car, 2001 (Equivalent Travel Times)  
Figure 5.38  Overall Accessibility by Public Transport, 2001 (Equivalent Travel Times)
CHAPTER 6

Figure 6.1 Housing Approvals in Sydney by Region, 1991/2 to 1996/7
Figure 6.2 Intercensal Growth in Housing Stock in Sydney, by Type
Figure 6.3 Attitudes to Changes in Housing Density in Sydney
Figure 6.4 Preferences for Alternative Housing Strategies for Sydney
Figure 6.5 Patterns of Expected Population Growth, 2001-2026, Sydney
Figure 6.6 Population Growth Expected 2001 - 2006 by Relative Overall Accessibility
Figure 6.7 Population Growth Expected 2002 - 2026 by Relative Overall Accessibility
Figure 6.8 Pattern of Expected Employment Growth, 2001-2026
Figure 6.9 Change in Equivalent Travel Times to Jobs by Car, 2001 - 2026 (due to change in employment growth only)
Figure 6.10 Change in Equivalent Travel Times to Jobs by Public Transport, 2001 - 2026 (due to change in employment growth only)
Figure 6.11 Shares of Expected Employment Growth by Relative Accessibility Level
Figure 6.12 Equivalent Travel Times to University by Car, Future Scenario B
Figure 6.13 Equivalent Travel Times to University by Public Transport, Future Scenario B
Figure 6.14 Differences in Equivalent Travel Times to University by Car: Scenario B - Scenario A
Figure 6.15 Difference in Equivalent Travel Times to University by Public Transport: Scenario B - Scenario A
Figure 6.16 Changes in Equivalent Travel Times to Employment by Car, 2001 - 2021 (planned transport improvements only)
Figure 6.17 Changes in Equivalent Travel Times to Employment by Public Transport 2001 - 2026 (planned transport improvements only)
Figure 6.18 Accessibility to Employment with Improved Public Transport Scenario (using current ETT scale for public transport)
Figure 6.19 Accessibility to Employment with Improved Public Transport Scenario (using current ETT car scale)
Figure 6.20 Relative Accessibility to Employment by Public Transport for People with Mobility Difficulties, 2001
Figure 6.21 Accessibility to Employment by Public Transport for people facing a Mobility Handicap (using the ETT by public transport scale for people without a disability)

CHAPTER 7

Figure 7.1 Simplified Life "Spiral".
CHAPTER 1: INTRODUCTION

1.1 THE IMPORTANCE AND ROLE OF ACCESSIBILITY

"A citizen's real standard of living, the health of himself and his family, his children's opportunities for education and self improvement, his access to employment opportunities, his ability to enjoy the nation's resources for recreation and culture ... are determined not by his income ... but by where he lives" (Gough Whitlam, quoted in Logan, Maher, McKay and Humphreys, 1975, p219).

Location, and the access it provides, is vital. According to popular myth, "location, location, location" summarises all one needs to know about real estate. This sentiment is underpinned by the central role, which the concept of accessibility plays in our cities, and in wider spatial realms. Indeed cities themselves evolved primarily because of the increased accessibility and security they provided to their citizens.

Accessibility, together with sustainability and social equity, are increasingly seen as the key goals of urban and transport planning. The days of simply providing transport infrastructure to meet ever-increasing demand are coming to an end, in favour of an emphasis on the end product of the transport-land use system - accessibility to opportunities. This change in emphasis is now commonly found in planning strategies and documents. For example:

- Portland, Oregon, was one of the first cities in the United States to embrace growth limits and light rail over continued reliance on car-based, low-density development on the urban fringe. Since then many other cities have followed and there is now a substantial "smart growth" movement aimed at achieving greater transport and land-use integration and more sustainable accessibility (Cervero, 2001).
- "Shaping our Cities" - the planning strategy for the Greater Sydney Region (NSW Department of Urban Affairs and Planning, 1998) sets out as one of its four key aims to "create cities that provide viable transport systems and urban structures with equitable access to jobs, services and leisure". Key planning principles include creating a compact urban structure; creating employment opportunities in locations which support access by public transport; enhancing opportunities for walking, cycling and public transport; and containing the growth in travel demand.
- Local authorities are following suit. For example Liverpool City council is developing a CBD strategy aimed at achieving a CBD which is legible and accessible, with public transport priority and a pedestrian focus (Liverpool City Council, 2002).

What is Accessibility?

There have been many definitions of accessibility. However what may be termed the "classic" view is summarised by Morris, Dumble and Wigan (1979, page1) in the following terms:
"Accessibility has generally been defined as some measure of spatial separation of human activities. Essentially it denotes the ease with which activities may be reached from a given location using a particular transportation system".

Black (1977) took a somewhat wider view of the concept to incorporate socio-demographic and other characteristics of residents (page 2):

"Accessibility is an abstract concept which describes where activities are located in relation to dwellings and how convenient or difficult it is to get to these activities. Residents' accessibility is a rather more useful concept than the accessibility of a residential site. In order to gain an understanding of residents' accessibility we need to know the type of resident we are dealing with (age, preferences, lifestyle), the different kinds of activities they want to visit, the transport modes available to them and the amount of money they are willing (or can afford) to pay for goods, services and travel."

More recently, the growth of the Internet and advanced communications systems has led some to the concept of "virtual accessibility", achieved by means of electronic communications rather than physical transport.

In addition, the term "accessibility" has also been applied to the more specific meaning of physical accessibility, particularly for people with disabilities, which affect their mobility. "Accessible" transport has come to mean systems which are designed to minimise such problems, through for example, the use of lifts, ramps or easy-access entries for people in wheelchairs or with other physical disabilities, or the design of voice-based, visual or touch-based aids for people with visual or hearing disabilities.

For this study, I will adopt the following broad definition of accessibility:

<table>
<thead>
<tr>
<th><strong>Accessibility</strong> to a class of opportunities is a measure of the ability to reach or otherwise access those opportunities or the facilities which provide them. It thus incorporates the attractiveness or appeal of those opportunities or facilities and the time or other costs involved in accessing them. In turn, these will depend on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• the nature of the opportunities or facilities</td>
</tr>
<tr>
<td>• their spatial arrangement in relation to residential areas</td>
</tr>
<tr>
<td>• the transport and communications systems linking them</td>
</tr>
<tr>
<td>• the characteristics of persons desiring access.</td>
</tr>
</tbody>
</table>

The study is therefore concerned with the wider concept of accessibility, though it will also refer to some of the more specific aspects related to "accessible" transport.

**The Role and Importance of Accessibility**

Accessibility plays a number of key roles, particularly in an urban context:
• It affects individual short-term decisions, such as the number and destinations of trips people undertake and the transport modes they use.
• It also influences longer-term decisions such as where residents choose to live and where businesses choose to locate. Over time, these decisions impact back on housing and land prices, and ultimately on land-use patterns.
• It is also impacted on by both transport investment decisions (such as the construction or freeways or railway lines) and by land-use changes.

Significance for the Individual

As Burns (1979, page 5) notes: “there is strong evidence that suggests that individuals value accessibility. This evidence includes the migration of individuals to opportunity-rich cities and the ubiquity of accessibility-enhancing innovations such as the automobile and the telephone”.

Models of travel behaviour for individuals have evolved over recent decades, but usually consider the types of opportunities which are available (including their characteristics and value to the individual) and the costs of accessing those opportunities, including travel time and out-of-pocket costs such as fares, petrol costs or parking costs. The opportunities might include:

• Opportunity to work and gain an income
• Opportunity to purchase goods or services
• Opportunity for recreation, or social interaction
• Opportunity to learning and educational opportunities
• Opportunity to receive health care

In all cases, these opportunities are not uniformly distributed in space, but are usually clustered or concentrated at particular locations. For example there are high concentrations of jobs in locations such as the Central Business District and other centres, while there are only a finite number of universities or hospital emergency wards in any given city.

In most cases people access these opportunities by traveling to them; in some cases the opportunity itself may be brought to the person (ambulance services, traveling library services, door-door salesperson); and in others the opportunity can be accessed electronically rather than physically by communications technology (for example online shopping or dating services).

Consequently behaviour, and especially short-term behaviour such as travel, is strongly linked to accessibility.

Equally, individuals’ longer term decisions such as housing choices or car ownership are also influenced by accessibility. In many cases these decisions may be jointly made—for example people may decide to pay more for housing in order to be close to a rail station, thereby allowing them to operate with out a car, or with one rather than two vehicles.
Significance for the City

At the urban level, all of these individual decisions combine to create overall travel patterns and indeed the built form of the city. However the individual decisions are not independent, but rather interact in complex ways. For example travel speeds on roads and highways are closely related to traffic volume/capacity ratios - the more people who decide to drive on a given route, the longer they will all take to make their trip. This in turn can act as a deterrent - some people may avoid the trip, change route, change the time of travel, change their mode of travel, or decide to access an opportunity electronically rather than physically.

Similarly many people may wish to locate themselves close to the CBD or to good public transport - areas with higher than average accessibility. However the extent to which this is possible depends on zoning and density controls is usually limited at any given time. Hence housing prices in such desired locations are bid up, creating rent gradients across a city. These in turn can influence which individuals and groups can afford to live in particular areas.

Thus accessibility can be seen as a key concept in linking transport systems, land use patterns and travel patterns in cities:

Figure 1.1 Transport, Land Use and Accessibility

1.2 CLASSIC APPLICATIONS OF ACCESSIBILITY

The concept of accessibility has been extensively used in an urban and transport context. A few examples illustrate some of its applications in relation to cities:

- Patton (1970) examined the effects of accessibility on residential density, using data from Melbourne. He found that simple measures such as distance from the city centre were no longer appropriate given the increase in car ownership and dispersal of employment, and suggested that residential models should be reformulated in terms of accessibility or relative accessibility.

- Black (1977) in a work entitled “Public Inconvenience” analysed access and travel of residents to places of employment, schools, shops, health services, sport and
recreation for seven Sydney suburbs. The study examined whether the process of development had resulted in a "fair" distribution of facilities throughout the metropolitan region, and analysed the transport problems, which arise when residents have poor access.

- Watterson (1993) analysed a range of alternative land use options, travel demand management measures and transport investment strategies for the Puget Sound Region in the United States, and how these impacted on motor vehicle travel, air pollution and greenhouse gas emissions.

- Banister (ed.) (1995) provides an overview of issues and recent studies in transport and urban development. In the opening chapter, Banister and Lichfield (1995) highlight the key importance of the improvements in accessibility brought about by transport infrastructure, and of the importance of this for subsequent land use decisions. Indeed the term "accessibility" is referenced no less than 22 times in the overall volume, the most of any subject.

- Attorney-General's Department (1997 a) examined the potential impacts of improved public transport accessibility. This report focused on the issue of "accessible transport" and the likely patronage increases arising from improvements to the physical accessibility of mainstream public transport services.

- Landis and Cervero (1999) examined the impact of improved public transport accessibility arising from the expansion of the Bay Area Rapid Transit (BART) on land use changes, housing prices and office rents near BART stations.

- Waddell (2002) discussed the use of a new integrated micro-simulation model, "Urban Sim", for analysing land use, transportation and other urban parameters, and its application to the city of Eugene-Springfield in Oregon. The model uses accessibility at both the regional and local scale for estimating land values, land use changes and subsequent trip patterns.

- A recent report from the University of Sydney, "Towards a City of Cities" (Warren Centre 2002) examined the main issues facing transport in Sydney, and set out key strategies to improve both accessibility and sustainability.

In addition to being applied in a strictly urban context, accessibility has also frequently been studied in a rural or regional context. For example:

- Cattan (1992) examined the accessibility by rail and air services to European cities based on travel times, and developed attractiveness indices based on inter-city air and rail passenger volumes. He found a linear relationship between the two in the case of rail, and a log linear relationship in the case of air.

- Nichols (1994) developed indices for measuring potential accessibility for rural towns in NSW, for both passenger and freight movement. This enabled the impact of changes to both the road network and to population distribution to be evaluated.

- Mosely (1979) examined accessibility in rural areas in the United Kingdom.

- Geurs and van Eck (2001) reviewed the use of accessibility measures and applied them to case studies of access to employment in the Netherlands, examining the impacts of a range of alternative land use scenarios on accessibility to jobs.
1.3 NEW PERSPECTIVES

Time and Activity Analysis

While most studies of accessibility focus on land use patterns and transport infrastructure, a number of writers have drawn attention to the social dimension of accessibility, by focusing on issues such as the impact of gender on travel patterns, activity patterns and the use of time. For these writers, any measure of accessibility needs to incorporate the characteristics of the person and the type of activity as well as physical dimensions such as land use patterns and transport links. It also needs to take into account wider issues of the use of time and activity patterns, and how these are constrained by various factors. For example:

- Bhat and Misra (1999) examined time use and episodic data from the Netherlands to analyse the impact of age and work-duration on discretionary activity.
- Abraham (1998) examined transport disadvantage for women and concluded that there needs to be a focus on accessibility rather than on mobility.
- Gollner and Dowling (2001) reported on preliminary findings from a Sydney study, which highlighted the role of gender and parenting roles on car usage.
- Stead, Williams and Titheridge (2000) contrasted the traditional cause and effect relationship between land use characteristics and travel patterns, with a more complex “interactive” relationship which also involves socio-economic characteristics of the population (see below):

![Figure 1.2 Cause and Effect of Urban Travel Patterns](image)

Source: Stead et al. (2000)

Virtual Access

From a quite different perspective, other writers have drawn attention to the potential of information technology and the Internet to create “virtual access”, thereby profoundly altering concepts of physical accessibility.

The information revolution and the growth of the information economy are now widely accepted as one of the key forces shaping modern societies. As Evans and Wurster
(1999, page 20) point out, this goes beyond the way in which consumers may use the technology (such as via electronic banking or shopping over the Internet) to the way in which business itself is structured:

"Information, in short, may be the end product of only a minority of businesses, but it glues together value chains, supply chains, consumer franchises, and organisations across the entire economy. And it accounts for a grossly disproportionate share of competitive advantage and therefore of profits. The advent of rich connectivity and information standards...melts the information glue that binds activities and participants together. It also allows an informational value chain to separate from the physical chain. Since the economics of information and the economics of physical things are fundamentally different, this can release tremendous economic value: value that was suppressed by their mutual compromise."

For example, a study on “The Emerging Digital Economy” (U.S. Department of Commerce, 1998) charted the rapid growth of communications technology and its use in the United States, and examined a range of case studies to illustrate how it was changing business-business and business-consumer relationships, as well as workplaces.

While Marshall McLuhan (1967) may have been premature in his prediction of the demise of cities in the information age: “the city no longer exists, except as a cultural ghost for tourists”, many writers see the new information technology as profoundly altering our cities over time. Mitchell (1999, page15), describes the process as he sees it unfolding in the following terms:

"Like their pipe- and - wire predecessors, however, digital telecommunications networks will not create entirely new urban patterns from the ground up; they will begin by morphing existing ones. Generally in the past, new urban networks have started by connecting existing nodes that had been made possible and sustained by earlier networks. (After all, what else could there be to connect?). Then, like parasites taking over their hosts, they have transformed the functioning of the systems on which they were superimposed, redistributing activities within these systems, and eventually extended them in unprecedented ways."

The most recent stock market shakeout of Internet stocks (the “Dot Bomb”) has thrown some doubt over the real significance of the Internet revolution. However its potential impact on cities and on physical accessibility remains an important issue to consider.

1.4 KEY RESEARCH QUESTIONS

Rationale

This brief introduction has highlighted the key rationale for the research:

- Accessibility is a key concept in understanding urban systems, and is increasingly central in urban and transport planning
However although it is frequently discussed and used, there has not been any agreement on simple and generally agreed ways to measure it, and it has been many years since the last comprehensive study of accessibility in Sydney in particular.

Recent developments such as the awareness of social factors in influencing travel patterns, and the growth of the Internet make it desirable to review the validity of traditional concepts of accessibility.

Focus of the Thesis

Accessibility is a wide topic, and this thesis interprets accessibility in its wider social as well as its physical and economic context. In other words, the study will consider the importance placed on accessing a range of different kinds of opportunities or activities by different groups in the community, and not simply accessibility to employment by those in the workforce. Equally, the thesis considers accessibility issues for the whole population, rather than the more specific issue of "accessible transport" for people with physical difficulties (though problems for this group will not be ignored).

It has therefore been necessary to limit the scope of the study somewhat. In particular, it focuses on:

- Activities outside the home (and not with activities inside the home, except where they can substitute for activities outside the home, such as home banking).
- Urban accessibility (rather than rural or national accessibility issues), with a particular emphasis on Sydney.
- Accessibility at a metropolitan regional scale, rather than at a very local scale. Hence the study concentrates on opportunities which draw on wider catchments (such as jobs, universities and shopping centres) rather than on highly localized catchments (such as corner stores or primary schools).
- Accessibility by the predominant modes used in urban transport (walking, car, train, bus, and ferry) though other modes (such as taxi or cycle) will also be referred to.

The table below summarises the focus of the study in terms of the location and timing of activities covered:

<table>
<thead>
<tr>
<th>Time of activity / opportunity</th>
<th>Location of activity / opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Within the home</td>
</tr>
<tr>
<td>Normal weekdays and weekends</td>
<td>Included if these can be substituted for activities outside the home</td>
</tr>
<tr>
<td>Holiday Periods</td>
<td>Outside Scope</td>
</tr>
</tbody>
</table>

Table 1.1 Focus of this Study
In particular, access to activities or opportunities outside the urban area, or access by people living outside the area to activities within the urban area, are outside the scope of the study. Similarly access to activities during major work or school holiday periods, when time pressures and activity patterns tend to be different, are not dealt with.

Research Questions

The key research questions which this thesis seeks to address are:

• How valid is the “classic” concept of accessibility in a contemporary urban context, and does it need to be modified to take account of social factors and of the concept of “virtual access”?
• What are the patterns of accessibility in Sydney, and how do these vary for different groups, locations, activities and modes?
• What are the accessibility problems facing particular individuals or groups?
• How can accessibility be improved, both overall and for those people with particular access problems? Which transport investment strategies, planning policies or other measures are likely to be the most effective in this regard?

1.5 STRUCTURE OF THE REPORT

As discussed in detail in Chapter 3, the broad approach adopted for the thesis was to proceed from a general literature review on the topic of accessibility, to the specifics via a survey to gather original data, and back to the general again by developing and applying accessibility indicators. The structure of the report closely follows this approach, and is described briefly below:

Chapter 2: Literature Review

Chapter 2 provides a review of the literature on accessibility and related topics such as travel behaviour, land use and transport interaction, time-use, virtual access and access difficulties. It discusses some of the key findings from theoretical and empirical research, and highlights uncertainties or areas of controversy, which would benefit from new research.

Chapter 3: Methodology

Chapter 3 discusses methodological issues related to the thesis. In particular:

• Section 3.1 discusses the options available for addressing the research questions identified above.
• Section 3.2 then describes how the methodology adopted for the thesis was developed. In particular, it canvasses issues of data availability, including the lack of up-to-date and relevant data on accessibility issues, and identifies the need for a
survey help fill this data gap. It also discusses the need to develop appropriate accessibility indicators for use in analysing patterns and trends in accessibility.

- Section 3.3 describes the design and conduct of the survey, including its focus, sampling approach, and relationship to other surveys.
- Section 3.4 establishes desirable properties for accessibility indicators, evaluates commonly used indicators against these criteria, and proposes the use of Equivalent Travel Time (ETT) and its derivatives as appropriate measures for analysing patterns and trends in accessibility.

Chapter 4: Generation and Analysis of Survey Data in Sydney

Chapter 4 analyses the results of the survey of accessibility in Sydney, and sets out the conclusions in areas such as:

- accessibility and travel patterns
- accessibility and housing choice
- accessibility and the use of time
- virtual accessibility
- access difficulties

Chapter 5: Accessibility Patterns for Sydney

Chapter 5 applies the accessibility indicators developed in Chapter 3 to detailed data on employment, public hospitals, retail centres, population, and universities to examine patterns of accessibility to these attractions across Sydney. These are mapped to show spatial patterns and to highlight variations between different areas and modes of travel.

Chapter 6: Applications of Accessibility

Chapter 6 examines applications of accessibility, including the impacts of a range of potential policy measures which could be taken to improve accessibility or to address access difficulties. These include urban consolidation and the compact city, changes to employment distribution and centres policies, and policies to alter the location of services such as university places.

Chapter 7: Conclusion

The report concludes in Chapter 7 by:

- reviewing the research questions and hypotheses
- summarising the main findings of the research
- identifying a range of accessibility-related issues, which would benefit from future research, and suggesting how these might be further investigated.
- Offering some final comments on the subject of accessibility and the significance of the research.
1.6 DESIGN AND CONDUCT OF THE SURVEY

The survey detailed in this thesis was designed and analysed by the author. However Surveys Australia, a commercial market research company, undertook the survey interviews and the data coding and checking.
CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

As discussed in the Introduction, accessibility is a key concept in linking transport, land-use and travel patterns. Furthermore, the growth of the Internet raises important questions on the concept of "virtual accessibility". This Chapter therefore seeks to review the literature on accessibility and related topics, and is arranged as follows:

- Section 2.2 examines different approaches to defining and measuring accessibility.
- Section 2.3 explores the links between accessibility and travel behaviour
- Section 2.4 examines relationships with land use and housing
- Section 2.5 reviews the emerging research into activity and time use analysis
- Section 2.6 discusses the implications of communications and "virtual accessibility"
- Section 2.7 provides some insights into the access difficulties facing different groups in the community
- Section 2.8 presents some relevant data relating to travel patterns and trends, housing preferences and Internet usage at home.
- Section 2.9 summarises some of the findings from the literature on accessibility, and highlights key issues to be further explored in later stages of the research.

2.2 DEFINING AND MEASURING ACCESSIBILITY

While the notion of accessibility can be readily understood to mean "how easy it is to get to things", defining and measuring accessibility has proved to be a difficult task, and a wide variety of "accessibility indicators" have been developed. As Gould (1969, page 64) noted: "accessibility... is a slippery notion...one of those common terms which everyone uses until faced with the problem of defining and measuring it."

Almost thirty years later, Niemeier (1997, page 377) highlighted another problem in operationalising the concept of accessibility: "although there is a constant outcry suggesting the need for improving mode and destination accessibility, there is really little to no information on how an individual might actually value changes in accessibility. Consequently, it is difficult to assess if the cost of improving mode or destination accessibility would outweigh the consumer's willingness or ability to pay."

The following discusses a range of accessibility measures which have been developed.

Spatial Indicators

If we are only interested in the accessibility of one location to another, the simplest measure is the cost of travel between them, sometimes called the "relative accessibility".
If we are interested in the accessibility of a given location to many other locations, then more sophisticated measures can be used, such as the "separation measure". This can be defined as a sum of terms, each of which is a function of the cost between the given location and one of the other locations of interest. Usually the function will be the inverse of the cost, or some inverse power of the cost, so that the higher the cost the lower the accessibility.

A commonly used alternative is the "cumulative opportunity index" which simply counts the number of activities or attractions which can be reached or accessed from the given location within a given distance, time or cost. This can also be referred to as a "threshold index".

Hansen (1959) introduced a more sophisticated measure of accessibility based on the "gravity index" approach, where the relevant attractions were weighted by their importance and by the square of the generalised cost of accessing that attraction, and the accessibility index calculated as the integral across the space of attractions. The general formula is of the form:

\[ A(i) = \sum_j \left( \frac{S(j)}{C(i,j)^2} \right), \]

Where:
- \( A(i) \) = Accessibility index for point (i)
- \( S(j) \) = Measure of Attractiveness of opportunity (j)
- \( C(i,j) \) = Cost of accessing location j from location i.

The Hansen accessibility index, or variants thereof, have been widely used in urban transport modelling and in other applications, and have the benefit of relative simplicity. They are also familiar in the sense that they are based on the gravity model used to predict gravitational attraction between two bodies. The general gravity index replaces the inverse square function with a more general function (which is however usually an inverse power or inverse exponential) – these models are discussed in detail by Sen and Smith (1995).

Morris, Dumble and Wigan (1979) analysed different types of accessibility, identifying some thirteen types of indicators. These were classified in several ways:

"Relative" versus "Integral"

- "Relative Accessibility" Indicators simply measure the costs or trip rates between any two points in space
- "Integral Accessibility" Indicators provide some weighted summation of the relative accessibility from a given location to all other locations, and thus provide a measure of the accessibility from that point to all other places in the area of interest.

"Process" versus "Outcome"

- "Process Accessibility" Indicators only take into account such factors as the costs of travel from a location to other locations and the relative attractiveness of those other locations.
"Outcome Accessibility" Indicators measure the actual travel undertaken between a location and one or more other locations.

"Supply" versus "Supply-Demand"

- "Supply Accessibility" Indicators measure the attractiveness of various locations in terms of the number of opportunities available (such as retail floor space at that location)
- "Supply-Demand Accessibility" Indicators take their measure of attractiveness of a given location the measure of demand at that location (such as the level of shopping trips to that location)

In addition, distinctions were drawn between measures of the accessibility via a given transportation system and the accessibility to a given transportation system – the latter is generally concerned with walking distances to public transport stops or car parking areas. All of these measures can be broadly classified as Spatial Accessibility Indicators, in that they take into account (to varying degrees) the spatial characteristics of an urban (or regional) area including:

- The distribution of activities or opportunities in that area
- The time and/or dollar costs of travel between those activities by various modes
- The attractiveness of those opportunities.

Utility-Based Indicators

Some economists and others have criticised the Hansen index as lacking a theoretical foundation, and developed alternative measures of accessibility utilising consumer behaviour and utility theory. These in effect, however, produced very similar measures of accessibility.

As noted by Geurs and Van Eck (2001), despite its theoretical advantages, the utility concept of accessibility has not been widely used in practice. However there have been some examples, such as Koenig (1980), and Sweet (1997). Another example is the study by Niemeier (1997), who examined commuting in the Puget Sound area in Washington State using utility-based indicators of accessibility. She estimated the compensating variation, or CV (the amount a person would need to be compensated by to be as well of as before a given policy change) for various scenarios. For example, low-income earners (those earning less than $35,000 pa) would need to be compensated by $1.29 per day for the loss of accessibility if it was no longer possible to go to work in the CBD. By contrast, high-income earners (those on over $35,000 pa) would value the loss of accessibility implied by such a policy at $6.33 on average, reflecting both their higher incomes and their higher propensity to use private automobiles.

Spatial-Temporal Indicators

Hagerstrand (1975) took a slightly different approach in considering issues of accessibility, focusing on the constraints on freedom of action in time-space.
Drawing on this approach, Burns (1979) developed an approach to measuring *Spatial – Temporal Indicators* of accessibility in terms of the freedom of individuals to participate in different activities.

Burns thus emphasised three inter-related components of accessibility: the spatial, the temporal and the transportation system, whereas the classical “spatial accessibility” measures ignored the temporal dimension to some degree. For example as Burns pointed out, there is little point in being able to physically access a given facility if it is closed when you get there. Hence the hours of opening of shops or banks might be more important than their actual locations in determining how easy it is for people to access their services. Within this framework, Burns focussed on how people negotiate time-space, and the extent to which they have flexibility in that space to engage in a series of activities over time.

While this approach offers insights into accessibility, it has proved difficult to operationalise, despite a body of research into time use and activity.

**Evaluation of Indicators**

Geurs and van Eck (2001) provide a slightly different typology of accessibility measures to that of Morris, et al. (1979), classifying them as:

- Activity-based measures
  - Distance measures
  - Contour Measures
  - Potential Accessibility Measures
  - Inverse Balancing Factors
  - Accessibility Measures from Time-Space geography

- Utility-based measures

They noted that, when compared with activity-based measures, utility-based measures had both advantages and disadvantages, as summarised below.

<table>
<thead>
<tr>
<th>Advantages of Utility-Based Measures</th>
<th>Disadvantages of Utility-Based Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound theoretical basis in terms of random utility theory</td>
<td>Not easily interpreted</td>
</tr>
<tr>
<td>Represents accessibility of individual rather than accessibility of location</td>
<td>Difficult to compare different utility functions, for example, by region or neighbourhood</td>
</tr>
<tr>
<td>Do not result in unrealistic outcomes when aggregating individual accessibility</td>
<td>Logsum values are difficult to interpret because logsum gives total utility associated with an alternative (e.g. destination) which includes the utility of the destination and the disutility of the travel required</td>
</tr>
</tbody>
</table>

*Source: Geurs and Van Eck (2001)*
Geurs and Van Eick conclude that (page. 68):

- "The more or less "common sense" measures of accessibility – cumulative opportunities and the basic potential accessibility measures – are used the most in practical applications of activity – based accessibility measures.
- Mathematically more complex measures (i.e. inverse balancing factor) or measures with a theoretical (i.e. utility-based measures) or behavioural underpinning (i.e. space-time measures) are much less used in practical applications, although these measures are superior from a theoretical point of view.
- Most of the activity-based accessibility measures are used to analyse accessibility to jobs and the population; there are much fewer studies analysing accessibility of other destinations (e.g. retail, public and health services). An exception is the space-time accessibility measure, which is only used for analysis of non-work destinations (e.g. shops, schools and public service)."

Summary of Accessibility Measures

The table below summarises how some of the different measures of accessibility have been defined, and the elements they incorporate.

<table>
<thead>
<tr>
<th>Class of Indicator</th>
<th>Specific Type of Indicator</th>
<th>Formulae</th>
<th>Characteristics of Transportation System</th>
<th>Attractiveness of Destination</th>
<th>Temporal Constraints on Travel</th>
<th>Characteristics of Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial (1)</td>
<td>Relative Accessibility</td>
<td>$A_{ij} = C_{ij}$</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Separation Measures</td>
<td>$A_{ij} = \text{Sum } j = s (F(C_{ij}))$</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>incorporating distance</td>
<td>Cumulative Opportunity Index</td>
<td>$A_{ij} = \text{Sum } C_{ij} &lt; C_{\text{max}} V_{(ij)}$</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Gravity-type Index</td>
<td>$A_{ij} = \text{Sum } (T_{ij} \ast F(C_{ij}))$</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Gravity type Index</td>
<td>$A_{ij} = \text{Sum } (V_{(ij)} , D_{ij}) \ast F(C_{ij})$</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Utility (2)</td>
<td>Utility</td>
<td>$V_{(k)} = f(c(k) / inc , TP_{(k)}, S_{(k)}, e_{(k)})$</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Spatial-Temporal (3)</td>
<td>Spatial Opportunity</td>
<td>$A_{ij} = \text{Max } j = R (\text{Sum}(B(g,l,T_{ij}))$</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Where:
\[ A_{ij} = \text{Accessibility of destination } j \text{ from origin } i. \]
\[ C_{ij} = \text{Cost of reaching destination } j \text{ from origin } i. \]
\[ A_i = \text{Accessibility of Location } i. \]
\[ F(C_{ij}) = \text{a function of the cost of reaching location } j \text{ from location } i. \]
\[ j \text{ in } S \text{ means all destinations } j \text{ in a set of possible destinations } S \]
\[ C_{\text{max}} = \text{Some specified maximum cost (or time)} \]
\[ T_{ij} = \text{Measure of attractiveness of opportunity } j \]
\[ D_{ij} = \text{No of trips to opportunity } j \]
\[ V(T_{ij}, D_{ij}) = \text{value of attractiveness of opportunity } j \text{ based on attractiveness of } j \text{ and on the number of trips to } j. \]
\[ A_{ig} = \text{Accessibility of location } i \text{ to person from group } g \]
\[ B(g,i,T_{ij}) = \text{benefit obtained by person in group } g \text{ in being able to access opportunity } j \text{ for a time } T_{ij} \]
\[ T_{ij} = \text{time spent at opportunity } j. \]
\[ V_k = \text{indirect utility of mode-destination choice } k \]
\[ C_k = \text{cost of travel for mode-destination choice } k \]
\[ Inc = \text{household income} \]
\[ TP_k = \text{vector of modal attributes} \]
\[ S_k = \text{vector of spatial characteristics} \]
\[ E_k = \text{unobserved random portion of utility}. \]

(1) - adapted from Morris et. al. (1979)
(2) - adapted from Niemeier (1997)
(3) - adapted from Burns (1979)

In summary, there is no single measure of accessibility, which has been universally recognised as suitable for all applications or encompassing all relevant information. However accessibility indicators generally can be of great assistance in analysing urban and spatial issues. More recent formulations have extended the spatially-based definitions to include the characteristics of individuals and the temporal constraints on their activities, though these have yet to be operationalised for use at the scale of urban areas.

The issue of accessibility indicators will be further discussed in Chapters 3 and 5.

2.3 ACCESSIBILITY AND TRAVEL BEHAVIOUR

Accessibility is linked to travel behaviour in urban theory and in urban transport models in several ways:

- The demand for travel from a residence to an attraction or activity (such as a place of work, a shopping centre or an educational facility) is usually assumed to be influenced by the accessibility of that attraction to that place of residence. Hence accessibility is assumed to influence the spatial distribution of travel.
- The mode chosen for particular trips is also usually assumed to be influenced by the relative accessibility provided by those modes. In this case, the concept of
accessibility incorporates both the access to those modes (e.g. walking distance to a public transport stop, availability of a car or availability of free parking) and the access provided by those modes (in terms of waiting times and travel times to reach a given destination).

- Somewhat more controversially, accessibility is sometimes considered to influence the total number of trips made, although more commonly standard trip rates are used, independent of the level of accessibility.

Many writers have examined this issue. The following examples illustrate some of the approaches and results.

Brunton (1997) analysed the relationship between journey to work distances and accessibility to work places using data from Melbourne. He found that there was a relationship between accessibility to work and average journey to work trip length, and also a relationship between accessibility to home-places and the journey to work trip lengths, although the latter was relatively weak. He speculated that

"this may have policy implications ... in order to reduce journey to work trip lengths it is more effective to move home-places close to workplaces than it is to move workplaces close to home-places".

Black, Cheng, Ton and Masuya (1992) examined the question of whether changes in journey-to-work trip lengths are a function of:

1) changes in the relative location of homes and workplaces (land-use effect);
2) commuters' general preference to travel longer, rather than shorter, distances relative to the location of activities (behavioural travel effect); or
3) a combination of both effects.

The study used data from Sydney covering the 1961-81 period, Sapporo, Japan between 1972 and 1983, and Shanghai in 1986. These are three very different cities in terms of urban structure and transport development. The authors utilised a journey-to-work preference function, which is a curve of the relationship between the proportion of travelers from a given origin zone who reach their workplace destination zone, given that they have passed a certain proportion of the total metropolitan jobs.

Among their findings were that:

- Preference functions vary significantly within each of the cities at any given time, generally with the peripheral zones having steeper raw preference functions (since they have a relative job deficit locally).
- In Sydney and Sapporo, where time series data existed, there was a tendency for travel behaviour to tend more towards the travel maximising pattern, though this was not universal.
- The most dramatic shifts in the direction of distance maximization occur on the periphery of cities, when essentially ex-urban communities that initially have a high degree of intra-zonal travel to free standing towns are “hooked” into a metropolitan commuting system.
Standard land-use - transport models tend to assume that preference functions are constant across an urban area and over time. This can lead to errors in estimating travel behaviour. For example, the authors estimate that the misallocation of predicted trips to destination zones ranges from about 11% for workers from the City of Sydney, to 17% for a middle distance suburb of Bankstown, and up to 43% for a peripheral area such as Gosford.

Moriarty and Beed (1988) analysed travel patterns in four Australian capital cities (Sydney, Melbourne, Adelaide and Perth), relating this to factors such as the distribution of employment. While their data is somewhat dated, a number of their findings are of interest (see figure 2.1):

- For journey to work trips, they defined the theoretical minimum work trip length by assuming the spatial distribution of all worker residences and jobs is given, but workers may switch jobs until total travel is at a minimum. Analysing the data for the four cities they found that the actual average work-trip length was roughly double the theoretical minimum, and 60-80% of the average distance of the workforce from the CBD. However actual average trip lengths appeared to rise more slowly than average distance from the CBD, indicating the effect of decentralised jobs.
- Average work-trip lengths also increased within each city with distance from the Central Business District (CBD).
- Average travel speeds are higher in the smaller cities, and congestion is lower.
- While average work-trip lengths were longer in Sydney in particular than in other cities, total per capita car-km travelled was less than in the smaller capitals. The authors concluded that this was due to higher trip rates for non-work trips in the smaller capitals than in the larger capitals. This in turn was due to the greater convenience of car travel in the smaller cities, which allows more travel for the same outlay of time and money.

This suggests that accessibility (which is generally higher in inner suburbs than outer suburbs) affects travel behaviour in terms of trip lengths, mode and trip frequency. The overall impact is that people living in more accessible inner suburbs need to travel less in total, and particularly by car, than people in less accessible locations. The slower car travel speeds, more difficult parking conditions and better public transport accessibility in those areas also tends to lead to a lower car mode share of travel in the inner suburbs.

This is borne out by other research. For example Glazebrook (2002 a) found that the average energy consumption per capita by both car and public transport in Sydney was inversely related to the level of their public transport accessibility (Figure 2.2). Buxton (2000, p63) found in a study of the Victorian Greenhouse Neighbourhood Project that "the combination of higher residential densities, mixed use neighbourhoods and public transport can lead to large reductions in transport energy consumption, travel times and distances, and infrastructure costs".
Figure 2.1  Journey to Work in Four Australian Cities, 1981

Source: Moriarty and Beed, 1988

Figure 2.2  Energy Consumption by Public Transport Accessibility

Source: Glazebrook (2002 a).
The link between accessibility and travel has partly underlain the debate about urban compactness versus decentralisation (see for example Williams, Burton and Jenks, 2000). Proponents of the former (for example Newman and Kenworthy, 1989, and Ewing, 1997) argue that compact urban forms and higher densities lead not only to shorter trips but to higher public transport use, and that the combination of these factors lead to significantly lower energy consumption for travel, as well as other benefits. Proponents of the latter (for example Stimson, 2002 and Pund, 2001) argue that processes of decentralisation linked with car use are either inevitable, or are desirable in that they reduce congestion and provide economic benefits in terms of lower land costs. Dieleman, Dijst and Spit (1999) reviewed 30 years of experience with compact development in the Netherlands, finding that the Dutch experience confirms the legitimacy of the arguments in favour of compact development for minimising travel, especially by car. However they sounded a caution in that current conditions of urbanisation in the Netherlands are changing, and that the specific conditions under which compact development was pursued may not pertain in future.

Other research also highlights the link between accessibility and travel behaviour. For example Gitlesen and Thorsen (2000) analysed the impact of changes to road network connectivity (and hence accessibility) on travel patterns in western Norway. Their study used a modified form of the competing destinations model to predict how commuting flows would alter as a result of the introduction of new bridges and roads, enabling the substitution of previous ferry connections. The authors concluded that the greater choices in destinations offered by the increased accessibility would lead to increased commuting volumes and travel distances, with in some cases increased travel times despite the higher speeds afforded by the road links. They also noted that the there were difficulties in interpreting the results of an aggregate model because it included two choice models, one related to the job search strategy and one to the probability of receiving a job offer.

Serra and Colome (2001) investigated optimal location choice for outlets (such as shopping centres) based on various alternative formulations of consumer choice. They found that, ideally, prior analysis of consumer choice behaviour is needed so that one can decide how best to model the impact of distance on choice of outlet. However if this cannot be made or is too costly, the traditional MAXCAP model (which simply allocates customers to the nearest facility based on distance) is the next best procedure. This indicates that when examining overall patterns of travel to various competing attractions, the relative accessibility of the various attractions to the population is more important than being too precise as to the impedance functions used in modelling travel behaviour.

Thorsen and Gitlesen (2002) used a simulation approach to examine how changes in transport infrastructure lead to changes in subsequent land use patterns and longer-term changes in travel behaviour. They also pointed out that the common practice in traffic studies of ignoring such effects can lead to underestimation of "induced" traffic. Lakshmanan, Nijkamp, Rietveld and Verhoef (2001) analysed the theoretical links between transport and land use, showing how these are one of the causes of externalities involved in transport, a reason why economic analysis of the benefits and costs of transport is complex.
Finally it might be noted that the impact of accessibility on travel behaviour at a larger scale has also been examined. For example, Wardman and Tyler (2000) analysed the impact of accessibility to the rail network, on the demand for inter-urban travel in the United Kingdom. They found that accessibility to rail stations (as measured by the generalised cost of access) was a relatively minor factor in determining the mode share for rail compared with other variables such as the overall journey length, previous experience in using rail, and the rail fare.

2.4 ACCESSIBILITY, LAND USE AND HOUSING

Land Use and Urban Development

Accessibility is intimately connected to land use, land values and urban development, as many studies have attested. Furthermore, this relationship is a two-way street. In particular, just as shifts in land use patterns alter accessibility patterns, so shifts in accessibility through investment in transport systems impact on land values and subsequent land use patterns. Although this two-way interaction has been known for a long time - for example Black and Rimmer (1987) discuss it in relation to the decision to build the Sydney Harbour Tunnel - pinning it down has proved more elusive. As Garrett and Wachs (1996) note (p211):

"Unfortunately, the state of the practice with respect to the mathematical modeling of urban form is probably even less advanced than the state of the practice of transportation modeling. As complex as models of travel and air quality need to be to realistically represent those policy variables and forecast them with reasonable accuracy, urban development models must be even more complex. They are based on economic and social principles and must recognise unique physical topography of urban areas, their patterns of in-and out-migration and of racial, ethnic and class differences in employment and residential location, and much more. Many scholars who have reviewed the literature of urban development modeling and forecasting have concluded rather pessimistically that the power of these models falls far short of what policy makers appear to demand of them".

While most early models of cities assumed simple, mono-centric cities, with all the jobs located in the Central Business District, it has been clear for some time that this is an over-simplification of the real world. In particular, the growth of "edge cities" and suburban employment clusters on the one hand, and the re-emergence of inner city living on the other, highlights the complexities of land uses and resultant accessibility patterns.

The following discussion briefly illustrates some of the research into those patterns and relationships:

Miyamoto, Kuwata, Noami and Yokozawa (1992) developed a rent-bidding simulation model to evaluate large-scale transport projects such as motorways or new rail lines. In their approach, various potential users of land (including residential, business, central
commercial, neighbourhood commercial, industrial and agricultural) bid competitively for sites, based on the utility values which those sites have for them. These utilities in turn depend on the locational and other attributes of the sites. They developed a mathematical model, RURBAN, for exploring these relationships, and tested it using data for Sapporo, Japan. The results showed correlations between actual and predicted land use ranging from .82 (industrial) and .81 (residential) to .51 (neighbourhood commercial), providing strong support for the postulated relationships and for the importance of accessibility in influencing land values and land uses.

O’Connor and Blakely (1989) examined the relationships between CBD’s and suburban areas in San Francisco and Melbourne, challenging the conventional wisdom that the two are in competition for jobs and growth. Instead they deduced that (page 99):

“a new pattern is emerging where the vitality of the central area is related to the economic activity in the whole metropolitan economy”.

They noted that the suburbs are now recognised to be both socially and economically diverse, with complex internal transport patterns and networks of sub-centres. Much of the growth of jobs in the suburbs in the 1980’s and 1990’s in cities around the world has come from the growth in services, the relocation of remaining manufacturing and wholesaling jobs which were earlier concentrated near the CBD’s, and the growth in secondary office centres termed “edge cities”. These shifts in turn have been partly the result of changes to accessibility patterns caused by the growth of car ownership, and investment in freeways and motorways, including ring-roads such as London’s M25 or Boston’s Route 128. These have had the effect of lessening the relative accessibility advantages previously enjoyed by CBD areas at the hub of radial public transport networks.

More recent analyses such as Freestone and Murphy (1998) have carried the analysis further. For example they identify many different types of suburban sub-centres, including “Fringe CBD”, “Second CBD”, “Suburban Town Centre”, “Office Corridor”, “Business Zones”, “Regional Business Parks”, “Office Parks”, and “Technoburbs”.

Freestone and Murphy also highlighted the differences between urban development patterns in Sydney and those typified by most US cities. For example, Sydney’s CBD remains relatively more important than most US CBD’s, in terms of the percentage of regional employment. Furthermore most of the other large sub-centres (for example North Sydney, Chatswood, Parramatta, Liverpool, Blacktown and Bankstown) are located on major rail lines and have extensive bus services, rather than being located at the junction of freeway systems. Again, these differences reflect the relatively greater role of public transport accessibility in Sydney than is the case for most US cities (with a few exceptions such as New York). Simons and Black (1992) examined the relationships between transport, urban form and accessibility, and developed three potential future scenarios for Australian cities based on these considerations.

Haywood (1996) analysed the decentralisation of office location in Manchester following the deregulatory policies adopted in the 1980’s, noting that this had been associated with rapid growth in car-based traffic and declines in public transport
patronage, and concluded that a reversion to stronger planning controls would be needed to improve transport - land use integration.

Landis, Subharjit, William and Ming (1995) and Landis and Cervero (1999) examined the impact of changing accessibility arising from the construction of the Bay Area Rapid Transit system (BART) on land prices and land development. The 1999 study findings included that:

- The construction of BART was associated with major growth in office development in downtown San Francisco, but had not (by 1990) had much effect on stimulating office development in the East Bay area (Alameda and Contra Costas Counties). The reason for this was found to be the critical role played by local planning and development policies, such as site clearance and land assembly, and downtown-oriented commercial zoning in the case of the City of San Francisco, which reinforced the accessibility of BART.
- BART also had only a minor and uneven impact on land use changes in the Alameda and Contra Costa Counties, in marked contrast with the impact of freeway interchanges.
- There was however a trend for housing prices to reflect positively the proximity to BART stations, while proximity to freeway interchanges was reflected negatively in housing prices. Office rents however did not show such a pattern.

The authors concluded by noting (page 14) that:

"BART's major achievement has been to link downtown San Francisco with the growing suburbs of Contra Costa County. This has allowed San Francisco to maintain its pre-eminence as the business and financial centre of the Bay Area, even as regional auto use and traffic congestion have increased many times over. On a more modest scale, BART has helped spark new commercial and residential developments around several suburban stations, most notably Walnut Creek, Pleasant Hill, Concord and Fremont.

There have also been notable failures. So far, BART has not triggered hoped-for levels of re-investment in downtown Berkeley, Oakland or Richmond...

There are many reasons why BART's land use and development effects have to date been so modest. BART is essentially a commuter railroad, and the fact that most suburban BART stations are surrounded by parking lots or in freeway medians has made nearby development difficult. In Berkeley, El Cerrito, and parts of San Francisco, neighbourhood groups have long opposed more dense development around BART. Site assembly and financing difficulties combined with a lack of commercial demand have stifled station area development along the Fremont line... In short, the accessibility benefits from BART as capitalized into station-area land values have not been sufficient to overcome either weak local real-estate markets or entrenched opposition to development."

Van Ham, Hooimeijer and Mulder (2001) examined access to job opportunities in the Randstadt region of the Netherlands for both lower-income and higher-income workers. They noted the fact that deconcentration of employment is the driving force behind the
rise of complex urban forms of the polycentric city and the polynucleated metropolis. However their findings contradicted some assumptions made by some writers as to the benefits of this:

"It is often assumed that the deconcentration process improves job access for average and highly skilled workers, allowing them to move to peripheral residential locations and triggering a new round of urban sprawl. It is also hypothesized that access to suitable job opportunities is withheld from low-skilled workers living in inner city neighbourhoods as a result of the deconcentration of low-skilled employment beyond their commuting tolerance.

(However analysis shows that) major employment centres are clearly superior for households with highly skilled workers, making urban sprawl towards residential locations outside the Randstadt unlikely. It is also shown that for poorly skilled workers with limited commuting tolerance the central city is still the best place to live".

Accessibility also relates to land use patterns at a wider scale. For example Cattan (1992) examined the attractiveness of European metropolises in relation to their accessibility to the European air and rail networks, finding a significant linear relationship in the case of rail accessibility, and a non-linear relationship in the case of air accessibility.

Accessibility and Housing Choice

"Cities are mosaics of fragments and division. The forces driving residential choice are mainly economic, although cultural and social issues matter too, particularly for minorities. Localities which are accessible to jobs, services or good amenities are obviously more sought after, so in a bidding war the rich are the winners". (Murphy and Watson 1997, p 95.)

Housing is a key component of land use and the relationship between housing, population density and accessibility has also been extensively studied. The following examples illustrate the approaches adopted, ranging from theoretical models based on long-term historical data for a given city, to surveys of future housing preferences, to cross-sectional studies of different cities.

For example, Talen (2001) evaluated the likelihood that affluent suburban residents in the U.S. would endorse the ideas being promulgated by advocates of traditional urbanism. This term refers to urban developments with higher densities and greater transit and pedestrian-based accessibility than typical car-based suburbs. The study was based on a survey of mainly traditional nuclear families with children in a suburb some 25 miles from Dallas, Texas. The main question addressed in the study was whether affluent suburbanites would consider living in a more traditional urban environment, with its emphasis on greater access to amenities, more public space, mixed land uses, and lower automobile dependency. Among the author's conclusions were that (page 14):
"While suburban residents have a high level of satisfaction with suburban development in terms of community sentiment and are unlikely to agree with certain social and environmental liabilities that have been proposed, issues like travel time are more discernible. Since this acceptance (of new urbanism) pivots on a resident's negative experiences with suburban development, it could become stronger if suburban accessibility patterns worsen. Increasing urbanisation of suburban areas based on the same principles of separate land uses and automobile dependence are likely to increase resident discontent."

In other words, accessibility plays a key role in determining housing preferences — while cars continue to provide reasonable travel times and costs, low density suburban development is likely to remain popular, at least with many affluent Americans. However worsening traffic congestion or a steep rise in petrol prices might cause some residents at least to consider alternative housing options.

Braby (1989) examined the determinants of urban density in Australian cities. Noting that in general those urban centres with higher populations tended to have higher population densities, he explored the paradox that population density has been falling in most of our capital cities despite the fact that their populations have been rising.

### Table 2.3 Population Density for Australian Capital Cities, 1966 – 1986

<table>
<thead>
<tr>
<th>Census Year</th>
<th>Sydney</th>
<th>Melbourne</th>
<th>Adelaide</th>
<th>Brisbane</th>
<th>Perth</th>
<th>Weighted Average</th>
<th>Average Population Size (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>1891</td>
<td>1850</td>
<td>1443</td>
<td>1178</td>
<td>1308</td>
<td>1704</td>
<td>1300</td>
</tr>
<tr>
<td>1971</td>
<td>1916</td>
<td>1809</td>
<td>1461</td>
<td>1170</td>
<td>1215</td>
<td>1688</td>
<td>1478</td>
</tr>
<tr>
<td>1976</td>
<td>1894</td>
<td>1675</td>
<td>1429</td>
<td>1103</td>
<td>1092</td>
<td>1606</td>
<td>1545</td>
</tr>
<tr>
<td>1981</td>
<td>1919</td>
<td>1595</td>
<td>1352</td>
<td>1067</td>
<td>1019</td>
<td>1565</td>
<td>1617</td>
</tr>
<tr>
<td>1986</td>
<td>1892</td>
<td>1604</td>
<td>1381</td>
<td>1097</td>
<td>1069</td>
<td>1563</td>
<td>1697</td>
</tr>
<tr>
<td>% Change</td>
<td>+0.1%</td>
<td>-13.3%</td>
<td>-4.3%</td>
<td>-6.9%</td>
<td>-18.3%</td>
<td>-8.3%</td>
<td>+30.5%</td>
</tr>
</tbody>
</table>

Source: Braby (1989)

(Note: interestingly, as shown above, Sydney was the exception here, with overall density remaining approximately constant over the period. Note also that density appeared to level out after 1981).

Using multiple regression and small area analysis, he analysed the potential factors, which could be related to population densities, including housing occupancy rates, household incomes, and motor vehicle ownership. He also extended the analysis to 32 cities internationally using data from Newman and Kenworthy (1989 b).

The international results were consistent with the Australian studies in that motor vehicle ownership and per capita income both correlated negatively and significantly...
with density, and population size was positively correlated. Occupancy rate however produced mixed results. This suggests that the impact on overall population densities from declining household size is the combined result of a decrease (assuming housing stock remains unchanged) and an increase (if declining household size is associated with the development of higher density apartments). There was also a significant “country” effect - with countries such as the USA and Australia having urban population densities well below those in European cities even when the effects of city size, income and car ownership are removed.

Braby’s study highlighted systematic differences in population densities over time in a given city, and between different cities. Batty and Kim (1992) focused on the differences in density within a given city, highlighting the well-known tendency for urban density to decline with distance from the city centre (i.e. with declining accessibility). However they focused on what might be perceived as a rather esoteric topic - the exact form of the relationship between distance from the city centre and density. In particular, they re-examined the commonly assumed negative exponential relationship and argue instead for a negative power function. This meets the requirements for density and the flow of economic activity across space to be fundamentally constrained and thus determined by the geometric properties of their physical systems. From a theoretical standpoint, they argue that (page 1055):

- “Although the negative exponential emerges “naturally” from entropy maximising, this is due to the constraint on total travel distance adopted. There is in fact evidence to suggest that distance perception is logarithmic, this being the basis of the Weber-Fechner law in psychology. If the logarithmic constraint on travel distance is used, then it is easy to show that the inverse power function is the appropriate derivation using entropy – maximising”.

- Negative exponential functions have been popular because the mathematics involved is considered more tractable; however this only applies if the density function has no boundary – i.e. the city has no edge. If boundary conditions apply, then the negative power function is in fact easier to deal with.

- The negative power function, unlike the negative exponential, is invariant to a change in scale, and therefore exhibits “fractal geometry” or the property of self-recurrence. This is consistent with the notion of cities as being composed of self-similar phenomena such as networks and centres which repeat themselves on many levels.”

A practical application of the theory to density data for Seoul, Korea, found a close fit between the theoretical variation in density and the actual variation, with the key parameter of fractal dimension being estimated at between 1.5 and 1.8. This also fits with the theoretically expected value of 1.7. Their overall conclusion (page 1067) is fascinating as it hints that there may be universal urban processes at work, which govern the way in which cities develop:

“If we can make progress here, it may be possible to begin to fashion a theory of city size, shape and form which enables us to classify cities in terms of their morphology and to consider its implications for processes of urban form and function.”
This concept of "organic" cities, or at least cities which evolve over time in a manner similar to organisms, has been taken further by writers such as Allen (1994), Portugali (1997) and Rooney (1998). For example, Potugali (p353) notes that:

"Self-organization, that is to say, the phenomena by which a system self-organizes its internal structure independent of external causes, is a fundamental property of open and complex systems. Such systems also exhibit phenomena of non-linearity, instability, fractal structures and chaos – phenomena which are intimately related to the general sensation of life and urbanism at the end of the 20th century."

He goes on to apply insights and simulation techniques from chaos theory to examine various types of cities, including dissipative, synergistic, chaotic, fractal, cellular automata, sandpile and other variants.

In this new paradigm, land use and transport systems are always evolving, and are never really in a "final" state. Consequently, accessibility patterns are also constantly changing and evolving. Furthermore the process of change is linked to the way in which the city (and its inhabitants and organisations) adapt to changes and learn new behavioural patterns over time in response to the ever changing environment. Rooney (1998) gave the example of "travel blending" in Adelaide as a way in which travel behaviour and car use changed over time through an initial input of information, which triggered a complex set of behavioral responses, including car-sharing, organizing trips into "chains", blending modes, and blending activities. Ward, Stimson and Murray (2001) illustrate how accessibility to roads and services can be used in a cellular-automata model of land use changes at a local scale.

Consideration of these aspects leads naturally onto the next topic, the role of accessibility in relation to how people utilise their time to undertake activities.

### 2.5 ACCESSIBILITY, ACTIVITIES AND THE USE OF TIME

As McPherson (1997, page 7) notes: "the study of transport and travel behaviour is the study of people and the activities they do or not do. Let's not forget participation in activities is the reason why people travel".

Recognition of this has led to a growing interest in how people use their time to undertake particular activities. When these activities are located at different places, this gives rise to travel and to issues of accessibility. Thus accessibility is intimately linked to the emerging field of time use and activity modelling.

For example, Wachs (1996) outlines the US Department of Transportation's efforts to undertake a Travel Model Improvement Program, while Spear (1996) reviews four responses to the program, noting that three of them proposed basing travel behaviour on an analysis of underlying activity needs.

Before reviewing some of the literature in this field, is it worthwhile to step back and ask the question "what is meaningful activity?", as McPerson did. She illustrated the
difficulty in answering this question by showing how attitudes to work have changed over the centuries, and are to some extent culturally determined. As she noted (page 4):

"Society is constantly evolving both in terms of activities people participate in and the meanings attached to these activities. Work, for example, is undeniably significant to this society and the way it is organised. But it is more than earning a living, it is about social meaning: status, esteem, acceptance, interaction. Largely it is viewed positively, more often it is accepted without thinking about it. However in ancient Greece (where any novice looks for inspiration) life was viewed very differently. Work was regarded negatively and was the domain of slaves and lower classes. Aristotle believed for those who were more luckily placed in society, the purpose of life was the pursuit of virtue. The goal of virtue was to be acquired through leisure, which was defined as the freedom from the necessity of being occupied".

This led McPherson to conclude that meaningful activities are those activities, which have meaning for the individual. Since travel is generated by people’s desire to undertake different activities in different locations, then travel needs to be analysed in the context of individual people’s desires and values. Similar comments apply to the issue of accessibility. Whilst being close to shopping or job opportunities may be important to many people, it may be largely irrelevant to others, for whom health facilities or the beach may be the key facilities they seek.

Thus the analysis of accessibility needs to take account where possible of the emerging research field of how different people use time and undertake activities. Examples of this research are given below.

Bhat and Koppelman (1999) reviewed developments in the field. Comparing the time-use activity-based approach to earlier “trip-based” approaches, they note that (page 121):

"In the trip-based approach, time is reduced to being simply a “cost” of making a trip... the central basis of the activity-based approach is that individual’s activity – travel patterns are a result of their time decisions. Individuals have 24 hours in a day (or multiples of 24 hours over longer periods of time) and decide how to use that time among activities including travel (and with whom) subject to their schedule, socio-demographic, personal and other contextual constraints."

They conclude that while there has been significant research into the use of time, there has been much less into activity episode analysis, and that this deficiency needs to be remedied.

Turner and Niemeier (1997) analysed why travel to work patterns by women tend to be typically shorter than for men, linking this to child care and household responsibilities. Garling, Gillholm and Garling (1998) argued that successfully forecasting of travel behaviour relies on a distinction between planned, habitual and impulsive behaviour, as defined below.
Table 2.4 Planned, Impulsive and Habitual Behaviour

<table>
<thead>
<tr>
<th>Degree of Intent</th>
<th>Degree of Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little or No Planning</td>
</tr>
<tr>
<td>No Intention Formed</td>
<td>Habitual Behaviour</td>
</tr>
<tr>
<td>Intention Formed</td>
<td>Impulsive Behaviour</td>
</tr>
</tbody>
</table>

Source: Garling, Gillholm and Garling (1998)

Thus they assumed that work trips would more often be habitual than shopping or leisure trips, shopping trips more often impulsive than work or leisure trips, and leisure trips more often planned than work or shopping trips. Given that predicting impulsive behaviour is difficult, it is likely that shopping trips would be more under-predicted than other types of trips. This was borne out by experimental studies in Umea and Gothenberg, Sweden, on attempts to reduce car usage. The results included that:

- People tend to underestimate all types of trips, but the underestimation is much higher for shopping than for other trip purposes.
- Asking people to consider in advance how to reduce car trips appeared to have an impact on subsequent actual behaviour.
- Providing better information on public transport, including personalised information on options to use public transport for work trips did not appear to produce any significant reduction in car trips.

They also raised the distinction between attitude, intention and behaviour - noting that Krauss (1995) found a relatively low correlation of .38 between attitude and behaviour, but that the relationship between attitude and behaviour is higher if predicted from intention.

Garling, Gillholm and Montgomery (1999) examined the issue of over-commitment – when people have committed themselves to perform too many activities in a limited period of time. They hypothesized that people in that situation adjust by a combination of short and long-term planning to eliminate or defer activities in response to anticipated time pressure. Using data on activity patterns from 28 undergraduates at Gothenberg University, Sweden, they developed a simulation model to analyse behavioural responses. While the data are limited, the research highlighted some key issues. For example:

- Compressing, sequencing and eliminating activities in short term planning can reduce time pressures. Longer term planning to avoid time pressures can include declining commitments, such as quitting a part time job. All of these can have impacts on travel patterns and travel choices, ranging from what mode to use for a particular trip to decisions on car ownership.
- The choice of which activities to eliminate depends on costs or dis-utilities, which in turn depends on such factors as personal motives, physiological needs, institutional requirements and social obligations.
The results indicated, somewhat surprisingly, that anticipated time pressures appear to be quite frequent, indicating that even scheduling of routine activities might be quite frequent. Thus almost every day may require some degree of planning; impacting on travel patterns since on many days the sequence of activities can vary.

Levinson (1999) examined relationships between space, money, life-stage and the allocation of time, using data from the 1990 Nationwide Personal Transportation Study in the United States. As the author noted (page 141):

"travel and activity are two sides of the same coin, activities must be pursued in space and over time, and space must be traversed in time to engage in activities. Furthermore, how time is spent depends on how money is earned – the decision to work profoundly alters daily schedules for two main reasons: less available time and more available money”.

In this context, Levinson posited that individuals will travel farther for non-home activities at which they spend more time. The figure below shows average activity and travel duration for different activities. The data analysis suggested that although travel times and activity duration are positively associated, other factors including activity frequency and the spatial distribution of opportunities also play a role.

**Figure 2.3 Activity Duration and Travel Times**

![Activity Duration and Travel Times](image)

*Source: Levinson (1999)*

Other findings included that (page 168):

"the time per activity showed only relatively small variations explainable by economic, demographic, spatial or temporal factors. Travel and work were positively associated with income. However individuals with more money don't spend particularly more time
out of the home purchasing services that with less money they would perform at home. This suggests that the primary trade-off between money and time is located in the decision to work. Men and women, and workers and non-workers had markedly different behaviours, as has been found in previous research.”

Levinson also examined whether the rises in travel experienced in the US in recent decades are the result of suburbanization, rising personal incomes, or the increase in female labourforce participation. He concluded that (page 168):

“the rise in travel over the past few decades can largely be attributed to the discretionary time loss due to changes in female labourforce participation rather than the concomitant rise in low-density living, sunbelt migration, or per-capita income.”

Finally, it is worth noting that there has also been some interesting research into how much time people spend when at work. There has been a general trend to increased average hours of work in the last decade, at the same time as part-time work has increased. Sheehan (1998) explains this in terms of the “core – periphery” model. This holds that “some employees are central to the firm’s operations and work exceptionally long hours, while many others have a more marginal attachment, and work only a small number of hours per week” (Sheehan, 1998, p322, quoted in Healy, 2000, p38).

Healy (2000), using unpublished data from the ABS Labour Force Survey, found a marked trend away from “standard” working hours (35-40 hours per week) and towards both shorter hours and longer hours, particularly the latter (see table 2.5 below).

Although this is evident for managerial and professional workers, it is also true across the occupational spectrum, and also for males, and for both married and single women. As Healy pointed out, the data thus provides only weak evidence for the “core – periphery” model, which assumes that only workers in the "core" jobs are experiencing the longer hours of work.

This has some interesting implications for accessibility. As discussed in more detail in Section 6.2, the trend to gentrification of the inner suburbs means that higher-income individuals and households are increasingly occupying the most accessible locations in cities like Sydney.

Given the long hours worked by managerial and professional workers, and the concentration of many of these jobs in the CBD, this is understandable. However many other lower-income workers, who are increasingly located in the outer suburbs and face long commutes, are also working longer hours. Consequently there is considerable time pressure on many of these individuals.
Table 2.5 Percent of those working longer hours in Australia by Occupation

<table>
<thead>
<tr>
<th>Occupation and Gender / Marital Status</th>
<th>% of Occupational Category working over 45 hours per week</th>
<th>Increase 1986/7 to 1995/6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1986/87</td>
<td>1995/6</td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management / Admin</td>
<td>64.6%</td>
<td>67.4%</td>
</tr>
<tr>
<td>Professional</td>
<td>36.0%</td>
<td>44.3%</td>
</tr>
<tr>
<td>Para Professional</td>
<td>22.4%</td>
<td>32.0%</td>
</tr>
<tr>
<td>Tradespersons</td>
<td>25.9%</td>
<td>34.1%</td>
</tr>
<tr>
<td>Clerks</td>
<td>14.8%</td>
<td>23.5%</td>
</tr>
<tr>
<td>Personal Service</td>
<td>33.1%</td>
<td>35.3%</td>
</tr>
<tr>
<td>Plant &amp; Machine Operators</td>
<td>31.4%</td>
<td>40.2%</td>
</tr>
<tr>
<td>Manual Labourers &amp; Related</td>
<td>19.0%</td>
<td>21.9%</td>
</tr>
<tr>
<td>Married Women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management / Admin</td>
<td>36.2%</td>
<td>39.5%</td>
</tr>
<tr>
<td>Professional</td>
<td>16.2%</td>
<td>24.3%</td>
</tr>
<tr>
<td>Para Professional</td>
<td>6.5%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Tradespersons</td>
<td>15.5%</td>
<td>21.0%</td>
</tr>
<tr>
<td>Clerks</td>
<td>4.5%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Personal Service</td>
<td>10.7%</td>
<td>13.0%</td>
</tr>
<tr>
<td>Plant &amp; Machine Operators</td>
<td>6.2%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Manual Labourers &amp; Related</td>
<td>4.4%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Single Women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management / Admin</td>
<td>40.8%</td>
<td>52.4%</td>
</tr>
<tr>
<td>Professional</td>
<td>21.0%</td>
<td>30.3%</td>
</tr>
<tr>
<td>Para Professional</td>
<td>12.7%</td>
<td>14.8%</td>
</tr>
<tr>
<td>Tradespersons</td>
<td>17.7%</td>
<td>19.1%</td>
</tr>
<tr>
<td>Clerks</td>
<td>5.7%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Personal Service</td>
<td>6.3%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Plant &amp; Machine Operators</td>
<td>11.0%</td>
<td>15.4%</td>
</tr>
<tr>
<td>Manual Labourers &amp; Related</td>
<td>6.9%</td>
<td>6.7%</td>
</tr>
</tbody>
</table>

Source: Healy (2000)

2.6 COMMUNICATIONS AND "VIRTUAL" ACCESSIBILITY

The relationships between communications and transportation have been discussed in the transportation literature for at least 30 years (see for example Jones, 1973 and Kahn, 1976. Mokhtarian, 1990 provides a review of some of the literature to the late 1980's and a conceptual framework).

However the rapid growth in the power, access to and usage of computers and communications in the last decade and a half has been profound. In particular, computers have moved from esoteric machines operated by banks and other large-scale organisations to commonly available tools used at work or home, while the growth of the Internet in the last decade has been truly phenomenal.

These trends have led some writers to proclaim that "virtual reality" will essentially "dissolve" physical space, creating a "new world" where people will travel
electronically to access work, shopping, entertainment and social contacts. If these forecasts prove correct, then the impact of "virtual accessibility" will indeed be dramatic. While it is still too early to be definitive, it is worth reviewing some of the literature and research in this area to gain some insights into what is a rapidly evolving story.

The Technology Optimists

Marshall McLuhan (1967) was one of the first writers to draw attention to the potential of developments in communications technology to impact on cities, declaring: "The city no longer exists, except as a cultural ghost for tourists."

Following the likes of McLuhan, many writers forecast massive change to economies, cities and urban life as a result of the growth of telecommunications and its applications, including applications to transport. For example:

- Parker (1976) argued that the information age removes the barriers on economic growth, even if the economy reaches steady state with respect to consumption of materials and energy.
- Martin (1981) argued that the growth of a telecommunications society would relieve some of the population pressures on the cities, reducing pollution, raising the quality of life, and lessening the drudgery of commuting.
- Toffler (1981) argued that the electronic cottage could be the basis of a new form of decentralised home life in which the potential of tele-based work and services means that home and work can be separated by long distances. This would lead to new forms of decentralised urban environments in which functions can be separated by large distances, with the consequent dispersal of urban concentrations and the substitution of telecommunications for physical movements.
- Schladover (1993) highlighted the potential role of ITS - Intelligent Transport Systems which utilise developments in communications and computing - to reduce the contribution of transportation to global warming and to ameliorate some of the congestion and other problems associated with urban transport, particularly by cars.
- More recently, Johnston (1997) argues that the communications revolution is leading to compression of time-space, and a relative reduction of the importance of local, national and international links but a growth of transnational and global links. In his view, the concepts of fixed spatial structures and the constraints provided by distance and accessibility are becoming less relevant, and subordinate to connectiveness. Levy (1997) argues for a radical re-making of the world based on a view of collective intelligence and the development of cyberspace.

The Skeptics

However there have also been many writers who have been skeptical of extent to which telecommunications and the information age would change fundamental life styles and in particular, reduce the need for face-face communication and the role of cities. This skepticism stems from several sources:
• Human behaviour – people will continue to want to congregate and interact at a personal level, and the attractions of cities for face-face communication will remain even after the information revolution.

• The global city phenomenon – the rise of telecommunications will be accompanied by a rise in high-skilled information jobs. This will reinforce, rather than reduce, the role of key “global cities” such as New York, London, Tokyo, Paris or Sydney.

• Complexity of impacts – telecommunications technologies will have a range of impacts on both society and economies, some of which will stimulate the need for face-face communication, travel, and cities rather than substituting for them.

Evidence gathered from many studies during the 1990’s gives some weight to the skeptics’ views. For example:

• Though there has been some growth in telecommuting, the number of people working from home has not exploded as predicted by some early commentators. Analysts have pointed to a range of factors which may have limited the extent of telecommuting to date, including psychological needs (eg the need for face-face contact), problems of separating work life from home life, difficulties in supervision etc. Bagley and Mokhtarian (1997) examined the potential for centre-based telecommuting, which has been proposed as one way of addressing some of these factors. However their study of the preferences of some 600 employees in San Diego found that although there was a significant interest in telecommuting, the strong preference was for telecommuting from home rather than from a centre. McNamara and Smith (1997) found that there was a reluctance of older workers to work from home, and, perhaps surprisingly, that there was a preference for working at home by those living closest to work.

• Gould and Golob (1997) explored the potential future growth of electronic shopping in the United States, using travel and activity survey data from nearly 7000 residents in Portland, Oregon, in 1994. The data demonstrated significant differences in time spent shopping (and travelling to shop) by gender, age and work location. Specifically females spent more time shopping than males, people in the 60-75 age group spent more time shopping than other age groups, and people working from home spent more time shopping than those working away from home. The authors concluded that while electronic shopping may find a niche role, particularly for working women who are time pressured, people with more free time will channel some of it to in-store shopping. They hypothesized that as people gain free time, shopping may be viewed as less of a chore and more as a form of recreation.

• Graham and Marvin (1996) and Marvin (1997) challenged the view that telecommunications will simply substitute for travel, leading to the de-materialization of the contemporary city, and point to a number of effects of telecommunications:
  ➢ Substitution Effects – where electronic flows and virtual electronic spaces replace physical flows and actual places.
  ➢ Generation effects – where telecommunications stimulate additional physical movement and development.
  ➢ Enhancement effects – where telematics increases the attractiveness and efficiency of existing infrastructure networks.
Indeed, as Graham and Marvin (1996, p276) note:

"while telecommunications have the potential to substitute and monitor physical flows, they have a powerful role in generating new physical problems through dispersal of land uses and the generation and enhancement of travel”.

- Ellen and Hempstead (2002) examined the potential of telecommuting to stimulate rural, rather than urban living, and to lead to changes in more decentralised housing choices. They found quite the reverse, at least for white-collar workers, with current telecommuters in the US less likely to live in rural areas and more likely to live in larger cities, based on data from the 1997 population study.
- Grubesic and Murray (2002) examined the availability of access to broadband services in the United States, and found that access is far from uniform, and may remain so given the costs involved in relation to the returns. Consequently the idea that such technology will be universally available, thus "dissolving space" is not grounded in a thorough understanding of the network costs of such systems and how this leads to uneven supply quality, just as in transportation networks.

Latest Views

The latest literature now seems to be leaning to a more complex and complete view of the likely impact of the telematics and information “revolution”, in which the impacts on transport and on cities vary according to a range of other factors. For example:

- Hall (1997) argued that a new kind of city is emerging – one which is “globalized (connected to other cities in global networks), “tertiarized or quaternarized” (dependent principally on advanced services), “informationalized” (using information as a raw material) and polycentric (dispersing residences and decentralizing employment into ‘edge cities’). Thus those cities which are well positioned in the global information networks will benefit, while other cities may well lose out. There will also be differential impacts within cities, and within different sectors of the economy.
- Winger (1997) argued that the impact of the new communications will depend on the characteristics of both existing channels (face-face, telephone, letter, fax etc) and the newer modes (internet, mobile phone etc), concluding that (page 255): “Cities, as we know them today, are not about to wither away. There are good economic reasons for expecting society to retain much of its current urban character. But there will be changes...if we wish to grasp and understand these changes as they impact on the shape and form of our settlement patterns, more attention will have to be paid to the choices people make with respect to how they communicate with one another as they play out their roles in the economic arena”.
- Shibusawa (2000) attempted to formally model a general equilibrium urban model with both cyberspace and physical space. In this model, a virtual production sector exists in cyberspace, producing virtual goods, alongside a physical production sector, located in the CBD, producing physical goods. The model examined the behaviour of both home and office workers, deriving market equilibrium by numerical simulation using specific utility and production functions, and was able
to generate land use patterns and time allocations of the workers, together with the spatial structure of the telecommunications and transportation networks. Whilst highly theoretical, the model produced some interesting results, in particular:

> In physical space, the production locations contain two separate areas, the CBD, and the home office sector in the suburbs. These are connected by both transportation and telecommunications networks. The transportation network has a large capacity near the CBD boundary. The office workers tend to be more concentrated in the inner suburbs, while the home office workers tend to predominate in the outer suburbs.

> Land rents are highest in the CBD, falling rapidly towards the CBD/suburb boundary, then less steeply thereafter.

> The telecommunications sector has a large capacity near the city centre and also high capacity in the outer suburbs (where it links home office workers to each other) but lower capacity in the inner suburbs.

- This model suggests that much of the physical form of the current city will probably remain. However there will be segregation over time in the workforces who commute to the CBD to engage in physical production, whilst home office workers will migrate to outer suburbs where land rents are lower, as they are less affected by transportation costs.

Bill Mitchell in his recent work, “Etopia” (1999) has provided a comprehensive and compelling discussion on the future of the city in the cyberspace age. Mitchell points out that urban places and indeed even the buildings we live in have always evolved partly in response to the technologies of the day – providing examples from the impact of piped water supplies on local village life, to the impact of printing presses on monastic communities. The telematic and information revolution is merely another step along a long path: as the author claims (page 7):

“Mindwork no longer demands legwork. Commerce isn’t impeded by distance. Community doesn’t have to depend on propinquity. Links among people are formed in hitherto unimaginable ways. Perhaps this new social glue can be turned to our advantage. Maybe homes and workplaces, transportation systems, and the emerging digital communications infrastructure can be reconnected and reorganized to create fresh urban relationships, processes, and patterns that have the social and cultural qualities we seek for the twenty-first century. Maybe there’s another way – a graceful, sustainable and liberating one”.

Mitchell then identifies key changes likely to be wrought by the new technology, including:

- the embodiment of artificial intelligence into many of the common machines around us (this is much more likely than the development of robots)
- the disembodiment of software into modules which can be downloaded or uploaded as and when required to perform specific functions
- the development of intelligent clothes and houses which will allow us to remain in communication much more easily with each other, and which will perform continual “background” communication with the environment
• the development of full videoconferencing and the electronic management of face-face meetings
• the growth of electronic Business-Business as well as Business – Consumer commerce, the further decentralisation of the workplace, the development of just-in-time manufacturing to order, and dramatic changes to organizational structures
• the development of the tele-serviced city, including the development of organisations with "electronic fronts and architectural backs".
• shifts in the proportions of communication conducted by different channels, including shifts between synchronous and a-synchronous communication, and between local and remote communication.

Mitchell argues that these trends are not without their potential downsides – for example electronic management of face-face meetings can render some members of society literally invisible to others: "If you don’t want to encounter other races, classes or genders, electronic interaction can effectively make sure that you never have to". Equally, the new technologies threaten to make major inroads into privacy unless suitable controls are put into place. In addition, the impacts of the new technology will be far from uniform. For example, those communities which have or can create attractive places to live can expect to benefit from the demand resulting from loosening the bonds of spatial propinquity, while those that cannot are likely to lose out.

According to Mitchell, the overall impact of the "virtual accessibility" on more traditional "physical accessibility" remains, at least partly, a matter of social and political choice. His preference is to utilise the technological trends to achieve "etopias – lean, green cities that work smarter, not harder", through adoption of five principles:

• dematerialization (using new technologies to lighten the load on the environment)
• demobilization (reducing the amount of physical travel)
• mass customization (reducing waste currently associated with standardised products or services)
• intelligent operation (everything from irrigation systems to highways)
• soft transformation (adapting existing buildings and urban places to new uses rather than replacing or building afresh).

In summary, recent views suggest that computer and communications technology is likely to have a range of complex impacts in cities, and that these may well depend on social choices, but that they are not likely to simply eliminate or substitute for the importance of physical accessibility.

2.7 ACCESS DIFFICULTIES

There is a substantial literature examining the access difficulties facing particular individuals or groups in society (for example Imrie, 2000, Hine and Mitchell, 2001, Lang 1992). Generally these fall into one or more of three broad categories:

• those living in areas with low accessibility (geographically disadvantaged)
• those with no access, or poor access, to a car (private transport disadvantaged)
those with a physical or other disability which limits their mobility (mobility disadvantaged).

In addition, many low income individuals may experience access difficulties by virtue of only being able to afford to live in areas with low accessibility, by being unable to afford car ownership, or by being unable to afford to use taxis to overcome difficulties in using mass transportation.

**Geographically Disadvantaged**

Most Australian research on geographical disadvantage within urban areas (as opposed to wider regional or rural contexts) has focused on the outer suburbs, which are more remote from jobs and services. This is particularly the case in Australia, where relatively strong Central business Districts have survived, and where gentrification processes have meant that lower-income groups are increasing forced to the urban fringe, or at least to middle and outer suburbs, by high rents and housing prices in the inner suburbs. For example Black (1977) found that accessibility to employment was higher the closer one was to the CBD, and that location, and in particular distance from the CBD was more important than socio-economic status in determining accessibility. Similarly, accessibility to employment was closely related to the distance residents live from the Sydney city centre (page 193). Access to schools and shops however was determined more by location at a sub-regional scale in relation to those facilities.

By contrast, the issue of geographic disadvantage is seen somewhat differently in the United States, where the suburbs have generally been seen as the home for the affluent middle classes, with the inner city areas inhabited predominantly by low income, disadvantaged groups. In addition, much of the dynamic job growth occurring in US cities has been in “edge cities” well away from the old CBD cores. Consequently there has been a significant debate in that country as to geographic disadvantage for low income workers those living in inner suburbs, particularly those without a car (see also discussion below). For example, Hughes (1995) outlined three strategies for improving job accessibility for low income workers: relocate their residence in or near job-rich areas (perceived to be the suburbs); create employment in low income communities; and improve transport links between residential locations and potential job locations.

As Shen (2001) argued, however, the premise that people living in inner city areas in US cities have poorer relative access to employment than those in outer areas ignores the role of job turnover, and hence underestimates the number of job openings appearing in the traditional CBD, even when it isn’t growing. In addition, the recent trend to gentrification and revival of inner city areas in US cities means this issue needs to be re-examined.

**Private Transport Disadvantaged**

The car is not simply a transport technology, but has literally reshaped our cities around it, making it almost essential for many people to function effectively. As Sheller and Urry (2000, page 737) noted:
"In the twentieth century this disciplining and domination through machine technology is most dramatically seen in the system of production, consumption, circulation, location and sociality engendered by the motor car".

Axhausen (2000, page 1859) expressed a similar theme:

"The urban visions of the first half of the 20th century isolated traffic as a separate function which, in the hands of the emerging transport planning and traffic engineering professions, developed its own logic. This, in turn, has often overpowered the urban logic. These urban visions all celebrated the car as clean, fast, liberating and all-round wonderful – the death knell of the hated 19th century city".

Since the rise of the car as the dominant mode of personal transport in cities in the developed world, land uses and urban forms have altered substantially to accommodate and facilitate it. No shopping centre developer, except perhaps in the central business district, would consider developing a major retail centre without providing it with extensive car parking facilities offering free parking, at least for the first few hours.

These shifts in land uses, coupled with the provision of free or heavily subsidised parking, have reinforced the advantages already available to car drivers compared with public transport patrons in terms of convenience and two-dimensional flexibility. Accordingly lack of access to a car effectively reduces one’s potential accessibility to a wide range of urban opportunities (and even more so, for opportunities outside the cities). This is clearly demonstrated later in this thesis, where the superior accessibility provided by cars compared with public transport is illustrated (Chapters 4 and 5).

Unfortunately the very flexibility and speed offered by the car has become something of a two-edged sword, encouraging suburban sprawl and ever-increasing travel distances, not only for commuting but for all trip purposes. As Axhausen again noted:

"the vision of contented middle-class life in an unstructured metropolitan area cruised through in the car ... does not match up to the reality of households headed by two working adults, who find that the co-ordination of the joint life becomes rather onerous in far-flung suburbia, especially where neither the house nor the children can be handed over to the supervision of the eyes on the street. The effort is greatest for those households which in the past benefited most from place-based networks: the poorer households" (page 1861).

Thus it is not immediately clear if society’s overall levels of accessibility are any longer improving, as travel distances and times increase (see later analysis of trends in Sydney). Indeed Kenworthy and Laube (2000) argue that cities with high automobile dependence tend to have lower accessibility despite allocating substantially more resources to providing mobility.

What is clear is that those without access to a car experience accessibility disadvantages relative to those with such access, and access to a car is related to household income, as shown below, among other variables.
Accessibility also depends on the quality or otherwise of the public transport alternatives available. Thus people living in outer suburbs have lower relative accessibility by both car and public transport than those in inner suburbs, but those with no car available and living in outer suburbs have the lowest accessibility of all.

For example, Lang (1992), focusing on the access problems facing women, found that they were not uniform, but differed according to factors such as residential location, car ownership, workforce participation, age, income and child care responsibilities. The worst problems were experienced by women remote from public transport and services but on low incomes and with low access to a car.

**Mobility Disadvantaged**

Surveys undertaken in Australia in 1993 (ABS, 1993a, 1993b) found that:

- 3.17 million people (18% of the population) had some form of disability, of which 1.83 million (10.3%) experienced handicaps which affect their mobility
- While slightly more than half of those with a disability affecting mobility could use public transport relatively easily, the remainder could not:
  - 24% (2.5% of the total population) could use all forms of mainstream public transport, but with difficulty or assistance
  - 6% (.6% of the total population) could use some forms of public transport, but only with difficulty / assistance
13% (1.3% of the total population) could not use mainstream public transport at all.

- 80,000 people (.44% of the population) use wheelchairs, and a further 460,000 people (2.6% of the population) used other mobility aids.

In addition, there is a much greater incidence of disability among older age groups than among younger age groups:

- 6.4% of people under 65 have some form of mobility handicap compared to 40% of those over 65
- People over 65 accounted for 11.3% of the population in 1993, but 45% of people with mobility handicaps in that year.

Thus a significant proportion of our population experiences accessibility problems caused by mobility difficulties. Furthermore, the problem of mobility handicap is expected to increase significantly in the future as the population ages (Attorney-General's Department, 1998 a):

- Between 2001 and 2021 the percentage of the population in Australia aged over 65 is expected to grow from 12.1% to 16.4%, and the proportion of those aged over 75 is expected to rise even faster.
- The percentage of the overall population with mobility handicaps is expected to grow from 10.6% to 12.1%.
- Allowing for population growth, the overall number of people with mobility handicaps is expected to grow from 2.07 million in 2001 to 2.91 million in 2021, or by more than 40%.

The ageing of society and its implications for transport are not new issues - Wachs (1979) highlighted the issues nearly a quarter century ago, including the need to find more effective solutions to the travel needs of the elderly. Tacken (1998) examined travel behaviour of the elderly in the Netherlands, and found that the "active" elderly had similar trip patterns to younger age groups, while those with mobility-related problems had much lower mobility rates.

It is important to realise that mobility-related handicaps affect many people other than those in wheelchairs or with walking aids. For example focus group research in NSW identified a range of difficulties facing people who are blind or have impaired vision; people with a psychiatric disability; people who have had a traumatic brain injury or an intellectual disability; and people who are deaf or with a hearing impairment (Disability Council of NSW, 1998).

The difficulties in using both mainstream public transport, as well as private vehicles, coupled with other factors such as employment status, mean that people with disabilities in Australia have quite different travel patterns to the wider community (Attorney-General's Department, 1998 a, 1998 b). For example:

- For people with a motor car available, the public transport trip rates of people with a disability are about 35% of those for able people.
• For people with no motor car available, the relative public transport trip rates are about 45%.
• Among people with a car available, those with disabilities make a much smaller number of trips by car (and particularly as car driver) than the general population.
• In all cases, people with a disability make a much smaller absolute number of trips than do able people.
• People with a disability make between 3 and 10 times as many trips by conventional taxi as do other people, and their proportion of trips by taxi is between 5 and 20 times higher than for other people.

Accordingly, there is a growing recognition of the accessibility problems of the “mobility disadvantaged”. For example Queensland Transport’s Mobility Management Unit (Queensland Government, 2001) issued a discussion paper on personal access and mobility in an ageing society, calling for measures to achieve “safe mobility, for all, for life”. Analysing current efforts to meet this objective, such as community transport initiatives, the authors found that there were still substantial “gaps” in services and “barriers” for people with mobility disadvantage. These include the high cost of and poor service provided by accessible taxis, difficulties with mainstream public transport, and the relatively small coverage of the community transport system.

Tisato (1997) analysed travel affordability for people with a disability, highlighting the significant time as well as money costs faced by this group, and analysed how these varied between conventional taxis, wheelchair-accessible taxis, and buses.

The Disability Council of NSW (1998) also identified weaknesses in the current “accessible taxi” services. This included their high cost for people dependent on that means of transport for much of their travel; lengthy delays in waiting for a WAT (wheelchair accessible taxi) vehicle compared with a regular taxi; poor attitudes of some drivers; and undesirable design features of much of the current WAT fleet.

Since the introduction of the draft Accessible Public Transport Standards in 1996 in Australia, there has been a significant effort to improve mainstream public transport services by introducing low floor buses and trams, and by improving accessibility of stations through provision of lifts, ramps etc. These can have benefits for the general public as well (Attorney-General’s Department, 1997a, 1997b).

Similarly State Governments have been increasing the fleets of WAT vehicles (IPART 1998). However even if the whole of the taxi fleet were wheelchair accessible (as is the case in London, for example) this would still not remove accessibility problems for people with mobility disadvantage, given that taxi fares per km are typically around 4-5 times higher than for mass transit. Indeed the ratio can be even higher for long trips. There is thus a substantial “gap” in the market between taxis and mass transit.

Glazebrook and McCombie (1999), and Glazebrook, Middleton and Ratcliffe (1994) therefore argued for the introduction of “personal public transport” using suitably designed maxitaxis to provide a more affordable anywhere-anywhere, anytime service.
This would be based on continuous multihire services, allowing per trip prices to consumers to be 30 – 50% cheaper than taxis. It would be available to the whole community, not merely those with mobility disadvantages, thus providing a more integrated service. People in wheelchairs or with other particular disabilities could receive, for example, a 50% subsidy, meaning that their per-trip trip costs would not be substantially higher than current mass transit fares for an equivalent distance trip.

As demonstrated by Schaller (1999) for the United States, the demand for taxi rides falls with increasing fares, with a fare elasticity of demand (the percentage change in demand divided by the percentage change in fare) estimated at -.22 for New York City). However demand rises with increasing service availability, with the demand elasticity for service availability (the percentage change in demand divided by the percentage change in service availability) estimated at +.28.

This suggests that the introduction of continuous multihire services would increase overall demand, whilst helping to smooth out the peaks and troughs in demand across the day (IPART 1999 a) which currently lead to low overall productivity of the taxi industry.

2.8 RELEVANT PATTERNS AND TRENDS

This section presents some relevant data from a variety of sources on:

- travel patterns and trends
- housing preferences
- access to and use of computers and the internet

This provides a statistical backdrop to assist in interpreting the literature review in the context of Australia, and in particular Sydney.

Travel Patterns and Trends

Since 1997/8, personal travel patterns in Sydney have been regularly monitored through continuous household travel surveys (HTS), which have superceded the earlier practice of periodic major Home Interview Surveys conducted every decade or so (1971, 1981, 1991). Consequently, a reasonably comprehensive and up-to-date picture of travel patterns in Sydney is available, and is published by the NSW Transport Data Centre. The most recent publication (NSW Transport Data Centre, 2002) draws on the surveys to 2000/2001, as well as longer term data dating to 1991. The following summarises key aspects of those patterns and trends. All tables and graphs in this section are generated by the author, but are based on data from that publication.

Overall Travel

Since 1991, travel in Sydney has out-stripped population growth, with a 13% increase in trips and 26% increase in motor vehicle kilometres compared with an 11% increase in population (see figure 2.5).
As shown in table 2.6 below, in the year 2000, Sydney’s residents made some 15 million trips on an average weekday, and 12.7 million trips on an average weekend day. Travel appears to be growing faster on weekdays than weekends, and faster still in the morning peak periods, reflecting the strength of the economy in 2000.

Table 2.6 Trips by Sydney Residents by Time of Week and Time of Day, 1991-2000

<table>
<thead>
<tr>
<th>Year</th>
<th>1991 (000)</th>
<th>1999 (000)</th>
<th>2000 (000)</th>
<th>% Change 1991-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Weekday</td>
<td>13148</td>
<td>14924</td>
<td>14978</td>
<td>13.9%</td>
</tr>
<tr>
<td>Average Weekend Day</td>
<td>11436</td>
<td>12858</td>
<td>12743</td>
<td>11.4%</td>
</tr>
<tr>
<td>Average Day</td>
<td>12659</td>
<td>14334</td>
<td>14339</td>
<td>13.3%</td>
</tr>
<tr>
<td>Average Weekday am pk</td>
<td>2692</td>
<td>3101</td>
<td>3084</td>
<td>14.6%</td>
</tr>
<tr>
<td>Total Weekly</td>
<td>65740</td>
<td>74621</td>
<td>74891</td>
<td>13.9%</td>
</tr>
<tr>
<td>Total Weekend</td>
<td>22872</td>
<td>25716</td>
<td>25485</td>
<td>11.4%</td>
</tr>
<tr>
<td>Total Weekly</td>
<td>88613</td>
<td>100337</td>
<td>100376</td>
<td>13.3%</td>
</tr>
</tbody>
</table>

Average household size has fallen slightly in Sydney, but not by enough to counteract the rise in trip rates per person, leading to a slight rise in trip rates per household on weekdays (see table 2.7).
### Table 2.7  Weekday Trip Rates in Sydney, 1991-2000

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Household Size</td>
<td>2.76</td>
<td>2.71</td>
<td>2.72</td>
<td>-1.6%</td>
</tr>
<tr>
<td>Average Weekday Trip Rate Per Person</td>
<td>3.68</td>
<td>3.81</td>
<td>3.77</td>
<td>2.4%</td>
</tr>
<tr>
<td>Trip Rate Per Household</td>
<td>10.17</td>
<td>10.35</td>
<td>10.25</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

### Travel by Trip Purpose

There has been a rise in travel for all purposes in Sydney over the last 9 years, with particularly strong growth in social/recreational and "serve passenger" trips.

### Figure 2.6  Trips by Purpose (Weekday Travel), 1991-2000

![Trips by Purpose Chart](image)

### Travel by Mode

Almost half of all (unlinked) trips in Sydney on a typical weekday are by vehicle drivers, and a further 21.7% by vehicle passengers. Roughly 12% are by public transport, with the remainder by walk, bicycle and other modes. Car – based travel grew much faster than overall travel in the decade – by 18.5%, public transport trips grew at a slower rate (6.5%) while walking and cycling trips grew more slowly (1.9%).
Table 2.8  Weekday Trips (unlinked) by Mode, 1991-2000

<table>
<thead>
<tr>
<th>Mode</th>
<th>1991 (000)</th>
<th>1999 (000)</th>
<th>2000 (000)</th>
<th>% Change 1991-2000</th>
<th>% Share 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Driver</td>
<td>6366</td>
<td>7482</td>
<td>7519</td>
<td>18.1%</td>
<td>48.0%</td>
</tr>
<tr>
<td>Vehicle Passenger</td>
<td>2850</td>
<td>3386</td>
<td>3403</td>
<td>19.4%</td>
<td>21.7%</td>
</tr>
<tr>
<td>Train</td>
<td>691</td>
<td>770</td>
<td>784</td>
<td>13.5%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Bus</td>
<td>917</td>
<td>963</td>
<td>921</td>
<td>0.4%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Ferry</td>
<td>33</td>
<td>37</td>
<td>34</td>
<td>3.0%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Walk Only</td>
<td>2700</td>
<td>2712</td>
<td>2724</td>
<td>0.9%</td>
<td>17.4%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>98</td>
<td>90</td>
<td>86</td>
<td>-12.2%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Taxi</td>
<td>103</td>
<td>109</td>
<td>119</td>
<td>15.5%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Other</td>
<td>20</td>
<td>47</td>
<td>61</td>
<td>205.0%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Total</td>
<td>13778</td>
<td>15596</td>
<td>15651</td>
<td>13.6%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total Private Vehicle</td>
<td>9216</td>
<td>10868</td>
<td>10922</td>
<td>18.5%</td>
<td>69.8%</td>
</tr>
<tr>
<td>Total Public Transport*</td>
<td>1744</td>
<td>1879</td>
<td>1858</td>
<td>6.5%</td>
<td>11.9%</td>
</tr>
<tr>
<td>Total Walk and Other</td>
<td>2818</td>
<td>2849</td>
<td>2871</td>
<td>1.9%</td>
<td>18.3%</td>
</tr>
</tbody>
</table>

* Includes Mass Transit (Train, Bus, Ferry) and Taxi

Note: The total number of unlinked weekday trips (15.651 million) in 2000 in the table above is greater than the number of linked trips in Table 2.6 (14.978 million), since some linked trips involve more than one unlinked trip components.

**Trip Purpose by Mode**

Different modes are used to different extents for different trip purposes (see below). In particular:

- Public transport is predominantly used for work and education trips.
- Walking and other modes are important for education, shopping, social/recreational and personal business trips, but not for work, business or serve passenger trips.
- Cars are the dominant mode for all trip purposes.

This reflects different characteristics of trips such as trip lengths, time of travel, ease of access etc.
However mode shares are changing differentially for different trip purposes and for different groups of the population. In particular, there has been a marked rise in the use of cars for personal business, shopping and education/childcare trips, mostly at the expense of walking and other modes. By contrast, mode shares for public transport trips have remained virtually constant for most trip purposes (except education/childcare).

### Figure 2.7 Mode Shares for Different Trip Purposes, 2000

<table>
<thead>
<tr>
<th>Mode Share</th>
<th>Private Veh</th>
<th>Public Veh</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education/Childcare</td>
<td>39.8%</td>
<td>31.2%</td>
<td>29.0%</td>
</tr>
<tr>
<td>Shopping</td>
<td>58.3%</td>
<td>7.4%</td>
<td>34.3%</td>
</tr>
<tr>
<td>Social/recreational</td>
<td>63.9%</td>
<td>6.9%</td>
<td>29.2%</td>
</tr>
<tr>
<td>Personal Business</td>
<td>61.5%</td>
<td>9.0%</td>
<td>29.5%</td>
</tr>
<tr>
<td>To work</td>
<td>68.7%</td>
<td>23.1%</td>
<td>8.2%</td>
</tr>
<tr>
<td>Other work related travel</td>
<td>84.1%</td>
<td>5.1%</td>
<td>10.8%</td>
</tr>
<tr>
<td>Serve passenger</td>
<td>85.4%</td>
<td>2.2%</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

### Figure 2.8 Change in Mode Share by Trip Purpose, 1991-2000

- **Serve passenger**: -2.1%
- **Other work related travel**: -1.7%
- **To work**: -0.6%
- **Personal Business**: -4.9%
- **Social/recreational**: -1.3%
- **Shopping**: 4.1%
- **Education/Childcare**: -5.5%
Reasons for Using Particular Modes

As shown below, the household travel survey also gathered data on people’s stated reasons for travelling to work by car or public transport. The responses have been grouped to allow some comparisons. The data indicate that:

- The predominant reason for people using their car is speed, comfort / convenience, and lack of availability of public transport alternatives. The need to use the car for work related business, or the fact that a car was provided by the employer were also significant reasons.
- By contrast, the major reason for people using public transport was to avoid parking problems / costs or because a car was not available. However public transport did provide benefits such as speed, convenience / comfort and economy for some. Only a small percentage indicated environmental benefits, and very few have any employer incentives to use public transport.

Figure 2.9 Reasons for Travelling to Work by Car or Public Transport

Trip Lengths

Trip lengths have been increasing overall, from 9.1 km in 1991 to 9.5 km in 2000. However the trends have been different for different trip purposes and modes:

- Work trips have actually become slightly shorter, but remain the longest on average.
- There has been a rapid growth however in trip lengths for other work-related trips, and to a lesser extent, for other trips.
There are substantial differences in trip lengths for different modes, reflecting the characteristics of those modes and the uses to which they are put.

For example the average trip by train was 18.3 km in 2000, having fallen slightly since 1991. This is still however nearly double that of car drivers (10.7 km) and more than double that of car passengers (9.1 km), and more than 2.5 times that of bus passengers (7.2 km).
Car driver trips are lengthening, as are bus trips. Walking trips however are shortening, though the Transport Data Centre notes that the average distance of walking trips is over-estimated due to the formula used to calculate intra-zonal trips.

**Travel Times**

Trip times differ by trip purpose, being longest for work trips, and are generally increasing.

**Figure 2.12  Trip Times by Trip Purpose, 1991-2000**

Average trip duration and total time spent travelling per person per day have both increased over the 1990's. The increase in total time spent travelling reflects the combined impact of increasing trip rates and increasing travel time per trip.

**Table 2.9  Time Spent Travelling (Weekdays) 1991-2000**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Trip Duration</td>
<td>20 mins</td>
<td>21 mins</td>
<td>21 mins</td>
<td>5.0%</td>
</tr>
<tr>
<td>Average total time / person</td>
<td>73 mins</td>
<td>79 mins</td>
<td>79 mins</td>
<td>8.2%</td>
</tr>
</tbody>
</table>

**Trips by Time of Day**

Trip patterns across the day differ significantly by trip purpose:
• Around 21% of all weekday trips are made in the morning peak period (6:30am – 9:30pm), and this proportion appears to be relatively stable.
• Commuting and serve passenger trips are naturally heavily focused in the morning peak, with 27.5% of commuting and 23.6% of serve passenger trips occurring in that period.
• Most other trip purposes are relatively less frequent in the morning peak. For example only 4.7% of personal business, 6.9% of shopping and 7.6% of social recreation trips occur in that period.
• Commuting, serve passenger and education/childcare trips account for around 2.1 million of the 3 million trips made in the morning peak period in the year 2000.
• However commuting trips in the morning peak have grown only relatively slowly compared with serve passenger trips, social recreational and education trips.

Table 2.10 Morning Peak Period Trips (6:30 - 9:30am) on a Typical Weekday, 1991-2000

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning Peak Trips</td>
<td>2692000</td>
<td>3101000</td>
<td>3084000</td>
<td>14.6%</td>
</tr>
<tr>
<td>Total Trips</td>
<td>13148000</td>
<td>14924000</td>
<td>14978000</td>
<td>13.9%</td>
</tr>
<tr>
<td>AM Peak as % of total</td>
<td>20.5%</td>
<td>20.8%</td>
<td>20.6%</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.11 Morning Weekday Peak Trips by Trip Purpose, 1991-2000

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Social / recreational</td>
<td>194</td>
<td>234</td>
<td>21%</td>
<td>7.6%</td>
</tr>
<tr>
<td>Commuting*</td>
<td>780</td>
<td>849</td>
<td>9%</td>
<td>27.5%</td>
</tr>
<tr>
<td>Serve Passenger</td>
<td>538</td>
<td>727</td>
<td>35%</td>
<td>23.6%</td>
</tr>
<tr>
<td>Shopping</td>
<td>232</td>
<td>213</td>
<td>-8%</td>
<td>6.9%</td>
</tr>
<tr>
<td>Other Work Related</td>
<td>313</td>
<td>345</td>
<td>10%</td>
<td>11.2%</td>
</tr>
<tr>
<td>Education / Childcare</td>
<td>487</td>
<td>566</td>
<td>16%</td>
<td>18.4%</td>
</tr>
<tr>
<td>Personal Business</td>
<td>135</td>
<td>144</td>
<td>7%</td>
<td>4.7%</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>5</td>
<td>-58%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Total</td>
<td>2691</td>
<td>3083</td>
<td>15%</td>
<td>100%</td>
</tr>
</tbody>
</table>

# Trips to return home are allocated priority trip purpose
* Includes trips to return to work

Profile of Travelers

Females make a lower proportion of trips by car than males, and a higher proportion by bus and walking. The mode share by walking and by bus has fallen for both men and women during the 1990's, but women have increased their share of trips as vehicle driver, while men have increased their share as vehicle passenger. This reflects some of the social changes in the decade, together with rising car ownership amongst women.
Table 2.12  Mode Shares by Gender, 1991 and 2000

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Driver</td>
<td>52.8%</td>
<td>39.2%</td>
<td>53.2%</td>
<td>42.8%</td>
<td>0.4%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Vehicle Pass</td>
<td>16.1%</td>
<td>25.6%</td>
<td>18.5%</td>
<td>25.0%</td>
<td>2.4%</td>
<td>-0.6%</td>
</tr>
<tr>
<td>Train</td>
<td>5.1%</td>
<td>5.0%</td>
<td>5.1%</td>
<td>4.9%</td>
<td>0.0%</td>
<td>-0.1%</td>
</tr>
<tr>
<td>Bus</td>
<td>5.9%</td>
<td>7.4%</td>
<td>5.2%</td>
<td>6.6%</td>
<td>-0.7%</td>
<td>-0.8%</td>
</tr>
<tr>
<td>Walk Only</td>
<td>17.9%</td>
<td>21.4%</td>
<td>15.7%</td>
<td>19.2%</td>
<td>-2.2%</td>
<td>-2.2%</td>
</tr>
<tr>
<td>Other</td>
<td>2.2%</td>
<td>1.4%</td>
<td>2.3%</td>
<td>1.5%</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With regard to age, there are significant differences in mode shares for different age groups:

- The mode share for cars is high for the under 11’s, falls significantly for the 11-20 year age group, then rises sharply again peaking at nearly 80% for the 41-50 age group. It then falls again significantly with age, being only 54% for those over 70.

- The pattern for public transport is almost the reverse of this, being highest for the 11-20 year group (23.6% of trips), then the over 70’s (16%) and lowest for the 41-50 year age group (6.5%).

- The mode share for walking is less variable, ranging between 14.4% and 29.7%. Interestingly, the group with the highest share is the over 70’s. This potentially reflects the lower car ownership amongst this group, difficulties with driving, and difficulties in using public transport, particularly for those with mobility – related disabilities.

Figure 2.13  Mode Share by Age Group (2000, weekday unlinked trips)
There have however been significant shifts in the use of different modes by some age groups during the 1990's in Sydney. In particular:

- There have been large shifts away from walking and towards the use of cars by the young and the old. The shifts for middle age groups have been much smaller.
- There has been a small shift across all age groups away from public transport and towards the use of cars. However the shift among those aged 61-70 has been pronounced, a reflection of the different car ownership rates from today’s 60-70 year olds compared with that of the same age group ten years earlier.

![Figure 2.14 Change in Mode Share by Age Group, 1991-2000](image)

**Housing Preferences**

The Australian Bureau of Statistics, in conjunction with the National Housing Strategy, undertook a major comparative study of housing characteristics and decisions in Sydney, Melbourne, Adelaide and Canberra (ABS, 1992), which provides valuable data on the link between accessibility and housing choices. The study was based on a survey of some 12,600 households in the four cities, of which approximately 4,300 were in Sydney. Key findings from the study of relevance include:

**Housing Tenure and Housing Type**

- There were significant relationships between housing tenure and household type. For example while nearly half of first homebuyers in Sydney were couples with...
children, only a quarter of households in public rental accommodation were of this household type.

- Similarly length of tenure varies significantly with housing type and tenure type, with home buyers living in separate houses generally having lived in their home for longer than purchasers of other types of dwelling.

**Home Ownership**

- Home ownership was very popular in 1991, with 94% of all homeowners and buyers in each city believing that the advantages of home ownership outweighed the disadvantages. By contrast, between 60% and 90% of renters stated the main reason for not having bought a home was either that they had never had the deposit or that they could not afford to buy. Less than 8% of private renters, and less than 15% of public renters, stated that they “never wanted to” buy a house.

**Travel to Work**

- The car was the most common means of reaching localities, particularly for men and for people from households with young children.

- Public transport usage is however more significant in Sydney than in the other cities, and more women than men use local services such as shops and doctors, and visit friends.

**Difficulties in accessing services**

- The types of services and locations that respondents found most difficult to access were similar in all cities except Canberra, with beaches and open countryside being considered difficult by the highest proportion of respondents. Access difficulties generally increased with city size, including access to the city centre, and access to public transport.

- Difficult access is most significant where respondents consider access to the service or location important. The community service to which the largest proportion (around 15%) of people found access to be both difficult and important in all cities was hospitals. Access to friends and relatives was also found to be both important and difficult by more than 10% of all groups (except for Canberra households with dependent children). Households in Sydney generally had the most difficulty in accessing households of friends and relatives, reflecting the city’s size.

**Housing Decisions by Recent Movers**

- There were some differences between cities and between different housing tenures as to the relative importance of the neighbourhood or the dwelling in housing decisions. In particular:

  - For private renters and for changeover buyers, the neighbourhood was more commonly nominated as the major factor in Sydney and Melbourne, whereas in
Adelaide and, in particular, Canberra, the dwelling was more commonly mentioned as the main factor.

- For first home buyers in Sydney and Adelaide, similar proportions nominated the neighbourhood as nominated the dwelling as being the most important; in Melbourne, a slightly higher proportion nominated the neighbourhood, and in Canberra a much higher proportion nominated the dwelling.

- In terms of the reasons for selecting a particular area:
  - For private renters, proximity to work was the most commonly mentioned main reason, followed by affordability then access to public transport.
  - For first homebuyers, affordability was the most commonly mentioned main reason, followed by characteristics of the area, then proximity to work.
  - For changeover buyers, “characteristics of the area” was the most commonly mentioned reason for all cities, followed by affordability. Neighbourhood services and proximity to work were the next most commonly mentioned main reasons, generally in that order.

There were also differences by city. For example, recent movers in Sydney nominated affordability as the main reason more frequently than did those in other cities (particularly Adelaide), but the proportions nominating accessibility to work and services, neighbourhood characteristics or family/social contacts did not vary much between cities. The main difference was in “other factors” indicating that in those cities with more affordable housing (Adelaide and Canberra) people were able to take other factors into consideration.

**Figure 2.15 Reasons for Recent Movers Choosing an Area**

<table>
<thead>
<tr>
<th>City</th>
<th>Main Reasons</th>
<th>Other</th>
<th>Family/Social Contacts</th>
<th>Neighbourhood</th>
<th>Accessibility to work and services</th>
<th>Affordability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney</td>
<td>4.3%</td>
<td>11.6%</td>
<td>26.2%</td>
<td>30.2%</td>
<td>30.4%</td>
<td>24.1%</td>
</tr>
<tr>
<td>Melbourne</td>
<td>4.0%</td>
<td>13.6%</td>
<td>27.1%</td>
<td>24.7%</td>
<td>30.6%</td>
<td>15.6%</td>
</tr>
<tr>
<td>Adelaide</td>
<td>13.1%</td>
<td>12.7%</td>
<td>30.6%</td>
<td>28.1%</td>
<td>30.4%</td>
<td>20.6%</td>
</tr>
<tr>
<td>Canberra</td>
<td>11.2%</td>
<td>13.9%</td>
<td>24.1%</td>
<td>30.6%</td>
<td>30.6%</td>
<td>20.6%</td>
</tr>
</tbody>
</table>
In terms of the specific patterns for Sydney:

- Affordability was the single most frequently mentioned “main reason” and also the most frequently mentioned factor overall (see below).
- The next most important individual factor was “handy to work or partner’s work”, followed by “scenically / environmentally attractive area”, and “family / social contacts”. Accessibility to other services / locations (such as public transport, health/medical, shops, recreational/cultural or schools/child care were much less frequently mentioned as the main reason (less than 4% in each case) but were nevertheless factors in the decision for between 9% and 25% of recent movers. Similarly, other features of the local area (such as “close community feel”, “familiarity with the area”, “good quality houses”, “people of similar background” and “safe area” were relatively rarely mentioned as the main factor, but were mentioned by between 8% and 22% of recent movers as factors in their decision.
- Unlike the reasons for moving and selecting areas and dwellings, tenure status does not influence the types of compromises made to a great extent. Compromises on the size of the dwelling are the most common for all tenure groups, especially for first-home buyers. A relatively high proportion of changeover buyers compromised on the size of land.
- Whilst affordability was the single most important factor, the combined importance of accessibility (to work, public transport, health/medical facilities, shops, recreational facilities and education/child care) is of a similar order of importance.

Figure 2.16 Reasons for Choosing their Area (for Sydney)
Information Technology in the Home

ABS (1999c) provides a recent snapshot of the rapid growth of computers and use of the Internet in the home in Australia. For example the percentage of households with a computer rose from under 30% in February 1994 to almost 50% by November 1998, while the number with Internet access rose from virtually zero to nearly one in five over the same time period.

Furthermore, nearly 12% of households without a computer in 1998 said they intended to purchase one in the following twelve months. Access to a home computer in Australia appeared to be slightly ahead of that in the US and UK.

Figure 2.17 Growth of Computers and Internet Access at Home

The actual use of computers has grown in line with their availability. ABS data on the use of time indicates that between 1992 and 1997 the average time spent using a computer increased from 97 minutes to 103 minutes a day for those who used a home computer.

However access to and usage of computers and the Internet varies with family type, age, sex and income. For example:

- Teenagers are the heaviest users of computers and the Internet.
- For any age group, males used computers and the Internet somewhat more frequently than females. This reflected the greater use by males of computer games and for work purposes – usage for study purposes was similar between males and females.
• Usage of the Internet also rose with educational attainment, being under 10% for people over 18 with year 12 certificate versus almost 30% for people with bachelor degrees or higher.
• There were only small differences by State in the availability and use of computers, except for the ACT where it is much higher.
• Availability and use of computers and the internet also reflects family type, being most common among couples with children and least common among lone person households.

Figure 2.18 Computer and Internet Usage, Australia, 1998

The most recent data from the 2001 Census (ABS 2002) indicates that computer and particularly Internet usage continued to grow rapidly in the last few years.

For example, in the week preceding the Census:
• 42.0% of the population had used a personal computer at home.
• Almost 7 million people, or 37% of the population, had used the Internet
• Some 5.4% of the population had used the Internet at work only, 18.7% at home only, and 3.8% elsewhere only, with the remainder using it at more than one location.

Further information on Internet usage is discussed in Chapter 4, drawing on the results of the survey conducted as part of the Thesis.
2.9 SUMMARY

Key Conclusions from the Literature Review

Definitions of Accessibility

- Classical definitions of accessibility generally take into account the distribution and quality of opportunities available, and the difficulty or otherwise of accessing those activities or opportunities measured in terms of travel time, cost or generalised cost.
- Economists developed utility-based indicators, which have been used to measure the value of accessibility in monetary terms, and which placed accessibility on a firmer theoretical foundation. However in practice these are essentially the same as the earlier classical definitions.
- Hagerstrand (1975), Burns (1979) and others introduced spatial-temporal indicators. These also take into account constraints on movement in time-space (such as the need to meet someone at a particular time and place, the unavailability of public transport after certain hours, or the fact that shops are only open between certain hours). Although offering some insights into aspects of accessibility, such measures have proved difficult to convert into practical indicators for use at an urban scale.
- There is no single measure of accessibility, which has been universally recognised as suitable for all applications or encompassing all relevant information. However accessibility indicators generally can be of great assistance in analysing urban and spatial issues.

Accessibility and Travel Behaviour

- The relative accessibility of various opportunities or activities to a person affects the likelihood of that person in traveling to (accessing) that activity. Accessibility thus affects individual travel behaviour in terms of the spatial distribution of trips.
- Relative accessibility of an activity by different modes also affects the use of those modes and hence overall mode shares.
- Relative accessibility also appears to influence trip lengths – people in outer suburbs (and who have lower accessibility to jobs, for example) tend to make longer trips than people in inner suburbs. Similarly, people in larger cities tend to make longer trips than people in small towns. However many other factors also influence trip length, and preference functions appear to vary between different cities and over time for the same city. Similarly the value of accessibility to individuals has been found to vary with incomes and mode used.
- It is less clear however whether accessibility impacts on the number of trips people make. There is some evidence, for example, that trip rates for Sydney may be lower than for some of the smaller Australian cities.
- For travel patterns within a city, the data seem to suggest that accessibility (which is generally higher in inner suburbs than outer suburbs) impacts on travel behaviour in terms of trip lengths, mode and, possibly, trip frequency. The overall impact is that people living in more accessible inner suburbs tend to travel less (km) in total, and particularly by car, than people in less accessible locations. The slower car travel
speeds, more difficult parking conditions and better public transport accessibility in those areas also tends to lead to a lower car mode share of travel in the inner suburbs.

**Accessibility, Land Use and Housing**

- Accessibility is intimately connected with land use, land values and urban development. Changes in land use patterns affect accessibility; equally, changes in accessibility tend to be reflected in land values and subsequent changes in land use patterns.
- Early models of the city were based on simple, mono-centric city structures. However, the development of "edge cities" and suburban employment clusters, and the gentrification of inner suburbs and indeed central business districts highlights the complexities of land uses in practice and their resultant accessibility patterns.
- While improvements in urban accessibility through investment in mass transit systems or freeways often results in changes in land values and densities, the impacts are not automatic and depend on zoning and other restrictions on development opportunities.
- The relationship between accessibility and housing depends on a range of factors, including the dominant modes of transport. For example, analysis of Tokyo, where transit is the major mode, shows close relationships between improvements in rail travel speeds and the radius of the Tokyo metropolitan area. By contrast, survey research from outer suburbs in Houston indicated that while cars continue to provide reasonable travel times and costs, low-density suburban development is likely to remain popular, at least with affluent residents.
- In Australia, population densities in our larger cities fell until the mid-1980's, except for Sydney where it was roughly constant. In the last decade densities have begun to increase with urban consolidation.
- Analysis of data from 32 cities internationally suggests that motor vehicle ownership and per capita income correlated negatively with density, while population size was positively correlated. It also indicated that there was a significant "country" effect, with countries such as the USA and Australia having urban densities well below those of European cities even when effects of city size, income and car ownership are removed.
- Urban and population density generally declines with distance from the city centre. Most studies have automatically assumed a negative exponential relationship, but some research suggests that the negative power function provides a better fit and can be explained in terms of "fractal" geometry.
- While early models of the city were based on "mechanical" concepts, more recent theorists have focused on the concept of "organic cities" which evolve over time and are rarely if ever in equilibrium. In these models, accessibility patterns are also constantly changing and evolving, while travel behaviour can also change over time in response to behavioural changes, such as those initiated by initiatives such as "travel blending" programs designed to reduce car usage.

**Accessibility and Time Use / Activity Modelling**

- In the "trip-based" approach to studying travel behaviour, time is reduced to being a "cost" of making a trip. By contrast, the central basis of the activity-based approach
is that individual's activity — travel patterns are a result of their decisions on how to use their time. Travel is thus intimately liked with activities.

- Analysis of travel patterns has found consistent differences between individuals — for example women's work travel patterns are typically shorter than for men, and this is seen as linked to other factors such as child care and household responsibilities which tend to fall mainly on women.
- An activity approach also distinguishes "planned", "habitual" and "impulsive" trips. Travel patterns are also hypothesized to be influenced by the extent to which people are under time pressures or are over-committed, and the strategies they adopt for coping with this.
- Analysis of US data on the time spent at activities have found only relatively small variations explainable by economic, demographic, spatial or temporal factors. However, travel and work were positively associated with income, suggesting that the primary tradeoff between money and time is located in the decision to work.

The data also confirmed markedly different behaviours between men and women, and between workers and non-workers.

**Communications and "Virtual Accessibility"**

- Some early writers forecast massive changes to economies, cities and urban life as a result of the rise of communications, and even the "death of the city".
- This has not so far been borne out, with the rapid growth of the Internet and other communications systems so far associated with increasing growth of many of the world's largest cities. Similarly, teleworking and home shopping have so far grown relatively slowly. Research suggests that home shopping may find a niche role, especially for time-pressed working women, but that as people gain more free time they are likely to view shopping as less of a chore and more as a recreation.
- The most recent writings seem to be leaning to a more complex and complete view of the likely impacts of telematics and the information "revolution". For example:
  - A new kind of city is emerging which is connected globally to other cities, depends primarily on advanced services, uses information as its primary raw material, and is polycentric, with decentralisation of employment to a number of key sub-centres.
  - The new communications media will not replace entirely the need for face-face communications but will add to existing channels and lead to a re-allocation of communications traffic according to the qualities required (synchronous versus a-synchronous; data versus non-verbal; local versus remote).
  - Much of the physical form of the city will probably remain. However there will be segregation over time in the workforce, with those who commute to the CBD to engage in physical production living in the inner suburbs, while home office workers engaged in the "virtual economy" migrate to outer suburbs, where land rents are lower, as they are less affected by transportation costs.
  - The minitiarisation and declining cost of computing power means that it will be increasingly embedded into everyday products, houses and even clothing.
  - The impacts of the new communications will be non-uniform, and will depend in part on deliberate social and political choices made by particular communities, and in part on the extent to which particular places are or can become attractive and desirable places to live.
Access Difficulties

- People with access difficulties generally fall into one or more of the following three categories:
  > Those living in areas with low accessibility (geographically disadvantaged)
  > Those with no access, or poor access, to a car (private transport disadvantaged)
  > Those with a physical or other disability affecting mobility (mobility disadvantaged).

- Low income can be a factor leading to access difficulties, as it affects the ability to afford housing in accessible areas, car ownership, and the affordability of taxis.

- In Australian cities, the focus of geographical disadvantage is the outer suburbs, particularly those at a distance from the main rail lines, which as demonstrated in Chapter 4, have low relative levels of accessibility by both car and public transport.

- In the United States, there has however been some recent focus on accessibility problems for low-income workers in inner city areas, where employment has generally been less buoyant than in the new suburban centres and edge cities. However analysis of job turnover data casts some doubt on this perspective.

- The reshaping of developed economy cities, including Sydney, around the car has been significant in the last fifty years. For example most new developments outside the CBD provide extensive car parking facilities and cars are the dominant means of access for most trips other than to the CBD. Consequently those without ready access to a car have relatively lower accessibility than those with access to private transport.

- However the success of the car has helped encourage urban sprawl, and with it longer journeys and more time spent travelling. It is now debatable whether overall levels of accessibility are increasing, and some have argued that cities with high levels of car dependence in fact have inferior accessibility despite spending more overall social resources on mobility.

- Approximately 10% of Australia’s population have a disability, which affects their mobility. This includes 3% who use wheelchairs or other mobility aids, as well as many with sight, hearing, intellectual or other disabilities.

- 45% of those with a disability affecting mobility are over 65. The ageing of Australia’s population means that the number of people with mobility handicaps is expected to increase by 40% by 2021.

- Almost half of those with a mobility handicap experience difficulty in using mainstream public transport, or cannot use it at all. They are therefore very dependent on taxis and in particular wheelchair accessible taxis (WAT). Despite efforts to make the bus and rail systems more accessible and to increase the size of the WAT taxi fleets, and the various taxi subsidy schemes, surveys of those with mobility handicaps reveal continued accessibility problems.

- Various strategies have been proposed for helping to address these issues, including the introduction of “personal public transport” based on appropriately designed maxitaxis operating on a continuous multihire basis. This is estimated to allow a fare structure 35-50% cheaper than current taxis, which together with 50% subsidy from government, could make accessible transport significantly more affordable and available for those with a mobility handicap.
Relevant Patterns and Trends

Travel Patterns and Trends in Sydney

- Personal travel in Sydney, particularly by car, is growing faster than population.
- Average household size has fallen slightly during the 1990’s, but not by enough to counter-act the growth in trips.
- Travel is rising for all trip purposes, with particularly strong growth in social/recreational and “serve passenger” trips.
- Nearly half of all weekday (unlinked) trips in Sydney in 2000 were made by car drivers, and 70% were by either car drivers or passengers.
- Private vehicle trips grew by 18.5% between 1991 and 2000, compared with a growth of 13.5% in rail trips. There was almost no change in the number of bus trips or walking trips during the decade, and a fall in bicycle trips of 12%.
- Cars are the dominant mode for all trip purposes, while public transport is particularly important for education / childcare trips (31%) and work trips (23%).
- The 1990’s has seen a significant mode shift away from walking to car trips for education / childcare, shopping, personal business and serve passenger trips, and small shifts away from public transport towards the car for most trip purposes.
- The most common reasons given for using cars for work trips is their superior travel times, comfort and convenience. Significant numbers also state availability or other problems with public transport, and the need for a car for company work / business.
- Trips are getting longer in Sydney for virtually all trip purposes (though trip lengths declined slightly for work trips). Trips are increasing in length for car drivers and bus passengers, but have reduced slightly for rail trips.
- Travel times have increased for most trip purposes (including work trips). This indicates rising road congestion. Total time spent travelling increased by 8% during the 1990’s, a factor of both rising average trip duration (5%) and rising trip frequencies.
- The number of people travelling increased at all time periods, and there is limited evidence of peak spreading, except for the latter part of the evening peak.
- There has been a significant increase in car driver trips by females, and by car passenger trips by males, and declines in bus and walk trips by both males and females.
- Mode shares vary significantly by age group, with car use peaking for the 41-50 year age group, and public transport being relatively more common for the 11-20 and over 70 year age groups. The percentage of trips by walking was relatively constant across the age groups, but highest among those over 70. However there have been major shifts in modal shares by age, with large declines in walking for those under 20 and over 60.

Overall the data indicates significant differences in travel patterns by age and gender in particular. They also suggest large shifts in modal travel patterns by the young and older age groups, and especially for education and social/recreational trips. These reflect a range of factors including rising car ownership and licence holding among females and safety / security concerns in relation to women and children. At the same time travel patterns of middle-aged groups have remained relatively stable.
Total travel is increasing rapidly, as is total time spent travelling. This is a function of increasing trip frequency, longer trips and rising traffic congestion, reflecting the changing population distribution patterns of Sydney as well as underlying social changes.

**Housing Preferences and Trends**

- The desire for home ownership has been very strong in Australia, with a significant majority of renters choosing that form of tenure because home ownership was unaffordable for them.
- There are some differences between Sydney and most other Australian capital cities. In particular the use of public transport is higher, housing is more expensive, densities are higher, and access problems are greater, reflecting the sheer size of the city.
- Among those who relocated residence between 1986 and 1991, accessibility was the main reason for choosing a location in Melbourne, Adelaide and Canberra, but was just beaten into second place by affordability in Sydney. For recent movers in Sydney, accessibility to work and family/social contacts were the most important, followed by access to public transport, schools/child care, shops, recreational/cultural and health/medical.
- Housing choice is however a complex phenomenon, with different individuals applying different weights to different factors.

**Information Technology in the Home**

- Nearly half of all households in Australia had access to a computer by the end of 1998, up from 30% five years earlier. The percentage of households with Internet access grew from zero to 18.6% over the same period. Usage of home computers appears to have grown in line with their availability.
- However the distribution and use of computers and the internet is not uniform: 
  - Teenagers are the heaviest computer users, and males have slightly higher rates of use than females
  - Use of the internet is linked with education and also family type, being most common among couples with children and least common among lone person households
- People’s ability to utilise computers and communications to provide “virtual access”, such as for home shopping, home banking or teleworking, is therefore linked to educational levels.

**Issues for Research**

The review of both local and international literature, and of trends and patterns in travel, housing and internet use in the home suggests a number of key issues to be examined using detailed survey data from Sydney. These are outlined in the table below:
### Table 2.13 Issues for Research

<table>
<thead>
<tr>
<th>Area</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel Behaviour</td>
<td>The extent to which accessibility influences the frequency of travel for different trip purposes</td>
</tr>
<tr>
<td>Housing Choice</td>
<td>The relative importance of accessibility in influencing housing preferences and choices for different sub-groups in the community</td>
</tr>
<tr>
<td>Time Use and Activity Patterns</td>
<td>The value placed on accessibility to different opportunities, and the extent to which this varies with lifestyle choices, socio-economic and demographic factors.</td>
</tr>
<tr>
<td>Internet and Communications</td>
<td>The extent of use of computers and the internet by different groups, and the degree to which this is affecting or likely to affect travel patterns</td>
</tr>
<tr>
<td>Access Difficulties</td>
<td>The extent and nature of accessibility problems for different groups in the population, and the ways in which this might be addressed.</td>
</tr>
</tbody>
</table>

Accordingly the survey questionnaire and survey design was structured so as to enable these issues to be analysed, using up-to-date and relevant data from Sydney. The details of the approach adopted are discussed in Chapter 3, while Chapter 4 presents the results of the analysis. These in turn are integrated with the results of mapping accessibility patterns in later Chapters of the thesis.
CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter examined the literature on accessibility and related topics, summarised some of the key findings, and identified a range of issues for which further research would be beneficial. This chapter discusses details of the research methodology adopted. In particular:

- Section 3.2 reviews the research objectives and findings from the literature review, and examines questions of data availability
- Section 3.3 describes the methodology adopted for this thesis and the reasons for adopting that approach
- Section 3.4 outlines details of the survey design adopted, including its focus, sampling method, and characteristics of the survey areas
- Section 3.5 describes the desirable properties of accessibility indicators, and evaluates a range of potential indicators against those criteria.
- Section 3.6 summarises the main points about the research methodology.

3.2 RESEARCH OBJECTIVES AND DATA AVAILABILITY

Key Research Questions

The key research questions identified for the thesis and outlined in Chapter 1 were:

- How valid is the “classic” concept of accessibility in a contemporary urban context, and does it need to be modified to take account of social factors and of the concept of “virtual access”?
- What are the patterns of accessibility in Sydney, and how do these vary for different locations, activities and modes?
- What are the accessibility problems facing particular individuals or groups?
- How can accessibility be improved, both overall or for those people with particular access problems? Which transport investment strategies, planning policies or other measures are likely to be the most effective in this regard?

The choice of Sydney as a case study is based on:

- The lack of recent studies of accessibility in Sydney
- The availability of key data on land use, transport and other factors
- The potential to link theoretical measures with detailed survey-based data
- The difficulty of undertaking such a comprehensive study in more than one city.

Accordingly the steps taken to answer the key research questions are to:

- Examine the meaning of accessibility in the current context
• Develop appropriate measures of accessibility which can be used to examine the patterns and trends in accessibility in Sydney, and to identify and analyse accessibility problems
• Explore potential policy measures and their impacts on relative accessibility and accessibility problems identified above.

Implications of the Literature Review

Chapter 2 explored some of the factors which underlie accessibility in an urban context, and some of the key relationships between accessibility and other variables. Some of the key findings are summarised briefly below:

Definitions of Accessibility

• There is no single definition of accessibility, which has been universally recognised as suitable for all situations. However most definitions take into account the spatial distribution of activities, and their relative importance or attractiveness, as well as the time or cost of reaching those activities.
• The "classic" definition involves use of a gravity index, and has been widely used. Alternative definitions based on utility theory have been developed and have a more solid theoretical base, but in practice are similar to the earlier approaches.
• Hagerstrand and others have developed spatial-temporal indicators which take into account time constraints, but these have not proved practical for application at a metropolitan scale.

Accessibility and Travel Behaviour

• Relative accessibility appears to influence mode choice and trip length but the extent to which it influences trip frequency is less clear.

Accessibility, Land Use and Housing

• Early models of urban structure and dynamics were based on simple, monocentric cities, and are no longer representative of real cities given the development of edge cities, suburban shopping malls and secondary centres.
• Hence accessibility modelling of real cities needs be more sophisticated so as to encompass this complexity. This implies use of relatively fine-grained data on land use patterns and travel times.
• Accessibility, housing development patterns and urban density have been shown to be closely related. Accessibility is a key input to housing choice.
• The impact of the car from the 1950's helped generate the spread of low density urban "sprawl" in Australian cities which led to declining density, but more recently the emergence of urban consolidation has led to increasing urban density.
• Recent theories of urban development have postulated "organic" growth processes, with the city never being in equilibrium, and with the possibilities of new "patterns" of growth emerging.

Accessibility and Time Use / Activity Modelling

• Research into people's use of time has highlighted the need to consider the purpose of travel being undertaken. It has also highlighted differences in travel
patterns between different groups, such as males and females, and the importance of a social dimension to travel behaviour.

**Accessibility and the Internet**

- The rapid growth of the internet and modern communications have not so far led to the demise of cities, or eliminated the importance of physical accessibility. The most recent writings suggest that the need for face-to-face communications will continue, and that much of the physical structure of cities will remain, but that there may be changes within cities such as the housing preferences of different groups, or patterns of travel behaviour.

**Access Difficulties**

- Those with relative access difficulties include residents in outer suburbs (particularly at some distance from rail lines), those without access to a car, and those with a physical mobility handicap.
- The spread of car ownership has improved accessibility generally, and changed land use patterns. This has increased relative access problems for the car-less.
- 10% of Australians have a disability, which affects their mobility, and half of these are over 65 years old. The ageing of society will increase the importance of this issue in future.

The literature review also highlighted some key issues for which additional research would be beneficial, in particular:

- Whether accessibility influences the trip frequency for different purposes
- The relative importance of accessibility in influencing housing choices for different sub-groups in the community
- The extent and use of computers and the internet by different groups, and the degree to which this is affecting or might affect travel patterns and the need for physical access.
- The extent and nature of accessibility problems for different groups in the community, and ways in which these might be addressed.

**Data Availability Issues**

Given the research objectives, the following summary examines the current situation with regard to the availability of relevant data

**Survey Data**

There have been a wide variety of surveys undertaken in Australia on topics with relevance to the issue of accessibility, including:

- ABS surveys on issues such as housing trends and preferences (ABS 1992, 1998 b, 1999 a, 2000); the use of time (ABS 1999 b); travel patterns and choices (ABS 1996 a, 1996 b, 1998 a); the growth of the internet (ABS 1999 c); and social and demographic change (ABS 1999 d, 1998 c)
• continuous household travel surveys undertaken by the Transport Data Centre to measure detailed travel behaviour (for example NSW Transport Data Centre, 2002). While based on a relatively small sample for the purposes of analysing travel at a fine geographic scale (smaller than a Statistical Local Area), this source provides details on trips for all purposes, as well as car ownership, socio-economic and demographic profiles.

• one-off surveys such as those undertaken by the Warren Centre (2001) and the Planning Research Centre (2002).

However there appear to be no recent surveys focusing specifically on the subject of accessibility in general, and specifically in Sydney. The most recent comprehensive study of accessibility in Sydney appears to be that by Black (1977). This provided detailed analysis of accessibility patterns but is based on data over 25 years old.

**Travel Model Estimates for Sydney**

Comprehensive, up-to-date and fine-grained estimates are available on travel times, land use (population, employment etc) and travel patterns for Sydney. In particular:

• The Transport Data Centre maintains a detailed database of population and employment at travel zone level, based on analysis of census and other data. This also includes estimates of land use patterns for the future.

• In addition, the TDC maintains a detailed transport model for the Sydney metropolitan area, which includes information on thousands of road and public transport links. This enables detailed estimates of travel times between specific travel zones to be estimated for both car and public transport. It also provides estimates of travel by motorised means (cars and major public transport modes) between zone pairs as well as travel demand on particular transport links.

**Multi-City Comparisons**

Some comparative information is available across different cities and for a range of countries. In particular Kenworthy and Laube (2000) provide cross-sectional and time series data for a selection of some 40 cities, including population and employment at a course geographic scale (CBD, inner areas, outer suburbs), car-based and public transport travel, energy consumption etc. However this data is too coarse-grained to allow detailed analysis of accessibility at sub-metropolitan scale, while difficulties with compatibility between different data sets would make comparisons between different cities difficult.

### 3.3 DEVELOPMENT OF RESEARCH METHODOLOGY

The research methodology adopted for the thesis (see Table 3.1) was generated by:

• Identifying the key study objectives
• Identifying the key data / information required to address those
• Examining the current situation and identifying any data deficiencies
• Developing an approach to address any data deficiencies and to enable the key objectives to be met.
Table 3.1 Development of Research Methodology

<table>
<thead>
<tr>
<th>Study Objective</th>
<th>Data / Information Requirement</th>
<th>Current Situation</th>
<th>Proposed Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate current validity of concept of accessibility</td>
<td>Detailed data on relationship between accessibility and other factors for different individuals / groups</td>
<td>No current data on importance of accessibility to different groups, impact of internet on travel patterns etc</td>
<td>Specific survey of Sydney residents to provide detailed cross-sectional data on these issues</td>
</tr>
<tr>
<td>Analyse patterns of accessibility in Sydney</td>
<td>Detailed maps showing accessibility across Sydney at small area scale</td>
<td>Most recent maps produced in late 1970's</td>
<td>Development and mapping of accessibility indicators based on fine-grained data for Sydney</td>
</tr>
<tr>
<td>Identify access difficulties facing particular groups</td>
<td>Analysis of access problems facing specific groups</td>
<td>Some information available but not at detailed geographic scale</td>
<td>Use combination of mapping and survey data</td>
</tr>
<tr>
<td>Analyse options to improve accessibility</td>
<td>Estimate improvements arising from different options such as changes in land use or in transport systems</td>
<td>Insufficient data to evaluate details</td>
<td>Use Indicators and mapping techniques to show changes in accessibility patterns arising from different options</td>
</tr>
</tbody>
</table>

Accordingly, the approach adopted includes:

- Conducting a specific survey of residents in Sydney to gather original and up-to-date data in Sydney related to accessibility issues, especially the issues identified in the literature review.
- Developing appropriate accessibility indicators which could be used for measuring patterns and trends in accessibility in Sydney at a reasonably fine geographic scale, and which could draw on available data and where appropriate the results of the survey data.
- Using the combination of the survey data and indicators to address questions such as access problems and ways to improve accessibility.

3.4 SURVEY DESIGN

Focus of the Survey

Given the nature of the research, questions were designed to provide information on the following topics of interest:

- The type of activities and opportunities, which people want to access.
- The importance people place on access to those activities / opportunities.
- The role of accessibility in influencing housing choices.
- The access problems which people face (including physical, time-related, financial and information-related).
- The availability of communications facilities (e.g., Internet, mobile phones) and people’s use of them for home banking, home shopping, teleworking etc.
- Lifestyle preferences, the use of time and time pressures
- Priorities for government action to address accessibility needs or to help reduce access problems.

In addition, the survey was designed to gather information on major aspects of travel (for non-holiday periods) including:

- locations of key activities utilised (work, school(s), main shopping centres, recreational facilities, friends and relatives frequently visited, medical and personal business facilities used etc)
- frequencies of travel to these activities
- modes of transport used.

Given that the Transport Data Centre has an on-going survey which collects very specific information on every trip undertaken by a representative sample of households across Sydney, it was considered unnecessary (as well as impractical) to collect this level of detail for the survey respondents. Rather the emphasis was on linking data on typical travel patterns to information on the underlying rationale for that travel.

**Demographic and other Household Data**

The literature review indicated that the key factors affecting accessibility and travel patterns were expected to include:

- location (in particular of housing, but also of employment, shops etc.), which affects the quality of accessibility by public transport and to a lesser extent private vehicles
- car ownership and availability (both between and within households)
- occupational status (full time, part time, not in workforce)
- age, sex and stage in the lifecycle
- role within the family (for example mothers tend to have more responsibilities for picking up children etc.)
- income levels.

Accordingly the survey included a range of questions to gather relevant socio-economic, demographic, dwelling details and car ownership data.

**Clustered Sample Design**

The sample was also designed to include:

- households from inner, middle and outer suburbs of Sydney
- households with varying levels of access to public transport within each of those areas
- a range of socio-economic groups from lower to upper income levels
data from as many members of a household as possible above the age of 18 years, so as to tap into the different accessibility needs and preferences of individuals within each household as well as the differences between households.

Budget restrictions limited the total sample size to approximately 600 respondents. Accordingly a clustered sampling technique was used to enable statistical testing and to ensure that sufficient sample sizes for key demographic and other sub-groups were obtained:

- The local government areas of South Sydney, Willoughby and Liverpool were chosen since they are located in different sub-regions of Sydney (the inner south, northern and western suburbs respectively), and have a range of socio-economic, housing and accessibility characteristics (see table 3.2 below).
- Within each LGA, four travel zones were selected, with different levels of access to public transport. This provided variation within each area (see figure 3.1).
- Within each of the twelve travel zones, streets were selected at random, and dwellings sampled within each street. This ensured a range of housing types, since, for example, apartments tend to be clustered in specific areas.
- Within each household, the adult (person over 18) with the next birthday who was at home was selected for a face-face interview. Additional interview forms for other adult members of the household were also left to be filled in and mailed back.

The map below shows the location of the 12 travel zones selected (four in each LGA), in relation to the overall Sydney region and to the rail network.

**Figure 3.1 Travel Zones Selected for the Survey**
The three LGA’s (South Sydney, Willoughby, Liverpool) differ significantly in terms of socio-economic and housing characteristics, and in terms of accessibility by both public transport and car, as shown in table 3.2 below.

### Table 3.2 Characteristics of Survey Areas

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>South Sydney</th>
<th>Willoughby</th>
<th>Liverpool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-Economic</td>
<td>Mixed age and income groups; undergoing gentrification.</td>
<td>Established area, mainly middle-upper income.</td>
<td>Mainly lower socio-economic groups but some areas with higher income groups</td>
</tr>
<tr>
<td>Housing</td>
<td>Mainly medium density terraces and apartments. A significant volume of new apartments is being added, particularly in the vicinity of Green Square, with extensive urban consolidation.</td>
<td>Mainly low density detached housing but with significant number of units in some areas near Chatswood.</td>
<td>Mainly low density detached housing though significant concentrations of older style unit development in some areas near Liverpool station. Large scale expansion of low density housing occurring in western areas.</td>
</tr>
<tr>
<td>Public Transport Accessibility</td>
<td>Generally high, given proximity to the CBD and other job concentrations and a relatively dense bus network. Completion of the Airport Rail line has further improved public transport accessibility.</td>
<td>Generally medium – high levels of accessibility depending on location in relation to rail line.</td>
<td>Generally low given the distance from CBD and other major centres and the relatively slow rail service. Areas remote from rail line have very low accessibility but this will improve with the Parramatta - Liverpool Bus-Only Transitway, currently under construction.</td>
</tr>
<tr>
<td>Road-based Accessibility</td>
<td>Generally high level of accessibility to employment, CBD, airport etc, though significant congestion and heavy industrial traffic. Completion of the Eastern Distributor has resulted in removal of some through traffic and reduction in road congestion.</td>
<td>Generally high accessibility to CBD, jobs, recreational facilities etc.</td>
<td>Generally low, given distances to major job concentrations and quality of road network. Some improvements have however occurred since the construction of the M5 motorway.</td>
</tr>
</tbody>
</table>

Source: ABS (various), Liverpool City Council (1999), South Sydney Development Corporation (2000).

As illustrated below, all three local government areas have experienced strong population growth in the last five years, being among the fastest growing LGA’s in the State (based on percentage growth rates). This meant that it was easier to find households with recent movers, which was important for examining issues such as housing preferences.
Table 3.3  Population Trends in Selected Local Government Areas

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>South Sydney</td>
<td>73,989</td>
<td>85,859</td>
<td>+11,870</td>
<td>+16.0%</td>
<td></td>
<td>4th</td>
</tr>
<tr>
<td>Willoughby</td>
<td>54,520</td>
<td>60,498</td>
<td>+5,978</td>
<td>+11.0%</td>
<td></td>
<td>12th</td>
</tr>
<tr>
<td>Liverpool</td>
<td>112,823</td>
<td>143,281</td>
<td>+30,458</td>
<td>+27.0%</td>
<td></td>
<td>3rd</td>
</tr>
</tbody>
</table>


Initial Classification by Accessibility

For the purposes of selecting zones and undertaking analyses of the sample, three broad measures of accessibility were used:

LGA Accessibility.

This is a crude measure of the overall accessibility to employment of the LGA within the Sydney Region. Liverpool, the furthest from the CBD and other key job concentrations such as the central industrial area, was classified “Low”; South Sydney, the closest to those major job concentrations, was classified “High” and Willoughby which is in an intermediate situation was classified “Medium”.

Public Transport Accessibility

Individual zones were classified as “Low”, “Medium” or “High” according to how far their centroid was from the nearest rail station, with “High” classification where the zone centroid is less than 1km from the nearest station, “Medium” where it is between 1 and 2 km, and “Low” where it is more than 2km.

Overall Accessibility

This was a composite measure defined as follows:

Overall Accessibility = LGA Accessibility + Public Transport Accessibility

Five classifications, ranging from “Very Low” to “Very High” were used.

More sophisticated measures of accessibility are developed in Chapter 5 of the report.

Sample Size and Data Collection

It was intended that a total sample of approximately 600 persons would be collected, with at least 40 from each zone. In the event, a total of 583 completed questionnaires were collected, broken down by LGA and Zone as shown in table 3.4. The minimum number of completed questionnaires from any one zone was 39.
Table 3.4  Initial Accessibility Measures by Zone

<table>
<thead>
<tr>
<th>Local Government Area</th>
<th>Zone No</th>
<th>Sample Size</th>
<th>LGA Accessibility</th>
<th>PT Accessibility</th>
<th>Overall Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liverpool</td>
<td>365</td>
<td>52</td>
<td>Low</td>
<td>Low</td>
<td>Very Low</td>
</tr>
<tr>
<td></td>
<td>582</td>
<td>52</td>
<td>Low</td>
<td>Low</td>
<td>Very Low</td>
</tr>
<tr>
<td></td>
<td>362</td>
<td>64</td>
<td>Low</td>
<td>Med</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>714</td>
<td>40</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Sub-Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>208</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willoughby</td>
<td>506</td>
<td>52</td>
<td>Med</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>501</td>
<td>58</td>
<td>Med</td>
<td>Med</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>504</td>
<td>47</td>
<td>Med</td>
<td>Med</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>788</td>
<td>45</td>
<td>Med</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Sub-Total</td>
<td></td>
<td></td>
<td>202</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Sydney</td>
<td>143</td>
<td>39</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>82</td>
<td>45</td>
<td>High</td>
<td>Med</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>79</td>
<td>39</td>
<td>High</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td></td>
<td>145</td>
<td>50</td>
<td>High</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Sub-Total</td>
<td></td>
<td></td>
<td>173</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>583</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Author

Thus there was a relatively even distribution within the total sample by the different measures of accessibility, as shown below:

Table 3.5  Distribution of Sample by Different Measures of Accessibility

<table>
<thead>
<tr>
<th>Classification</th>
<th>LGA Accessibility</th>
<th>PT Accessibility</th>
<th>Overall Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>35.7%</td>
<td>33.4%</td>
<td>17.8%</td>
</tr>
<tr>
<td>Low</td>
<td>34.6%</td>
<td>36.7%</td>
<td>31.6%</td>
</tr>
<tr>
<td>Med</td>
<td>29.7%</td>
<td>29.9%</td>
<td>15.4%</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td>15.3%</td>
</tr>
<tr>
<td>Very High</td>
<td></td>
<td></td>
<td>100.0%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Source: Author

Survey Instrument and Data Collection

The Survey Instrument used is included as Attachment 1. This was developed initially as a draft questionnaire, which was piloted before being finalised. As a result of the pilot testing, a number of questions were re-worded slightly and the codings changed to improve clarity. The researcher developed the structure of the survey and questions used, with assistance from the supervisor and review from the sponsoring group. In addition, technical assistance on specific wording of the questions was provided by Surveys Australia, who undertook the survey data collection and coding.

The actual survey was conducted between February and March 2001, to avoid school/university holiday periods.
Relationship to the Household Travel Survey

The proposed survey was designed to complement, but not overlap with, the continuous Household Travel Survey being carried out for the NSW Transport Data Centre. Details of that survey are summarised below:

- The HTS commenced in 1997, and involves 3,500 households per annum surveyed on a continuous basis of approximately 10 households per day. Data from the first three waves (1997/8, 1998/9 and 1999/2000) have recently been released.

- The survey covers:
  - detailed demographic and socio-economic characteristics
  - highly detailed inventories of every trip taken by every individual in the household for a given day
  - limited other information (e.g. on reasons for using or not using the car for the journey to work).

- The data is used for several purposes:
  - To monitor trends in overall travel patterns in Sydney, for example trends in mode share or in total vehicle kilometers of travel.
  - To provide inputs into the development of models for estimating travel in the Sydney Region.

The Transport Data Centre has recently completed development of its model for journeys to work. This model will enable estimates of car and public transport work trips at different times of the day and for future land use patterns and transport networks. The TDC is also calibrating new models for other trips purposes, probably four broad non-work trips categories (shopping; social-recreational; education; and employer and personal business). Calibration of these models will involve development of appropriate estimates of the distribution of attractions (retail facilities, social-recreational attractions; schools, universities etc; business and personal services). While the survey provides highly detailed snapshot information on actual travel patterns, it does not:

- ask any questions about accessibility per se.
- ask any questions about any transport or accessibility problems which people face
- examine travel patterns over longer timeframes (eg it does not measure the extent to which travel patterns for given individuals vary over the week).
- examine the time pressures on people or the details of the activities undertaken between trips.

Discussions with the Transport Data Centre indicated that they saw the proposed survey on accessibility as being complementary to their own survey and a potentially useful source of additional data. Currently the only accessibility analysis undertaken by the TDC is to produce maps of travel times by car and public transport to particular sites (eg potential shopping centre sites). In terms of detailed survey design, similar questions were used where possible (eg on socio-demographic data) to maximise complementarity with the Household Travel Survey.
3.5 DEVELOPING ACCESSIBILITY INDICATORS

Desirable Properties of Accessibility Indicators

As discussed earlier, there have been a wide variety of accessibility indicators used in the literature. To be useful, accessibility indicators should ideally have the following characteristics:

(a) **Intuitively understandable with a simple meaning and interpretation**

For example, indicators such the number of opportunities which can be reached within a certain time are intuitively easy to understand and interpret, whereas indicators which measure accessibility as an abstract number are less easy to interpret.

(b) **Able to distinguish between different groups in the community**

As discussed in the literature review, different groups in the community may place different value on access to different opportunities, or may have different characteristics (such as car ownership or a mobility handicap). Any indicators developed should be able to be applied as relevant to particular groups.

(c) **Able to reflect changes in land use and transport infrastructures/services**

Clearly any indicator should respond to changes in land use patterns or the provision of transport infrastructure or services since these are the key inputs to accessibility.

(d) **Broadly applicable and robust – i.e. not dependant on a narrow data set**

Some indicators involve formulae, which require calibration for particular cities or applications, based on extensive modelling and parameter fitting. This means that different formulae need to be used for different cities, or for the same city for different purposes. In addition, such indicators may need to be re-calibrated every time new information becomes available. Such measures are therefore neither robust nor widely applicable. By contrast, some indicators can be defined so that the formula is the same for different cities and for different purposes. Such indicators are therefore more universal, robust and likely to be widely applied.

Commonly used Accessibility Indicators

A large number of accessibility measures have been used in the literature. Three of the most common are described below, in terms of how well they satisfy the desirable properties:

(1) **Threshold Accessibility Indices**

These measure the number of opportunities which can be reached from a given location or zone within a given threshold – for example 45 minutes travel time, or 10 km. (see for example Black, 1977).
Threshold accessibility measures are easy to understand and interpret. They can also be defined as required for particular sub-groups of the population. For example for people without access to a car, travel times can be measured by public transport, while for people with a car, they can be measured as the minimum of the travel time by car and by public transport.

However they do not necessarily reflect changes in land use or transport systems and suffer from lack of robustness. In particular:

- The choice of threshold is essentially arbitrary, but can significantly alter the resultant measures. For example small cities might need to use smaller cutoffs than large cities, which makes comparison across cities difficult.
- Similarly, if a given zone is just beyond the threshold distance from a major job concentration such as the CBD, then this will affect its accessibility to employment compared with a zone which is just within the threshold.
- In addition, an upgrade to a rail line or road network, which occurs beyond the threshold of a given zone, will not be reflected in changes to the accessibility of that zone.

(2) Absolute Accessibility Values (AAV), measured across all opportunities

This type of measure sums the access to all opportunities in a region (usually metropolitan), taking into account a measure of attractiveness of the opportunity and the travel impedance to that opportunity, which is usually measured by some combination of travel time, distance and cost. Thus the Absolute Accessibility Value (AAV) of location (i) is defined as follows:

\[ AAV(i) = \sum_j (F(A_j) \times G_{ij}), \]

where:

- \( F(A_j) \) is the attractiveness of location j, a function of the number or size of attractions/opportunities at that location, and
- \( G_{ij} \) is the impedance between i and j, and is a suitable function of the travel time, cost, distance etc between the locations.

These types of accessibility indexes can also be applied to different sub-groups in the population, and they avoid the threshold problem. However they fail to have a readily understandable or intuitive meaning. For example it is not easy to interpret a result such as the accessibility of a given zone is, say, 146.2.

In addition, they are not necessarily robust in that they depend on the form of the impedance function (see discussion below on evaluation of robustness).

Several different impedance functions are commonly used, including inverse power functions and inverse exponential functions. Hence AAV indicators are not ideal from this perspective (see for example, Batty and Kim, 1992 for a discussion of the relative merits of these types of functions as applied to urban density models, and Sen and Smith, 1995, for an extensive discussion of such functions in relation to Gravity Models).
Relative Accessibility Values (RAV), measured across all opportunities

A variant of the above is to convert such absolute accessibility measures into relative accessibility measures, by dividing by the average accessibility across a region. For example:

$$\text{RAV} (i) = \frac{\text{AAV} (i)}{\text{Average Region} \ (\text{AAV} (i))}$$

This type of value can also be applied to particular sub-groups in the population, and also avoids the threshold problem. However it also has a major advantage in that it allows an intuitive interpretation. For example it makes intuitive sense to say that a given location has 50% of the average accessibility of the region.

However, as explained later, this measure is also not robust, in that it varies significantly according to the particular form of the impedance function used.

New Measures of Accessibility

From the above discussion, there is a need to find a robust indicator. The indicators below were developed to achieve this.

Equivalent Cost (EC) or Equivalent Travel Time (ETT)

A further type of measure, which can be derived from the earlier AAV function, is the equivalent cost or equivalent travel time. This is the cost or travel time which, if applied to all opportunities in the region, would lead to an equivalent value of absolute accessibility.

$$\text{EC} (i) = G^{-1} \left( \frac{\text{AAV} (i)}{\sum_j (A_j)} \right)$$

where $G^{-1}$ is the inverse of the impedance function used to calculate the Absolute Accessibility Value. For example, if the impedance function is based on travel time, then:

$$\text{ETT} (i) = G^{-1} \left( \frac{\sum_j (F(A_j) \ast G(T_{ij}))}{\sum (A_j)} \right)$$

where $T_{ij}$ is the travel time between $i$ and $j$.

Like the earlier threshold, absolute accessibility and relative accessibility indicators, EC and ETT indicators can be applied to particular sub-groups of the population. For example a person with a mobility handicap may not be able to drive, and may be only able to walk with difficulty. This can be reflected in the travel times and mode choices available to that person.

Furthermore, they have an intuitive meaning. For example, consider the case of access to university campuses, where there might be 10 facilities with a total of 100,000 student places, and where the measure of impedance used is simple travel time. Then to say that a particular location has an ETT of, say 25 minutes (by car) means that if all 100,000 university places were located in a single zone some 25 minutes away, this would produce an equivalent absolute accessibility value, as illustrated in the diagram below:
Figure 3.2  Concept of Equivalent Travel Time

(a) Access times to various opportunities with attractiveness $A_1, A_2, A_3, A_4, A_5$ are $T_1, T_2, T_3, T_4, T_5$, respectively.

(b) ETT is the travel time to a hypothetical opportunity $A$, with attractiveness equivalent to the sum $A_1, A_2, A_3, A_4$ and $A_5$.

EC and ETT indicators thus measure accessibility in commonly understood terms, such as dollars or minutes of travel time. By using EC or ETT as measures of accessibility, it is relatively easy to understand how accessibility to particular opportunities (such as university places) varies across a city.

These measures also reflect changes in land use or transport infrastructure, such as the effect of establishing a new campus, or improving the transport service to an existing facility. EI and ETT also have another important property – they are relatively robust in that they are less affected by changes to the particular form of the impedance function used to measure the accessibility values (see discussion in next section). They also do not have any arbitrary "cut-off" value as applies to the case of threshold indicators.

(5) Relative Cost (RC) or Relative Travel Time (RTT)

The Equivalent Cost / Equivalent Travel Time measure can be used to define new measures of Relative Cost / Travel Time in two ways:

(a) Relative to the Average across the metropolitan area, for a given mode

RC (i) = $\frac{EC (i)}{Average (EI (i))}$;  RTT (i) = $\frac{ETT (i)}{Average (ETT (i))}$

(b) Relative Cost / Travel Time between modes, for each zone.

RC (public transport / car) = $\frac{EC (public transport)}{EC (car)}$

RTT (public transport / car) = $\frac{ETT (public transport)}{ETT (car)}$

The former allows relative spatial variation to be more clearly seen, and is highly robust. The latter allows the patterns of relative accessibility between modes to be seen.
Evaluation of Robustness

Robustness is a measure of how invariant a measure is to changes in the particular functional forms and parameters used in the impedance function. In order to explore this issue for various accessibility measures, a simplified model has been constructed for a five-zone city. The model enables testing of the extent to which different types of accessibility indicator depend on the pattern of land-uses assumed in the city, or on the nature of the travel impedance functions used. The following discussion describes:

- The zone structure and travel times assumed between the different zones
- Five alternative land use scenarios
- Four alternative travel impedance functions
- Four types of accessibility indicator

Zone Structure and Travel Times

Imagine a simple 5-zone city, arranged in linear form, and with inter-zone travel times as shown in the table below and illustrated in Figure 3.3 (for simplicity, impedance is taken as travel time):

<table>
<thead>
<tr>
<th>From Zone</th>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>Zone 4</th>
<th>Zone 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Zone 2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Zone 3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Zone 4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Zone 5</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 3.3 Hypothetical Model - Travel Times from Zone 1

(Note: The 5-zone model is a simplification of the much more complex calculations used in actual calculations of accessibility, but serves to make the calculations more transparent).
Alternative Land Use Scenarios

Now imagine five alternative land-use arrangements, with different distributions of opportunities, as shown below (see also Figure 3.4):

Table 3.7 Hypothetical Model - Alternative Land Use Scenarios

<table>
<thead>
<tr>
<th>Distribution Type</th>
<th>Distribution of Opportunities (Total = 20 units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>Zone 2</td>
</tr>
<tr>
<td>(a): Uniform Distribution</td>
<td>4</td>
</tr>
<tr>
<td>(b): Polar Distribution</td>
<td>10</td>
</tr>
<tr>
<td>(c): Completely centralised</td>
<td>0</td>
</tr>
<tr>
<td>(d): Totally Asymmetric</td>
<td>20</td>
</tr>
<tr>
<td>(e): Off-Centre CBD with secondary centre</td>
<td>2</td>
</tr>
</tbody>
</table>

Alternative Travel Time Impedance Functions

Four alternative impedance functions are used below to illustrate typical formulations:

Table 3.8 Hypothetical Model - Alternative Impedance Functions

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (-1)</td>
<td>Power</td>
<td>$A(i) = \sum_j \frac{O(j)}{TT(i,j)}$</td>
</tr>
<tr>
<td>Power (-2)</td>
<td>Power</td>
<td>$A(i) = \sum_j \frac{O(j)}{TT(i,j)^2}$</td>
</tr>
<tr>
<td>Exponential (-1)</td>
<td>Exponential</td>
<td>$A(i) = \sum_j (O(j) \times \exp(-TT(i,j)))$</td>
</tr>
<tr>
<td>Exponential (-2)</td>
<td>Exponential</td>
<td>$A(i) = \sum_j (O(j) \times \exp(-2\times TT(i,j)))$</td>
</tr>
</tbody>
</table>

Alternative Measures of Accessibility

For each of these, four accessibility indices are calculated: AAV (Absolute Accessibility Value), RAV (Relative Accessibility Value), ETT (Equivalent Travel Time), and RTT (Relative Travel Time).

Resulting Accessibility Values

The accessibility values for each zone are shown in table 3.10 below, and results for the two relative measures (RAV and RTT) are illustrated in figure 3.4. As can be seen from the table and graphs:

- All measures capture the effects of land use and travel times on accessibility. For example:
  - the uniform land use distribution produces relatively constant values of accessibility across the zones, with slightly lower values for zones 1 and 5 at the extremities of the region
  - the polar distribution conversely produces highest levels of accessibility (and lowest levels of relative travel time) at the extremities
The centralised distribution produces a high peak of accessibility in Zone 3 where the opportunities are concentrated.

The asymmetric distribution produces highest accessibility at zone 1 where all the opportunities are assumed to be concentrated, with accessibility falling off with increasing distance from that zone.

The off-centre CBD with secondary centre distribution produces highest levels of accessibility in zone 2, but with the influence of the secondary centre also apparent.

For any given land use distribution, the AAV and RAV values for particular zones are dependent on the choice of impedance function. However the ETT and particularly the RTT values vary only slightly and in some cases do not vary at all. This demonstrates that ETT and RTT are the most robust measures.

Conclusion

The table below summarises the main features of the various measures and the extent to which they satisfy the desirable properties of an accessibility indicator.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Type of Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Threshold Indices</td>
</tr>
<tr>
<td>Ease of interpretation and understanding</td>
<td>High</td>
</tr>
<tr>
<td>Ability to reflect specific sub-groups in the population</td>
<td>Yes</td>
</tr>
<tr>
<td>Ability to reflect land use and transport changes</td>
<td>Low</td>
</tr>
<tr>
<td>Degree of robustness</td>
<td>Low</td>
</tr>
</tbody>
</table>

The EI/ ETT and RI/RTT indicators score well on all criteria. They are therefore considered the most appropriate to use for measuring accessibility for metropolitan areas, provided the data to support them is available. This issue is further considered in Chapter 5.
### Table 3.10  Hypothetical Model - Comparison of Accessibility Indicators

**Land Use Option:** Uniform Distribution

<table>
<thead>
<tr>
<th>Impedance Function</th>
<th>AAV</th>
<th>RAV</th>
<th>ETT</th>
<th>RTT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From Zone</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.46</td>
<td>0.29</td>
<td>0.12</td>
<td>0.03</td>
</tr>
<tr>
<td>2</td>
<td>0.52</td>
<td>0.33</td>
<td>0.14</td>
<td>0.03</td>
</tr>
<tr>
<td>3</td>
<td>0.53</td>
<td>0.34</td>
<td>0.15</td>
<td>0.04</td>
</tr>
<tr>
<td>4</td>
<td>0.52</td>
<td>0.33</td>
<td>0.14</td>
<td>0.03</td>
</tr>
<tr>
<td>5</td>
<td>0.46</td>
<td>0.29</td>
<td>0.12</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>0.50</td>
<td>0.32</td>
<td>0.13</td>
<td>0.03</td>
</tr>
</tbody>
</table>

**Land Use Option:** Polar Centralised

<table>
<thead>
<tr>
<th>Impedance Function</th>
<th>AAV</th>
<th>RAV</th>
<th>ETT</th>
<th>RTT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From Zone</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.60</td>
<td>0.52</td>
<td>0.19</td>
<td>0.07</td>
</tr>
<tr>
<td>2</td>
<td>0.38</td>
<td>0.16</td>
<td>0.08</td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>0.33</td>
<td>0.11</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>0.38</td>
<td>0.16</td>
<td>0.08</td>
<td>0.01</td>
</tr>
<tr>
<td>5</td>
<td>0.60</td>
<td>0.52</td>
<td>0.19</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>0.46</td>
<td>0.29</td>
<td>0.12</td>
<td>0.03</td>
</tr>
</tbody>
</table>

**Land Use Option:** Completely Centralised

<table>
<thead>
<tr>
<th>Impedance Function</th>
<th>AAV</th>
<th>RAV</th>
<th>ETT</th>
<th>RTT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From Zone</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.33</td>
<td>0.11</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>0.25</td>
<td>0.14</td>
<td>0.02</td>
</tr>
<tr>
<td>3</td>
<td>1.00</td>
<td>1.00</td>
<td>0.37</td>
<td>0.14</td>
</tr>
<tr>
<td>4</td>
<td>0.50</td>
<td>0.25</td>
<td>0.14</td>
<td>0.02</td>
</tr>
<tr>
<td>5</td>
<td>0.33</td>
<td>0.11</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>0.53</td>
<td>0.34</td>
<td>0.15</td>
<td>0.04</td>
</tr>
</tbody>
</table>

**Land Use Option:** Totally Asymmetric

<table>
<thead>
<tr>
<th>Impedance Function</th>
<th>AAV</th>
<th>RAV</th>
<th>ETT</th>
<th>RTT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From Zone</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.00</td>
<td>1.00</td>
<td>0.37</td>
<td>0.14</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>0.25</td>
<td>0.14</td>
<td>0.02</td>
</tr>
<tr>
<td>3</td>
<td>0.33</td>
<td>0.11</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
<td>0.06</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>5</td>
<td>0.20</td>
<td>0.04</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>0.46</td>
<td>0.29</td>
<td>0.12</td>
<td>0.03</td>
</tr>
</tbody>
</table>

**Land Use Option:** Off-Centre CBD with Secondary Centre

<table>
<thead>
<tr>
<th>Impedance Function</th>
<th>AAV</th>
<th>RAV</th>
<th>ETT</th>
<th>RTT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From Zone</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.46</td>
<td>0.26</td>
<td>0.12</td>
<td>0.02</td>
</tr>
<tr>
<td>2</td>
<td>0.70</td>
<td>0.59</td>
<td>0.23</td>
<td>0.07</td>
</tr>
<tr>
<td>3</td>
<td>0.55</td>
<td>0.34</td>
<td>0.16</td>
<td>0.03</td>
</tr>
<tr>
<td>4</td>
<td>0.49</td>
<td>0.31</td>
<td>0.13</td>
<td>0.03</td>
</tr>
<tr>
<td>5</td>
<td>0.35</td>
<td>0.15</td>
<td>0.06</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>0.51</td>
<td>0.33</td>
<td>0.14</td>
<td>0.03</td>
</tr>
</tbody>
</table>
Figure 3.4  Hypothetical Model - Robustness of RAV and RTT

(a) Uniform Distribution

(b) Polar Distribution

(c) Centralised Distribution

(d) Asymmetric Distribution

(e) Off-Centre CBD with Secondary Centre
3.6 SUMMARY

General Approach

The methodology adopted for this thesis was developed after considering:

- the key research questions identified in Chapter 1
- the findings from the literature review in Chapter 2.
- Issues of data availability.

Together, these determined an approach which included:

- Conducting a specific survey of residents in Sydney to gather up-to-date and relevant data on accessibility and related issues. This provides the detailed cross-sectional information unavailable from other sources.
- Developing appropriate indicators, which can be used to map accessibility across the Sydney region at a fine geographic scale. This is necessary to analyse spatial patterns and trends in accessibility, as well as to help analyse the impact of potential policies such as land use changes or transport infrastructure investments.
- Using the combination of survey data and indicators to address questions such as access problems and ways to improve accessibility.

Survey Design

A specific survey on accessibility was designed to gather original data on the types of activities people desire access to, the role of accessibility in influencing housing choice, and access problems which people face. Budget limitations led to a cluster sampling technique to enable statistical testing of the significance of key relationships, and to cover a range of socio-economic, demographic, housing and locational parameters.

Development of Indicators

In order to select appropriate indicators of accessibility, the desirable properties of such indicators were first established as:

- Ease of understanding and interpretation
- Ability to reflect specific sub-groups of the population
- Ability to reflect changes in land use and transport
- Robustness and ability to be applied generally

A number of commonly used indicators were discussed. These include:

- Threshold Values (e.g., the number of jobs within, say, 45 minutes travel time from a location)
- Absolute Accessibility Values (e.g., the sum of the number of opportunities in a region, weighted by a suitable function of the travel time or cost to access those opportunities)
• Relative Accessibility Values (i.e. the ratio of the absolute accessibility value for a given location to the average accessibility value across the region)

In addition, a new indicator - Equivalent Cost or Travel Time (EC/ETT) was developed. This is defined as follows:

• The Equivalent Cost (or Equivalent Travel Time) from a location to a set of opportunities (e.g., jobs) in a region, is the travel cost (or travel time) which, if it applied to all opportunities in the metropolitan area, would lead to an equivalent value of absolute accessibility. From this can be derived relative cost (RC) and relative travel time (RTT).

An evaluation of these potential indicators was undertaken against the four criteria, utilising a hypothetical model to test robustness. The evaluation found that the most desirable indicators were EC/ETT (Equivalent Cost / Travel Time) and RC/RTT (Relative Cost / Travel Time), in that they:

• have an intuitive meaning (i.e., are not measured in arbitrary units, but in understandable terms such as dollars or minutes of travel time)
• are able to be defined for specific sub-groups (such as those without a car, or with a mobility handicap)
• are sensitive to changes in land uses or travel times / costs
• are robust, in that they do not depend heavily on the specific form of the impedance function used. They can therefore be used for any type of opportunity (e.g., jobs, retail facilities, educational opportunities), for any city, and for any time period, without requiring special calibration or parameter estimation.

Accordingly this class of indicators is recommended for measuring accessibility patterns and trends in metropolitan areas, including Sydney.
CHAPTER 4: ANALYSIS OF SURVEY RESULTS

4.1 INTRODUCTION

Survey Details

As discussed in the previous chapter on methodology, a survey of 583 residents in three local government areas in Sydney (Liverpool, South Sydney and Willoughby) was undertaken to provide up-to-date and relevant data on accessibility and related topics.

A stratified sampling approach was adopted to provide sufficient sample size to enable statistical analysis. The three survey areas were chosen so as to provide a range of spatial locations (outer western, inner southern and middle northern suburbs) with a range of socio-economic and demographic characteristics. For example:

- Liverpool is a rapidly developing area on the urban fringe, with mainly low density housing, and low-medium income groups
- South Sydney is a rapidly gentrifying area with major apartment complexes under construction, especially around Green Square
- Willoughby is a traditionally middle - upper income area with predominantly low density housing, but also undergoing urban consolidation in some areas.

The survey data was collected in 2001, using face-face interviews conducted by a professional survey research firm. The questionnaire is included in the Attachment.

Results of the Survey

The following sections present detailed results of the survey, analysed under the following headings:

- Section 4.2 discusses Accessibility and Travel Patterns
- Section 4.3 discusses Accessibility and Housing Choices
- Section 4.4 discusses Accessibility, Activities and the Use of Time
- Section 4.5 discusses Communications and “Virtual” Accessibility
- Section 4.6 discusses Access Difficulties

The final section 4.7 summarises the key findings from the survey, and relates them to the earlier results of the literature research.

Unless otherwise specified, the data source for all graphs and tables in this Chapter is the author, based on the survey conducted.


4.2 ACCESSIBILITY AND TRAVEL PATTERNS

Introduction

As discussed in the literature review, accessibility has a number of relationships with travel behaviour and travel patterns. There are several key issues, which are investigated here:

- How is accessibility related to the number of trips people take?
- How is accessibility related to people’s choices of mode of transport?

The information collected in the survey on travel patterns is summarised below:

Table 4.1 Information on Travel Patterns included in the Survey

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Question Number</th>
<th>Information Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>8</td>
<td>How often activity was engaged in over last 12 months</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Usual work location</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Distance of work from nearest rail station</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Usual mode of travel to and from work</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Variation in starting / finishing time</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Variation in mode of travel</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Reason prefer car (if used)</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Frequency of working from home</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Future desired frequency of working from home</td>
</tr>
<tr>
<td>Education</td>
<td>18</td>
<td>Location and frequency of travel</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Usual mode for getting to and from main study activity</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Reason prefer car (if used)</td>
</tr>
<tr>
<td>Shopping</td>
<td>22</td>
<td>Details of most recent shopping trip</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>Mode used for most recent shopping trip</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>Reason prefer car (if used)</td>
</tr>
<tr>
<td>Sporting / Recreation</td>
<td>26</td>
<td>Details of most recent sporting / recreational trip</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>Mode used for most recent sporting/recreational trip</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>Reason prefer car (if used)</td>
</tr>
<tr>
<td>Social / Entertainment</td>
<td>30</td>
<td>Details of most recent social/entertainment trip</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>Mode used for most recent social / entertainment trip</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>Reason prefer car (if used)</td>
</tr>
<tr>
<td>Non Work / Education Activities</td>
<td>34</td>
<td>Frequency in which activity engaged in.</td>
</tr>
</tbody>
</table>

In developing hypotheses about travel behaviour, it is useful to distinguish between trips for work or education (which are largely non-discretionary) and trips for other purposes. Following the analysis of the literature, it was hypothesized that:

- the frequency with which people make trips for education and work purposes is dictated by the requirements of the activity – for example whether it is full – or part-time, rather than the accessibility of the person’s home location.
- the accessibility of the home location will, however, influence the mode used for travel for work and education trips.
by contrast, the total trip rate to other activities (shopping, health-related, sporting/recreational and social/entertainment) will be influenced to some extent by people's accessibility, since these trips are to some extent discretionary.

- the accessibility of the home location will also influence mode used and choice of destination for these trips.

Survey Results - Work and Education Travel

Participation Levels

Workforce participation (the percent of the adult population in the sample with a full- or part-time job) was found to be significantly related to LGA Accessibility, but not to the other measures of accessibility. However the participation in full-or part time education was not found to be significantly related to any of the measures of accessibility. (Note that for the purpose of this thesis, relationships are considered significant at the .05 level, and highly significant at the .01 level, using the standard Chi-squared test for analyzing categorical data (see, for example, Rice, 1995, Chapter 13).

Table 4.2 Significance Levels for Relationships between Accessibility and Participation

<table>
<thead>
<tr>
<th>Measure of Accessibility</th>
<th>LGA Accessibility</th>
<th>Public Transport Accessibility</th>
<th>Overall Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workforce Participation (Q7)</td>
<td>.000 sig</td>
<td>.061 ns</td>
<td>.055 ns</td>
</tr>
<tr>
<td>Education Participation (Q17)</td>
<td>.476 ns</td>
<td>.077 ns</td>
<td>.458 ns</td>
</tr>
</tbody>
</table>

Figure 4.1 LGA Accessibility by Workforce Participation
This reflects the greater proportion of retirees in Willoughby, and the high labourforce participation in South Sydney.

**Frequency of Work and Education Activities and Accessibility**

For those in the paid workforce, there was no significant relationship found between the number of days per week worked and their LGA accessibility or overall accessibility, but there was a significant relationship with PT accessibility (Chi-squared = 11.26, df=4, sig=.024). The data indicate that people living in zones with high accessibility to public transport are more likely to be working full time (at least 5 days per week).

**Figure 4.2 Frequency of Working by Public Transport Accessibility**

![Frequency of Working by Public Transport Accessibility](image)

There was no significant relationship found between the number of days people are engaged in education and any of the measures of accessibility.

**Working from Home**

The issue of how often people in the workforce worked from home was also analysed, but no significant relationships with any of the three measures of accessibility were found. Similarly there were no significant relationships with how often people would like to work from home in the future.

This is interesting in the light of the literature review which suggested that, over time, there would be a tendency for people with face-face contact jobs to concentrate in the more accessible inner suburbs, while those who could work at home would preferentially choose outer suburban locations.
Modes Used

However the mode used for travelling to work was highly significantly related to LGA accessibility (Chi-squared = 21.1, df=8, sig. = .007) and to overall accessibility (Chi-squared = 21.1, df=8, sig. = .001).

Figure 4.3 Mode for Journey to Work by LGA Accessibility

Figure 4.4 Journey to Work Mode Share by Overall Accessibility
As expected, the mode shares for walking, public transport and “other” modes was higher, and that for car driver was lower, for those zones with high or very high overall accessibility than for the other zones. However there was little difference between those zones with very low, low or medium levels of overall accessibility.

Analysis of the mode used for education trips found no statistically significant relationships with any of the measures of accessibility.

Survey Results – Other Trip Purposes

Frequency of Travel

An analysis was undertaken of the frequency with which people made trips for shopping, health-related, sporting/recreational and social/entertainment purposes, and its relationship with the three measures of accessibility. Results suggest that (see Table 4.3):

- There is a significant positive relationship between LGA accessibility and the frequency with which people engage in many non-work or education activities, including shopping, health-related, social/entertainment and certain sporting/recreational activities. The exceptions are playing golf, playing some other sport, and going to the harbour / Penrith Lakes / Hawkesbury River.
- In general there is no relationship between public transport accessibility and the frequency with which people engage in these activities, except for shopping trips to Parramatta, Chatswood or Liverpool, and other major shopping centres.
- The relationships with overall accessibility are broadly similar to those for LGA accessibility, indicating that the latter are the major influence (rather than public transport accessibility).
Table 4.3  Frequency of Visiting Activities by Level of Accessibility

<table>
<thead>
<tr>
<th>Activity / Destination</th>
<th>LGA Accessibility</th>
<th>Public Transport Accessibility</th>
<th>Overall Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Significance</td>
<td>Significance</td>
<td>Significance</td>
</tr>
<tr>
<td><strong>SHOPPING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the Sydney CBD</td>
<td>.000 **</td>
<td>.104</td>
<td>.000 **</td>
</tr>
<tr>
<td>Parramatta/Chatswood/Liverpool</td>
<td>.000 **</td>
<td>.000 **</td>
<td>.000 **</td>
</tr>
<tr>
<td>Other Major Shopping Centres</td>
<td>.000 **</td>
<td>.004 **</td>
<td>.004 **</td>
</tr>
<tr>
<td>Local shops</td>
<td>.000 **</td>
<td>.039</td>
<td>.000 **</td>
</tr>
<tr>
<td><strong>HEALTH-RELATED</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>.013 *</td>
<td>.178</td>
<td>.065</td>
</tr>
<tr>
<td>Another Health-Related Service</td>
<td>.008 **</td>
<td>.222</td>
<td>.001 **</td>
</tr>
<tr>
<td><strong>SPORTING / RECREATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watching sport at major stadium</td>
<td>.046 *</td>
<td>.899</td>
<td>.704</td>
</tr>
<tr>
<td>Watching sport at a smaller venue</td>
<td>.028 *</td>
<td>.182</td>
<td>.096</td>
</tr>
<tr>
<td>Playing golf</td>
<td>.911</td>
<td>.410</td>
<td>.361</td>
</tr>
<tr>
<td>Playing some other sport</td>
<td>.480</td>
<td>.414</td>
<td>.340</td>
</tr>
<tr>
<td>Going to a National park</td>
<td>.197</td>
<td>.733</td>
<td>.369</td>
</tr>
<tr>
<td>Harbour/Penrith Lakes/Hawkesbury River</td>
<td>.272</td>
<td>.131</td>
<td>.007 **</td>
</tr>
<tr>
<td>Surf Beaches in Sydney</td>
<td>.000 **</td>
<td>.072</td>
<td>.000 **</td>
</tr>
<tr>
<td>Going to a local park</td>
<td>.015 *</td>
<td>.222</td>
<td>.075</td>
</tr>
<tr>
<td>Walking/cycling in neighbourhood</td>
<td>.020 *</td>
<td>.089</td>
<td>.128</td>
</tr>
<tr>
<td><strong>SOCIAL / ENTERTAINMENT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visiting friends / relatives</td>
<td>.008 **</td>
<td>.367</td>
<td>.754</td>
</tr>
<tr>
<td>Major Venue(a)</td>
<td>.000 **</td>
<td>.064</td>
<td>.002 **</td>
</tr>
<tr>
<td>Wonderland</td>
<td>.000 **</td>
<td>.021</td>
<td>.006 **</td>
</tr>
<tr>
<td>Movies/museums/galleries/theatre</td>
<td>.000 **</td>
<td>.251</td>
<td>.001 **</td>
</tr>
<tr>
<td>Restaurants, cafes, clubs etc</td>
<td>.000 **</td>
<td>.089</td>
<td>.000 **</td>
</tr>
</tbody>
</table>

Note: (a) Darling Harbour / Fox Studios / Luna Park / Sydney Casino

** means significant at the .01 level * means significant at the .05 level

Key Conclusions on Accessibility and Travel

- The literature review indicated that there are differences between “discretionary” trips, such as shopping and social – recreational trips, and “non-discretionary” trips such as journeys to work or education.

- With regard to accessibility and workforce/educational participation, the survey found that:
  - There is a significant relationship between workforce participation and the local government area in which people lived, with a lower participation rate in Willoughby than in South Sydney or Liverpool, and a significantly higher proportion of the population in retirement.
  - There is no significant difference in the educational participation rates by accessibility.
  - For those in the paid workforce, there is no significant relationship between the number of days per week people worked and the LGA in which they lived, but there is with their accessibility to public transport, with those living in zones...
with high PT accessibility more likely to be working full time (at least 5 days per week).

- There are no significant relationships between accessibility and how often people worked from home.

- With regard to travel to non-discretionary activities:
  - The public transport and walk/cycle modes used for the journey to work are positively related to LGA and overall accessibility levels.
  - However there is no relationship found with mode shares for education trips.

- For "discretionary" travel:
  - There is a significant positive relationship between LGA accessibility and the frequency with which people engage in many types of shopping, health-related, social/entertainment and certain sporting / entertainment activities.
  - In general there is no relationship between public transport accessibility and the frequency of these discretionary trips.

- The survey broadly confirmed the findings of the literature review, suggesting that the mode but not the frequency of people's travel to work is related to their accessibility, and that the higher the accessibility, the more likely they are to use public transport or to walk/cycle.

- On the other hand, people in more accessible areas of Sydney make more trips for non-discretionary purposes. This is consistent with the contention by some that people operate with more or less fixed travel time budgets, so that people in accessible locations tend to make more, shorter trips while those in less accessible locations make a smaller number of longer trips.
4.3 ACCESSIBILITY AND HOUSING CHOICE

Introduction

As discussed in the introduction, accessibility varies significantly across the urban area, as do housing characteristics. Equally, accessibility is known to play a significant role in housing choices, in particular the choice of location, and the trade-offs people make with affordability, housing characteristics and other factors. Accordingly the survey sought to explore some of these relationships, by examining, among other issues:

- housing characteristics such as dwelling type and the length of time people had lived in their current homes
- factors which influenced people’s choice of their current home
- potential future housing preferences.

The specific questions in the survey relating to housing issues include:

Q1 How long people had lived in their current home
Q2 Whether they were involved in choosing their current home
Q3 Importance of various factors in making their selection
Q4 Future lifestyle preferences

The following discussion outlines the key results from the survey and how they relate to other relevant research. In particular the survey allows the testing of various potential hypotheses to identify if the data supports earlier research.

Housing Characteristics

The length of time people in the survey had lived in their current home varied significantly by local government area. (Chi-squared = 48.8, df=10, sig=.000). As shown above, survey respondents in Liverpool were much more likely to have moved into their home in the last year or two, while respondents in Willoughby were much more likely than average to have lived in their home for over 5 years (See Figure 3.5).

This reflects the urban changes occurring in the different areas, such as:

- urban consolidation and replacement of industrial uses in South Sydney with new apartments and medium density developments
- selected redevelopment of parts of Willoughby into higher density housing
- continued rapid expansion of housing in the outer suburbs of Liverpool LGA.
There was also a significant relationship between length of time lived in the current home and type of dwelling, with people in separate houses more likely to have lived for a long time in their current home than people in town houses/terraces or apartments. In particular, 37% of those surveyed living in a separate house had lived there for more than 10 years, compared with 20.6% of those in town houses/terraces and 5.4% of those living in apartments.

Table 4.4 Time Lived in Current Home by Dwelling Type

<table>
<thead>
<tr>
<th>Time Lived in Home</th>
<th>Separate House</th>
<th>Town House/Terrace</th>
<th>Apartment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>14.5%</td>
<td>31.4%</td>
<td>29.7%</td>
<td>20.1%</td>
</tr>
<tr>
<td>1-2 years</td>
<td>13.6%</td>
<td>18.6%</td>
<td>18.9%</td>
<td>15.4%</td>
</tr>
<tr>
<td>3-5 years</td>
<td>20.8%</td>
<td>17.6%</td>
<td>24.3%</td>
<td>20.7%</td>
</tr>
<tr>
<td>6-10 years</td>
<td>14.2%</td>
<td>11.8%</td>
<td>21.6%</td>
<td>14.8%</td>
</tr>
<tr>
<td>11-20 years</td>
<td>10.9%</td>
<td>8.8%</td>
<td>2.7%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Over 20 years</td>
<td>26.0%</td>
<td>11.8%</td>
<td>2.7%</td>
<td>19.7%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

*Note: Total does not include those not answering the question*
Factors affecting Current Household Choice

Nearly 80% of the people sampled were involved in choosing their current home location. The importance of various factors in making that choice are listed below in order of importance:

- quality of the local street and suburb
- features of the home itself
- amount of out-door open space.
- location and ability to get to things
- price and affordability
- ability to own your own home

The average weightings applied (from the five point scale, with 5 = very important and 1 = not important / relevant) are shown below:

![Figure 4.6 Importance of Factors in Choosing Current Home](image)

Accessibility would thus appear to be a key determinant of housing choice, as is usually assumed in theories of housing and land prices, and as previously found by the ABS survey on housing preferences for recent movers (ABS 1992).

Indeed the survey found that accessibility appears to have become even more important than it was a decade ago.

However it is important to examine how universal this pattern is, or how much it varies with socio-economic and other variables. In particular is was decided to test the following hypotheses (see table below):
Table 4.5  Hypotheses on Housing Choice

<table>
<thead>
<tr>
<th>Number</th>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>People in outer suburbs place less importance on accessibility (location and ability to get to</td>
</tr>
<tr>
<td></td>
<td>things) than people in middle suburbs, who in turn place less importance than people in inner</td>
</tr>
<tr>
<td></td>
<td>suburbs</td>
</tr>
<tr>
<td>2</td>
<td>People living in apartments or town houses / terraces place more importance on accessibility</td>
</tr>
<tr>
<td></td>
<td>than people living in detached houses in relation to housing choices</td>
</tr>
<tr>
<td>3</td>
<td>People living in areas with poorer relative public transport accessibility place less</td>
</tr>
<tr>
<td></td>
<td>importance on accessibility than those living in areas with higher relative public transport</td>
</tr>
<tr>
<td></td>
<td>accessibility</td>
</tr>
<tr>
<td>4</td>
<td>People on lower incomes place more importance on accessibility than people on higher incomes</td>
</tr>
<tr>
<td>5</td>
<td>Younger (under 25) and older (over 55) age groups place more importance on accessibility than</td>
</tr>
<tr>
<td></td>
<td>middle aged groups (25-54) who tend to be more likely to have children and to place a higher</td>
</tr>
<tr>
<td></td>
<td>importance on other factors.</td>
</tr>
</tbody>
</table>

Other Factors in Choosing a Home

<table>
<thead>
<tr>
<th>Number</th>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>People living in detached houses place more value on private outdoor space than people in</td>
</tr>
<tr>
<td></td>
<td>town houses / apartments</td>
</tr>
<tr>
<td>7</td>
<td>People with lower incomes place more importance on price and affordability than people on</td>
</tr>
<tr>
<td></td>
<td>higher incomes</td>
</tr>
<tr>
<td>8</td>
<td>Parents place more importance on the ability to own their own home, and on private outdoor</td>
</tr>
<tr>
<td></td>
<td>space, than people who are not parents.</td>
</tr>
</tbody>
</table>

Results from the Survey

Hypothesis 1

There was a significant relationship between the importance people gave to accessibility in their housing choice and the LGA in which they lived (chi-squared = 18.9, df=10, sig=.041). As expected, people in the sample living in South Sydney gave higher ratings on accessibility than people living in Liverpool or Willoughby, but there was little difference between the latter two LGA's (indeed the average was slightly higher for Liverpool).

Table 4.6  Importance of Accessibility in Housing Choice by LGA

<table>
<thead>
<tr>
<th>Importance</th>
<th>Liverpool</th>
<th>S Sydney</th>
<th>Willoughby</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Not important</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>7</td>
<td>18</td>
<td>39</td>
</tr>
<tr>
<td>4</td>
<td>38</td>
<td>22</td>
<td>50</td>
<td>110</td>
</tr>
<tr>
<td>5- Very important</td>
<td>95</td>
<td>93</td>
<td>89</td>
<td>277</td>
</tr>
<tr>
<td>Refused/DK/NA</td>
<td>13</td>
<td>7</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>166</td>
<td>133</td>
<td>164</td>
<td>463</td>
</tr>
<tr>
<td>Average*</td>
<td>4.44</td>
<td>4.61</td>
<td>4.39</td>
<td>4.47</td>
</tr>
</tbody>
</table>

* Excludes refused/don’t know/not applicable
Hypotheses 2, 3 and 4.

There was however no significant relationship found between importance of accessibility in housing choice and type of dwelling (sig. = .723). As shown below, the average importance by respondents living in detached houses was similar to that for people living in attached houses / townhouses or apartments. There was also no significant relationship with public transport accessibility (sig. = .098), or with income (sig. = .445).

Table 4.7 Importence of Accessibility in Housing Choice by Type of Dwelling

<table>
<thead>
<tr>
<th>Importance</th>
<th>Detached Houses</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Not important</td>
<td>1.2%</td>
<td>0.7%</td>
<td>1.0%</td>
</tr>
<tr>
<td>2</td>
<td>2.0%</td>
<td>2.2%</td>
<td>2.1%</td>
</tr>
<tr>
<td>3</td>
<td>10.0%</td>
<td>6.0%</td>
<td>8.6%</td>
</tr>
<tr>
<td>4</td>
<td>24.7%</td>
<td>24.6%</td>
<td>24.7%</td>
</tr>
<tr>
<td>5- Very important</td>
<td>62.2%</td>
<td>66.4%</td>
<td>63.6%</td>
</tr>
<tr>
<td>Total</td>
<td>251</td>
<td>134</td>
<td>385</td>
</tr>
<tr>
<td>Average*</td>
<td>4.45</td>
<td>4.54</td>
<td>4.48</td>
</tr>
</tbody>
</table>

* Excludes refused/don't know/not applicable

Hypothesis 5

The expected relationship between age-group and importance placed on location and the ability to get to things was found (Chi-squared = 25.5, df = 8, sig. = .001). In particular, younger people (under 25) and older people (55 and over) placed greater importance on that in their housing choice than did middle age groups.

Figure 4.7 Importance of Accessibility in Housing Choice by Age Group
**Hypothesis 6**

As expected, respondents living in detached houses tended to place much greater importance on private open space in housing choice than people in attached houses/townhouses or apartments (Chi-squared = 44.9, df = 4, sig. = .000). See figure 3.8.

![Figure 4.8 Importance of Private Open Space by Type of Dwelling](image)

**Hypothesis 7**

There was a significant relationship between income and the importance people placed on price and affordability when choosing their home. (Chi squared = 16.5, d.f. = 8, sig. = .035).

As expected a much higher proportion of low and middle-income earners (people with personal incomes of up to $15,000, and $16,000 - $50,000 per annum respectively) gave ratings of 5 (very important) than did people on higher incomes. It was interesting however that the proportion giving low ratings (1, 2 or 3) was virtually the same for all income groups.

(See Figure 4.9 below).
Figure 4.9  Importance placed on Price and Affordability in Housing Choice versus Income

Hypothesis 8

The final hypothesis tested was whether parents place more importance on the ability to own their own home, and on private outdoor space, than non-parents. The data failed to find any significant relationship in the first case (Chi-squared = 4.9, df=4, sig. = .295). However there was a significant relationship in the second case, parents as expected placing a higher overall average rating on private outdoor space in housing choice than non-parents (See figure 4.10).

Interestingly, this appears to be because a smaller proportion of parents gave this a very low or low rating (1 or 2) than did non-parents.
Figure 4.10 Importance of Private Open Space in Housing Choice by Role in Household.

Future Housing Choices

Overall Preferences

Question 4 of the survey sought to obtain information on people's current and future lifestyle choices, and how this might affect their future housing location choice. Implicit in the set of choices people were offered was the notion that, in general, there is a tradeoff between accessibility and the amount of private open space and housing quality which can be afforded on a given budget.

The overall response to the question is shown in Figure 4.11. This indicates that 32% of respondents could not contemplate moving from their current home, while 35% would stay in the same general area but move to a different home they preferred.

Hence only a third would elect to change location. Of these, more would move further from the city if necessary to get a larger house or more private open space (11% of the sample) than would move to a more accessible location even if this meant a smaller house or less private open space (7% of the sample). A further 11% would move out of Sydney altogether, while 4% nominated another choice.

This data indicates a slightly different picture from that obtained from Question 3, relating to people's ratings for various factors, where accessibility (location and ability to get to things) was given significantly higher ratings than the amount of private open space.
The data suggests the complexities of the tradeoffs which people make between a range of competing priorities for location, local environment, house, private open space, price etc. It also suggests that accessibility may generally decline in importance as people age (see later discussion).

In particular access to work would be expected to reduce in importance as people reach retirement age, hence people’s future housing preferences could be likely to differ from their past preferences (when they chose their current home). Such an interpretation would be consistent with patterns of retirees moving out (including out of Sydney altogether) while young adults move in to get the employment and lifestyle attributes they seek from the city.

Figure 4.11 Future Housing / Location Preference.

Differences in Preferences

The question of future housing / lifestyle preferences was analysed for different groups to see if there were significant differences. In this context:

- It would be expected that age would be a significant factor (as discussed above). In particular it is hypothesized from consideration of lifecycle factors that:
  - Young adults / teenagers (those under 25) would be more likely to want a more accessible location than the average.
  - Middle aged adults (25 – 45) would be more interested than the average in moving further from the city if necessary to get a larger house or more private open space.
➢ Older adults (over 45) would be more interested than the average either in moving closer in (and reducing their need for private open space) or in moving out of Sydney altogether.

- Factors such as the Local Government Area in which people live, as well as their gender and income, may have an influence on future housing preferences, although it is not immediately clear what these would be. Hence these variables were tested to see if any significant patterns emerged.

- Lifestyle preferences (Questions 36 - 40) would also be likely to be related to future housing preferences. In particular:
  
  ➢ People describing themselves as "very active" or "reasonably active" (Q36) might be expected to have housing preferences which favour access over private open space
  
  ➢ Persons who indicated that they “spend so much time travelling between activities that they don’t have time to relax” (Q39) might be expected to be more likely than average to want to move to a more accessible location
  
  ➢ People indicating that “there’s not much to do around here – I’m a bit bored”, or that “There are things I’d like to do but I find difficulty getting to them” (Q38) might be expected to be more likely than average to want to move to a more accessible location.
  
  ➢ People describing themselves as “a big city person” (Q40) would be more likely to want to move to a more accessible location than the average
  
  ➢ People indicating that they like to get out of Sydney or live on the outskirts (Q40) would be more likely to indicate a future housing preference for moving further from the city if necessary, or out of Sydney altogether.

Results from the Survey on Future Housing Preferences

Age

In terms of future housing preference, there were highly significant differences by age (Chi-squared = 60.1, df = 10, sig. = .000). In particular (See Figure 3.13):

- Older age groups are much less likely to want to move at all, and a lower proportion than other age groups were interested in moving further from the city if necessary to get a larger house of more private open space. A lower percentage would move to the same general area.
- Somewhat surprisingly perhaps, a lower proportion of older age groups would move out of Sydney altogether than was the case for younger and middle aged groups.
- The differences between those aged under 25 and the middle-aged group (25 – 54) were much smaller than the differences between older age groups and the remainder.
When the future housing preferences were examined, excluding those people who couldn't contemplate moving and those answering "other", a slightly different picture emerges (see figure below):

Figure 4.13  Future Housing Preferences (of those who would move) by Age Group
In particular:

- Around 55% of all age groups would move to a house they prefer in the same area.
- Around 22% of older groups would move to a more accessible location, compared to around 10% of young and middle-aged groups.
- By contrast a lower proportion of older age groups would move further out from the city, or out of Sydney altogether.

**Local Government Area, Gender, Income**

No significant relationship was found between the local government area in which people live and their future housing preference (Chi-squared = 14.6, df=10, sig.=.148). Similarly there was no significant difference with gender (Chi-squared = 3.4, df=5, sig.=.636), or with income (Chi-squared = 10.9, df=10, sig. = .261).

**Lifestyle**

Some of the expected relationships between “lifestyle” and housing preference were found to be supported by the data but not all. Specifically:

- There was no statistically significant link between activity level and future housing preference (Chi-squared = 14.5, df=15, sig=.485)
- However there was a statistically significant relationship between how people felt about their activity level and future housing preference (Chi-squared = 25.9, df = 10, sig. = .004). In particular (see fig 4.14):
  - People describing themselves as “quite happy with the number of things they are involved in” are less likely than others to contemplate moving.
  - There is however relatively little difference in housing preferences between those describing themselves as wanting to increase the number of activities they are involved in, and those wanting to lead a quieter life (although a smaller percentage of the latter would prefer to move to a more accessible location).
There was also a significant relationship between people who said “there are things I’d like to do but I find difficulty getting to them” and a future housing preference for moving to a more accessible location. (Figure 4.15).

Figure 4.15  Future Housing Choice by People having Difficulty Getting to Activities
Finally, future housing preferences could be expected to relate closely to the answers to question 40 (on future lifestyle and housing choice). Indeed there was a significant relationship (Chi-squared = 76.7, df=20, sig. = .000). However as shown below:

- The main relationship was that people with a future housing preference of moving out of Sydney altogether also tended to have a preferred lifestyle of "getting out of Sydney or living on the outskirts (see fig 4.16).
- People with an ideal lifestyle preference for "really getting out of Sydney or living on the outskirts) also had a much lower attachment to their current home – only around 17% couldn’t contemplate moving from their current home, versus 30 – 35% of all other lifestyle preference groups (see fig 4.17)

The key conclusions on accessibility and housing choice are discussed in the summary section at the end of this Chapter. However the main conclusion from the survey analysis was that a number, though not all, of the expected relationships were supported by the data, and that accessibility is a key factor in housing choice.

Figure 4.16  Future Housing Preference by Lifestyle Preference
Key Conclusions on Accessibility and Housing Choices

Importance of Accessibility

- The survey identified accessibility (location and the ability to get to things) as the single most important determinant of people’s current housing location choice, with average ratings as follows:
  - Location and the ability to get to things 4.47
  - Price and affordability 4.41
  - Quality of the local street and suburb 4.15
  - Features of the home itself 4.09
  - Ability to own your own home 3.85
  - Amount of private outdoor space 3.77

- The survey results are thus broadly consistent with earlier research by the ABS. For example, the percentages of recent movers (in Sydney) nominating different reasons for choosing their area were as follows:
  - Accessibility to work, local services and family / social contacts - 35.5%
  - Affordability – 27.3%
  - Neighbourhood Characteristics – 23.7%
  - Other (13.6%)
However while accessibility in a general sense may be the most important factor in selecting housing location, the decision to move itself may be influenced more by other factors. For example this is typically the desire to own a home in the case of first homebuyers, or the desire to buy a better home for changeover buyers.

Differences across groups

- The current survey found that the importance of accessibility varies between different groups; in particular:
  - It is more important for those living in South Sydney than those in Willoughby or Liverpool
  - It was more important for those on low or moderate incomes than for those on high incomes
  - It was more important for younger adults (under 25) and for those over 55 than for middle-aged groups (25-54)

- The survey did not find any significant difference in the average importance given to accessibility between those living in detached houses and those living in other dwellings (attached houses / townhouses or apartments). This also confirmed the results found in the earlier ABS Survey.

- The survey also found no significant relationships between the importance placed on accessibility and either public transport accessibility or income.

- There were also differences between different groups as to the importance placed on other factors. For example:
  - The importance of affordability is related to personal incomes, as might be expected, with a lower percentage of high-income individuals (over $50,000 pa) giving the maximum rating to affordability than for low and moderate-income earners.
  - Also as might be expected, those living in detached houses placed a much higher importance on the amount of private open space than those living in other dwellings (terraces, town houses, apartments)
  - Parents also tended to give a higher average rating to private outdoor space than non-parents.

- However the survey failed to find some expected relationships. For example:
  - There was no significant relationship between parents and non-parents and the importance placed on home ownership.

Future Housing Preferences

- Nearly one-third of survey respondents said that they “could not contemplate moving from their current home”, and 35% would elect to stay in the same general area but move to a different home they preferred.
• Eleven percent would move further from the city if necessary to get a larger house or more private open space to a more accessible location even if this meant a smaller house or less private open space, 7% would move to a more accessible location even if this meant a smaller house or less private open space, with the remainder moving out of Sydney altogether or nominating another choice.

• This suggests that the net impact of housing preferences over time is likely to continue to result in some pressure for urban expansion, though countered to a significant extent by some people electing to move closer to the city.

• Interestingly:
  ➢ There was no relationship found between current location (Local Government Area) and future housing preferences
  ➢ There was however a significant relationship with age. Older age groups are less likely to contemplate moving, but a higher proportion (22%) would move to a more accessible location than for young and middle age groups (10%), while a lower proportion of the over 55’s would move further from the city or out of Sydney altogether
  ➢ Generally there were few relationships between lifestyle variables and future housing preferences, except for those whose preferred lifestyle was to live on the urban fringe or out of Sydney altogether.
4.4  ACCESSIBILITY, ACTIVITIES AND THE USE OF TIME

Introduction

Accessibility for whom?

As discussed earlier, writers such as Stead et. al. (2000) point out that urban travel patterns depend not only on the spatial arrangement of housing, workplaces, shops etc, and the transport networks linking them, but also on the socio-economic characteristics of the population. They contrast the “traditional” view of cause and effect of travel with an “alternative” view based on inter-relationships between land use characteristics, socio-economic characteristics and travel patterns.

Extending this thinking to the issue of accessibility, a key research question is therefore whether different people place different value on access to different kinds of activities or opportunities in Sydney:

- at one extreme, if there were no significant differences between individuals on this issue, then purely physical measures of accessibility, based on the location of activities in space and the transport networks which link them would be sufficient to describe the concept of accessibility.
- at the other extreme, if different individuals place very different values on accessibility to different activities, then it is necessary to consider the concept of “social access needs” to supplement physical accessibility measures in order to better appreciate the patterns of relative accessibility.

Accessibility to What?

The arrangement of activities or opportunities in space within a city such as Sydney is far from uniform. For example:

- Certain opportunities or attractions, such as the harbour, surf beaches, the Sydney CBD, university campuses and major sporting or recreational complexes are concentrated in a limited area or number of locations. Consequently the physical accessibility to these facilities for Sydney residents depends on the residents’ home location and the extent to which the region-wide public and private transport networks provide accessibility to those locations for different residents.
- Other facilities such as primary schools, local shops, suburban libraries and local parks etc can be found widely distributed across Sydney. People’s accessibility to these facilities generally depends on their local accessibility. (It is worth noting here that private and selective state schools are not uniformly distributed and increasing numbers of school students travel significant distances to attend specific schools rather than their local school).

Accordingly, the concept of accessibility could be considered as a multidimensional concept with different dimensions for each class of activity or opportunity.
In order to probe this issue, the survey (Question 6) sought to measure the importance people place on accessibility to:

- a person's main job
- their own or their children's education
- shops and retail outlets
- hospitals, medical or health-related facilities
- friends and relatives
- entertainment
- personal interests
- local parks, local sporting facilities etc
- national parks or major areas of bushland
- major sporting or entertainment complexes
- beaches or Sydney harbour
- Sydney CBD.

Initial Hypotheses

Before analysing the results in this area, a number of potential relationships were postulated for testing the hypothesis that different people place different values on accessibility to different activities or opportunities. These arose from a number of considerations. For example:

- Gollner and Dowling (2001) report on preliminary findings from a Sydney study highlighting the role of gender and parenting roles on car usage. In particular, they report that (page 4) "women's continued responsibility for running households and their greater tendency to work part-time, rather than full-time, meant that compared to men, women generally:
  ➤ travel shorter distances but make more trips
  ➤ make more suburban trips
  ➤ make more trips that have more than one purpose
  ➤ make more non-work trips
  ➤ travel out-of peak
  ➤ use public transport marginally more (particularly buses)."

- Stead et al. (2000) reviewed a wide range of studies, concluding that a range of factors such as socio-economic group, car ownership, employment status, age, household structure and income affect travel patterns, in addition to land use factors such as distance from the centre of the city, settlement size, mixture of land uses, provision of local facilities etc. They then review the results of three particular studies (Stead, 1999; Williams and Banister, 1999; and Titheridge, Hall and Hall, 1999), based on data from the United Kingdom, summarising their findings as below.
Table 4.8  Relationships between Travel, Socio-Economic and Land Use Characteristics

<table>
<thead>
<tr>
<th>Measure</th>
<th>Total Distance Traveled</th>
<th>Travel to work dist.</th>
<th>Travel to work mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
<td>Stead, 1999</td>
<td>Williams &amp; Banister, 1999</td>
<td>Titheridge et. al., 1999</td>
</tr>
<tr>
<td>Socio-economic characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socio-economic group</td>
<td>sig</td>
<td>n.s.</td>
<td>sig</td>
</tr>
<tr>
<td>Car ownership</td>
<td>sig</td>
<td>sig</td>
<td>sig</td>
</tr>
<tr>
<td>Employment status</td>
<td>sig</td>
<td>n.s.</td>
<td>sig</td>
</tr>
<tr>
<td>Age</td>
<td>sig</td>
<td>n.s.</td>
<td>sig</td>
</tr>
<tr>
<td>Household Structure</td>
<td>sig</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Income</td>
<td>sig</td>
<td>sig</td>
<td>n.a.</td>
</tr>
<tr>
<td>Land use characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance from urban centre</td>
<td>n.s.</td>
<td>n.a.</td>
<td>sig</td>
</tr>
<tr>
<td>Settlement size</td>
<td>sig</td>
<td>sig</td>
<td>n.a.</td>
</tr>
<tr>
<td>Mixing of land uses</td>
<td>sig</td>
<td>n.a.</td>
<td>sig</td>
</tr>
<tr>
<td>Provision of local facilities</td>
<td>sig</td>
<td>sig</td>
<td>n.s.</td>
</tr>
<tr>
<td>Density of development</td>
<td>sig</td>
<td>sig</td>
<td>n.s.</td>
</tr>
<tr>
<td>Frequency of nearest bus service</td>
<td>sig</td>
<td>n.s.</td>
<td>sig</td>
</tr>
<tr>
<td>Distance from rail station</td>
<td>sig</td>
<td>sig</td>
<td>n.s.</td>
</tr>
<tr>
<td>Availability of residential parking</td>
<td>sig</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

sig signifies an interaction identified; n.s. signifies no interaction identified; n.a. signifies interaction untested. Source: Stead et. al. (2000).

It was therefore hypothesized that the importance of accessibility to different activities / opportunities would be influenced by locational, demographic, socio-economic and other factors. These are summarised in the table below, and discussed in more detail in the following section on survey results.

Table 4.9  Assumed Factors Affecting Importance of Accessibility to Different Activities

<table>
<thead>
<tr>
<th>Activity / Opportunity</th>
<th>Location</th>
<th>Demographic</th>
<th>Socio-Economic</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Main Job</td>
<td>LGA</td>
<td>Gender</td>
<td>LF Participation</td>
<td></td>
</tr>
<tr>
<td>B Education</td>
<td></td>
<td></td>
<td>Qualifications</td>
<td>Ed. Participation</td>
</tr>
<tr>
<td>C Shops / Retail</td>
<td></td>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Health-related</td>
<td></td>
<td>Gender, Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E Friends &amp; Relatives</td>
<td></td>
<td>Gender, Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F Entertainment</td>
<td></td>
<td>Age, Parent</td>
<td>Income</td>
<td>Lifestyle Pref.</td>
</tr>
<tr>
<td>G Personal Interests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H Local Parks &amp; sporting</td>
<td></td>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I National Parks / Bushland</td>
<td>LGA</td>
<td>Age</td>
<td>Income</td>
<td>Lifestyle Pref.</td>
</tr>
<tr>
<td>J Major Sporting / Entertainment</td>
<td>LGA</td>
<td>Gender, Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K Beaches or Sydney Harbour</td>
<td>LGA</td>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L Sydney CBD</td>
<td>LGA</td>
<td></td>
<td>Income, Quals.</td>
<td>Lifestyle Pref.</td>
</tr>
</tbody>
</table>
Survey Results

Access to Main Job

It would be expected that:

- Those living in inner suburbs may place a higher premium on access to employment, given the higher accessibility to CBD jobs in the former location. Hence we would hypothesize that residents of South Sydney would place higher importance on this than residents of Liverpool, with residents of Willoughby placed in the middle.

- Males might be expected to place more importance than females on accessibility to the main job, given that a higher proportion are in full-time employment.

- Those in full-time employment might be expected to place more importance on access to the main job than those in part-time employment, who in turn might be expected to place more importance than those who are unemployed or retired.

The actual findings were, however, somewhat surprising in some cases, and did not support all of the above hypotheses. For example:

- There was a no statistically significant relationship found between LGA and importance placed on access to main job (Chi-squared = 14.23, df=8; sig. = .076). (Indeed the average importance placed on access to main job was highest for Liverpool residents, and lowest for Willoughby residents, but the differences were not significant).

- There was a significant difference in the case of gender, with males as expected having a higher average rating (4.13 vs. 3.82) than females. (Chi-squared = 13.65, df=4; sig. = .008). However the difference seems to have arisen from a higher proportion of males giving a rating of 4, and a lower proportion a rating of 1, than was the case for females, with approximately the same proportion of both sexes giving a rating of 5; see figure 4.18 below.

- As was expected, there was a highly significant relationship between employment status and importance of access the main job (chi-squared = 279.7, df=20, sig=.000). For example nearly 80% of retired people gave a score of 1 (irrelevant / not important) whereas nearly 80% of full-time workers gave a score of 5 (very important). Part-time workers and those people who are unemployed but looking for work rated access to the main job almost as highly as those in work, but those who were unemployed and not looking for work gave a much lower rating. See figure 4.19 below.
Figure 4.18  Importance of Access to Main Job by Gender

Figure 4.19  Access to Main Job by Employment Status

The analysis suggests that the most important variable in explaining the importance people place on access to the main job is whether they are in the labourforce or not.
Access to Education

The participation in education is highly related to age and other socio-economic variables, so it might be expected that:

- Those people involved in full or part time education at school, TAFE, university or business college might be expected to give access to education a higher importance than those who are not.
- People with tertiary qualifications might give more importance to access to education than people without such qualifications (this could include the importance they place on access to education for their children)

Analysis of the data showed that:

- Student status was, as expected, significantly related to importance placed on access to education (chi-squared = 28.0, df=4; sig. = .000). Perhaps surprisingly however, nearly half of those who were not a current student still rated access to education as very important. See figure 4.20 below.
- Level of qualifications was not, however, statistically significantly related to the importance placed on access to education (chi-squared = 27.2, df=20; sig. = .128), though the data indicated some tendency for those with university or higher degrees to place more significance on access than those with school education or certificates / diplomas.

Figure 4.20   Access to Education by Education Status
Access to Shops and Retail Outlets

Numerous studies indicate that shopping is a strongly gender-related activity, with women spending significantly more time shopping and making more shopping trips. So it was hypothesized that there would be a strong relationship between gender and the importance placed on access to shops / retail outlets. However, as shown in figure 4.21 below, there was a tendency for a slightly higher proportion of women to rate access to shops and retail outlets as very important, but overall the difference failed to be statistically significant at the .05% level (chi-squared = 9.3, df=4; sig. = .055).

Figure 4.21 Access to Shops / Retail Outlets by Gender

Access to Hospitals, Medical or Health-Related Services

Usage of health-related facilities is known to be significantly higher for older people than for younger people, and also somewhat higher for women than men, and it was hypothesized that differences in the importance of access to these services would follow similar patterns.

As shown below:

- There was a very significant relationship between age and the importance which people place on access to health facilities (chi squared = 66.3, df = 32, sig. = .000), with the importance rising rapidly with age above the age of 45 (see Figure 4.22).
- There was also a significant relationship with gender (see figure 4.23), with women placing more importance than men on access to health services as expected, though the relationship was not as strong as with age. (chi squared = 10.6, df = 4, sig. = .032)
Figure 4.22  Access to Health Services by Age

![Graph showing access to health services by age.](image)

Figure 4.23  Access to Health Services by Gender

![Graph showing access to health services by gender.](image)
Access to Friends and Relatives

It might be expected that women might place a greater importance on access to friends and relatives than men since they are traditionally seen as spending more time and effort in maintaining relationships. Similarly, it might be expected that retired or older people may have more time to spend with friends and relatives than those in working age groups, and may place more importance on this given it may form the bulk of their social contacts.

Analysis of the data revealed that:

- Gender was not statistically linked with the importance of access to friends and relatives - women and men placed almost the same importance on this (Chi-squared = 1.28, df = 4, sig. = .864).
- Similarly, any link with age was not significant at the .05 level (Chi-squared = 43.8, df = 32, sig. = .079).

In other words, the importance of access to friends and relatives is reasonably widely spread amongst the community in terms of demographic variables. A further test was undertaken on individual income, and this was also not found to be significantly related.

Access to Entertainment

It might be expected that access to entertainment might be strongly related to age, being more important to teenagers and young adults, and to people whose children have grown up or who have no children, than to hard-pressed parents. It might also be expected that access to entertainment might be related to income, with higher income individuals placing more importance on this as they have more discretionary income. Similarly, it might be expected that access to entertainment might be strongly related to lifestyle choices and activity levels – for example being more important to the “big city” type person, or to those with higher activity levels.

Analysis of the data showed that:

- As expected, age was significantly related to the importance placed on access to entertainment (Chi-squared = 60.5, df=32, sig. = .002), with the young placing the highest importance on it, but with perhaps unexpectedly high importance also shown by those 75 years and over.
- Similarly, parents placed a lower rating than non-parents (Chi-squared = 31.1, df=4, sig. = .000).
- There was a relationship with “ideal lifestyle”, with, as expected, higher ratings by people describing this as “big city”, followed by those describing it as “inner suburbs”, followed by “lower density outer suburbs” and finally those preferring “right out of Sydney, or on the outskirts” (Chi-squared = 31.7, df = 16, sig. = .011).
- Income, however, was not significantly related (Chi-squared = 40.9, df = 32, sig. = .134).
Figure 4.24  Access to Entertainment by Age

Figure 4.25  Access to Entertainment by Ideal lifestyle
**Personal Interests**

Given the wide range of personal interests and the wide geographic spread of opportunities in this area, it was not expected that there would be any particular patterns emerging. A number of variables were tested, and it was found that:

- Age was significantly related, with younger people and the 65-74 year age group placing the highest rating on access to personal interests, possibly because they have more time to indulge these interests. (Chi-squared = 65.4; df = 32, sig. = .000)
- The rating declined for those over 75, indicating potentially lower capacity to follow personal interests as a result of age-related mobility or health problems.
- A number of other variables were tested, including “ideal lifestyle”, gender, type of dwelling, income and educational qualifications. No significant relationships with any of these were found (at the .05 level).

![Figure 4.26 Access to Personal Interests by Age Group](image)

**Local Parks and Sporting Facilities**

It was expected that there would be relationships between the ratings given to access to local parks and sporting facilities and age, and this was indeed found to be the case, with the importance rating peaking with those aged 25 to 45, and dropping thereafter (Chi-squared = 119; df = 32, sig. = .000).
Figure 4.27

Access to Local Sporting and Recreational Facilities by Age

![Bar chart showing access to local sporting and recreational facilities by age.](image)

**National Parks and Bushland**

Sydney is extremely fortunate in being surrounded by major national parks to the south, west and north, as well as having pockets of bushland in various locations, particularly in the north shore and Sutherland areas. Accordingly it was expected that the ratings on access to national parks and bushland would be:

- higher for residents in Willoughby and Liverpool than in South Sydney
- higher for those describing their "ideal lifestyle" as being "out of Sydney or right on the outskirts - nearer the bush or the countryside" than those wanting the "big city" life
- possibly higher for higher income people
- higher for middle-aged people than young people or those over 65.

As expected, it was found that:

- There were the expected differences by local government area, and they were significant, although these were not large. (chi-squared = 17.9; df = 8; sig. = .022)
- Surprisingly, the differences by "ideal lifestyle" were not significant (sig. = .334)
- Likewise, income was not significantly related (sig. = .120)
- Age, however, was significantly related (chi-squared = 55.9, df=32, sig. = .006), with the expected pattern of highest ratings for the 25-34 year age group.
Figure 4.28  Access to National Parks by Age

![Access to National Parks by Age](image)

**Major Sporting / Entertainment Complexes**

Sydney has a number of major sporting / entertainment complexes, including the Moore Park complex, Darling Harbour, the Homebush Bay complex, Wonderland, Fox Studios and the Penrith Lakes. It was expected that the rating of importance of access to these facilities would be related to gender (with males potentially placing a higher rating than females) and possibly to age. Given the proximity of South Sydney to the Moore Park / Fox Studio complex, it was also expected that residents of South Sydney might place a higher rating than residents in Liverpool and Willoughby, which are relatively remote from any of the major complexes.

Analysis of the data revealed (see figures below) that not all the expected patterns were found:

- There was a highly significant relationship with the Local Government Area of the Residents, with Liverpool residents having the highest rating, followed by South Sydney, both significantly higher than residents of Willoughby (Chi-squared = 39.6; df=8; sig=.000)
- There was also a significant relationship with age, with lower ratings for older people as expected. (Chi-squared = 82.3, df=32, sig. = .000)
- There was, however, no significant difference by gender.
Figure 4.29  Access to Major Sporting or Entertainment Complexes by LGA of Residents

Figure 4.30  Access to Major Sporting / Entertainment Facilities by Age
Access to Beaches / Sydney Harbour

It was expected that young people would give higher ratings to this than older people, and possibly that Liverpool residents would give lower ratings than Willoughby or South Sydney residents, who live closer to these amenities. The data revealed that:

- While those over 65 had lower ratings for access to beaches / Sydney Harbour, there was little difference among those aged up to 65 (Chi-squared = 55.4; df=32; sig. = .006)
- There was a highly significant relationship based on residential location, with as expected South Sydney residents giving the highest rating on average (3.57), followed by residents of Willoughby (3.21) and then Liverpool (2.92 (Chi-squared = 44.7; df=8; sig. = .000). See Figure 4.31.

Figure 4.31 Access to Beaches / Sydney Harbour by LGA

Access to Sydney CBD

Finally, it was expected that the rating given to access to the CBD would reflect a range of factors, including residential location, income, tertiary qualifications, and ideal lifestyle. Analysis of the data showed that:

- Residential Location (LGA) was highly significant, with equal average weightings (3.28) for Willoughby and South Sydney, and much lower (2.68) for Liverpool (Chi-squared = 34.6; df=8; sig=.000)
- There was a significant relationship with income, but the relationship was not simple, with very low and medium-high income earners giving stronger ratings to access to the CBD than low income earners (Chi-squared = 50.5; df=32; sig=.020)
- There also was a relationship with educational qualification level, with, in general, the higher levels associated with higher ratings for importance of access to the CBD
- this however broke down for those with only school education, or those with higher degrees (Chi-squared = 34.9; df=20; sig=.020)
- The relationship with lifestyle preference was highly significant (Chi-squared = 65.2; df=16; sig=.000).

Figure 4.32 Central Business District by Individual Weekly Income

Figure 4.33 Access to CBD by Qualifications
Figure 4.34  Access to CBD by Ideal Lifestyle

![Bar chart showing access to CBD by different ideal lifestyles.](chart1.png)

- Right in the City: 4.0
- In the inner Suburbs: 3.5
- In lower density suburbs: 3.0
- Near the outskirts/country: 2.5
- Other (specify): 2.0

Figure 4.35  Access to CBD by Local Government Area of Residents

![Bar chart showing access to CBD by local government area.](chart2.png)

- Liverpool: 25%
- S Sydney: 20%
- Willoughby: 15%
- 1- Not important/relevant: 10%
- 2: 15%
- 3: 20%
- 4: 25%
- 5- Very important: 30%
Key Conclusions on Accessibility, Activities and Use of Time

**Key Relationships**

The table below summarises the main findings from the above analysis.

Table 4.10  Factors affecting Importance Placed on Accessibility

<table>
<thead>
<tr>
<th>Type of Factor</th>
<th>Specific Factor</th>
<th>Location</th>
<th>Demographic</th>
<th>Socio-Economic</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Local Gov. Area</td>
<td>Gender</td>
<td>Age</td>
<td>Parental Status</td>
</tr>
<tr>
<td>A Main Job</td>
<td></td>
<td>n.s.</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Shops / Retail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Health-related</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E Friends &amp; Relatives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F Entertainment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G Personal Interests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H Local Parks &amp; sporting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I National Parks / Bushland</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J Major Sporting / Entertainment complexes</td>
<td></td>
<td></td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K Beaches / Harbour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L Sydney CBD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* indicates a significant interaction (sig. < .05);  ** indicates a highly significant interaction (sig. < .01); n.s. signifies no significant interaction identified. Blank cells indicate untested interactions.

In summary it can be concluded that:

- The survey data supported the general hypothesis that there are significant differences in the weightings placed on access to different opportunities or activities in Sydney between different groups in Sydney, based on a range of locational, demographic, socio-economic and other factors.
- However not all the factors considered likely to be significant in particular cases were found to be so from the survey data. Of the 32 relationships tested, 14 were
found to be statistically significant at the .01 level, 6 at the .05 level, and 12 were not found to be statistically significant (at the .05 level).

- Of the factors tested, age seems to be the most consistently significant factor. This is not surprising given that it relates to many other aspects of life, including role in society, health, labourforce participation etc.

- The local government area in which people live was also found to be significantly related to the importance placed on access to a number of activities / opportunities.
4.5 COMMUNICATIONS AND "VIRTUAL" ACCESSIBILITY

Introduction

The rapid growth in recent years of computers and the use of the Internet raises the possibility for "Virtual Access", where people can substitute communications for travel for a range of purposes, including:

- employment (for example by working from home either full-time or part-time)
- home shopping, home banking, paying bills or doing other personal business
- emailing friends, playing computer-based interactive games or otherwise using the internet for social or entertainment purposes.

The survey therefore sought to gain data on:

- who is using the Internet, how much time they are spending on the net, and what activities they are undertaking
- impacts on travel behaviour, either directly or indirectly.

Survey Results

Who is using the Internet?

The figure below shows use of the Internet by age and sex, for survey respondents.

Figure 4.36 Percent who have ever used Internet / Email by Age and Sex
This shows a close link with age (declining significantly for the over 55-year age group) but no significant differences between males and females.

There were also highly significant differences between specific groups as expected; for example (see figures below):

- 96% of people from homes with three or more computers at home had used the Internet or Email, whereas only 24% of people with no computers at home had.
- 83% of high income individuals had used the Internet / email compared with 48% of low income individuals.
- A higher proportion of people in Willoughby had used the Internet / emails than in South Sydney.
- Qualification level was also significantly related to use of the Internet / emails.

Figure 4.37  Percent who have ever used the Internet / Email for Different Groups
Figure 4.38 Percent ever used Internet / Email by Qualification

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Degree</td>
<td>94%</td>
</tr>
<tr>
<td>University degree</td>
<td>87%</td>
</tr>
<tr>
<td>Certificate/Diploma</td>
<td>75%</td>
</tr>
<tr>
<td>High School certificate</td>
<td>67%</td>
</tr>
<tr>
<td>School certificate</td>
<td>43%</td>
</tr>
<tr>
<td>Still at school</td>
<td>67%</td>
</tr>
</tbody>
</table>

How often is it being used?

For those people who are users, however, there was no significant difference by age as to the average number of times people accessed the Internet (Chi-squared = 10.3, df=10, sig. = .410).

Figure 4.39 Internet Use Last Month by Age Group

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 25</td>
<td>28%</td>
</tr>
<tr>
<td>25-54</td>
<td>35%</td>
</tr>
<tr>
<td>55 and older</td>
<td>46%</td>
</tr>
<tr>
<td>Total</td>
<td>35%</td>
</tr>
</tbody>
</table>

Legend:
- 22 or more
- 15-21 days
- 8-14 days
- 3-7 days
- 1-2 days
- No days
However there appears to be a greater dichotomy for older people between heavy users and occasional users. Interestingly, most people who are users are regular users – for example 35% reported that they used the Internet at least 22 days in the previous month, and a further 25% between 15 and 21 days. By contrast, only around 7% did not use it, and 10% used it only once or twice in the previous month (see figure 4.39).

There was, however a significant difference in usage rates amongst those who had ever used the Internet / email by personal income, with high-income users significantly more likely to be heavy users (>21 days last month). Similarly, gender was found to be significantly related to frequency of use, with males accessing the Internet / emails more often (Chi-squared = 15.1, df = 5, sig. = .01).

Figure 4.40  Internet Use Last Month by Personal Income

On the other hand, Local Government area and Qualifications were not found to be significantly related to frequency of use.
How much is it being used?

Males tend to spend more time on the Internet than females (see figure 4.42), and the number of hours per week spent using the Internet also varies significantly with income (see figure 4.43).

Figure 4.41  Usage per Month by Gender

Length of time

<table>
<thead>
<tr>
<th>Percent</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>22%</td>
<td>43%</td>
<td>28%</td>
<td>35%</td>
</tr>
<tr>
<td>15-21 days</td>
<td>27%</td>
<td>14%</td>
<td>25%</td>
</tr>
<tr>
<td>8-14 days</td>
<td>9%</td>
<td>22%</td>
<td>12%</td>
</tr>
<tr>
<td>3-7 days</td>
<td>11%</td>
<td>14%</td>
<td>12%</td>
</tr>
<tr>
<td>1-2 days</td>
<td>9%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>No days</td>
<td>8%</td>
<td>7%</td>
<td>7%</td>
</tr>
</tbody>
</table>

How much is it being used?

Males tend to spend more time on the Internet than females (see figure 4.42), and the number of hours per week spent using the Internet also varies significantly with income (see figure 4.43).

Figure 4.42  Hours per week Using the Internet by Gender

Length of time

<table>
<thead>
<tr>
<th>Percent</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 20 hrs</td>
<td>47%</td>
<td>66%</td>
<td>57%</td>
</tr>
<tr>
<td>11-20 hrs</td>
<td>13%</td>
<td>10%</td>
<td>12%</td>
</tr>
<tr>
<td>6-10 hrs</td>
<td>29%</td>
<td>18%</td>
<td>23%</td>
</tr>
<tr>
<td>0-5 hrs</td>
<td>12%</td>
<td>8%</td>
<td>12%</td>
</tr>
</tbody>
</table>
However low income users spend more time per week than middle income users, reflecting the role of teenagers and students (who tend to be high users but on relatively low incomes). Hours spent on the Internet / emails did not vary significantly with Local Government Area, the number of computers in the home, age, or qualifications.

The table below summarises the results on the factors which are associated with who uses the Internet, and how frequently and how many hours per week the Internet is used (users only).

Table 4.11 Relationships with Internet Usage

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Proportion who have ever used the Internet / Email</th>
<th>Number of Times used Last Month (users only)</th>
<th>Number of Hours spent per week on average (users only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>**</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Gender</td>
<td>n.s.</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>Personal Income</td>
<td>*</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>Qualifications</td>
<td>*</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Number of Computers at Home</td>
<td>*</td>
<td>**</td>
<td>n.s.</td>
</tr>
<tr>
<td>Local Government Area</td>
<td>*</td>
<td>*</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

* significant at the .05 level; ** significant at the .01 level; n.s. not statistically significant.

The data indicates that:
• Age group affects whether people have ever used the Internet, but amongst users, is not related to how often or how much people use it.
• Gender has precisely the reverse effect – it is not related to the likelihood of people ever having used the Internet, but is significantly related to how often and how much it is used amongst users.
• Personal income is positively related to all measures of Internet use.
• Qualifications however is only related to the proportion of people who have accessed the net.
• Interestingly, the number of computers at home and the local government area are related to the likelihood of a person having used the Internet, and how often it is used, but not how many hours per week it is used amongst users.

**What is it used for?**

Question 44 of the survey sought information on what people use the Internet for, and the results are summarised below (See Figure 4.44). Of those answering the question (around 50%), the Internet was accessed approximately 38 times in the last month, or a little over once per day.

• Social / entertainment activities accounted for almost half of the number of accesses - emailing friends or relatives or talking on chat programs was by far the most common single reason (41%), with other activities including interactive computer games (5%) and looking up information on entertainment (1%)
• Looking up information of a personal interest accounted for 22% of accesses
• Working from home accounted for 14%
• Trading shares on the stockmarket (9%) and banking / paying bills (5%) were also quite common, while shopping on line or using the Internet to look up information on public transport were all relatively uncommon (accounting for around 1% each).

**Figure 4.44 Average Number of Times Internet was Accesses Last Month (Users)**
This suggests that the Internet is being predominantly used at home for social, rather than business, applications. It also suggests that while the Internet was becoming popular for banking and paying bills, e-shopping has yet to become popular. It is interesting to note that amongst Internet users, the number of times the internet was used was only around a third of the number of physical trips people undertook per month (approximately 120 trips).

**Impact of Using the Internet on Social Life and Time Allocation**

A much higher proportion (44%) of people from homes with three or more computers feel that the Internet has made a difference to them in terms of making friends or social communications, than was the case for people from homes with zero, one or two computers. (Chi-squared = 19.1, df=9, sig. = .024).

**Figure 4.45** Has the Internet Made a Difference in Making Friends / Social Communications?

Educational qualifications were also significantly related (Chi-squared = 25.7, df=15, sig=.04). However there was no significant relationship with age, gender, personal income or local government area.

Of the 43% of the sample who thought that the Internet has made a difference to them in terms of making friends or social communications, the most common effect was on widening their circle of friends (42% of the 43%, or about 18% of the total sample).

Nearly as many (35% of the 43%, or 15% of the total sample) felt the Internet had taken up time otherwise allocated to in-home activities, while only 11% (5% of the total sample) felt it had reduced time allocated to social activities outside the home.
Figure 4.46  Impact of Internet on time and other activities around the home

<table>
<thead>
<tr>
<th>Educational Qualifications</th>
<th>Percent thinking Internet has impacted on watching TV, reading books or other activities inside the home</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>35%</td>
</tr>
<tr>
<td>Higher Degree</td>
<td>27%</td>
</tr>
<tr>
<td>University degree</td>
<td>18%</td>
</tr>
<tr>
<td>Certificate/Diploma</td>
<td>49%</td>
</tr>
<tr>
<td>High School certificate</td>
<td>50%</td>
</tr>
<tr>
<td>School certificate</td>
<td>40%</td>
</tr>
<tr>
<td>Still at school</td>
<td>57%</td>
</tr>
</tbody>
</table>

Figure 4.47  Type of Impact for those for whom there is an impact

Analysis of the nature of the impacts by different groups revealed no statistically significant relationships with age, income, education, number of computers at home, local government area or gender, with the following exceptions:
- Level of education was related to the impact on indoor activities (with the impact being higher for people with high school or certificate level education as compared with those with tertiary education)
- There were significant relationships by Local Government Area, with a much higher proportion of people in Liverpool than the other LGAs thinking that the Internet had impacts on their other in-house activities.

**Figure 4.48** Percent who feel use of the Internet impacts on time for Indoor Activities by qualification and LGA

<table>
<thead>
<tr>
<th>ED QUALS</th>
<th>Liverpool</th>
<th>Willoughby</th>
<th>S Sydney</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Degree</td>
<td>27%</td>
<td>29%</td>
<td>30%</td>
<td>57%</td>
</tr>
<tr>
<td>University Degree</td>
<td>18%</td>
<td>29%</td>
<td>30%</td>
<td>55%</td>
</tr>
<tr>
<td>Certificate / Diploma</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School Certificate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School Certificate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Still at School</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LGA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Impact on Travel Patterns**

A key issue for the future is whether “virtual access” will complement or substitute for “physical access”. Questions 48 and 49 of the survey sought to shed some light on this issue. On the overall question of whether the Internet, email and computers have so far made an impact on travel patterns or the way people get access to things (see figure 4.49):

- one in six of those who had used the Internet thought it had definitely made a difference
- a similar proportion thought it might have made a difference
- 58% felt it had made no difference and 6% were unsure.

There were some minor differences between different groups. For example the proportion of those under 25 who agreed that the Internet etc. had made a difference was much smaller than for middle-aged and older groups (Chi-squared = 15.4, df = 6, sig. = .017). This could possibly be explained by the fact that younger people have grown up with computers and the Internet and are less familiar with lifestyles before
these innovations (see figure 4.49). However none of the other variables tested (gender, income, number of computers, LGA, qualifications) were significant.

On the question of how the Internet etc. has affected travel patterns, the survey indicates that, of those thinking that the Internet would definitely or possibly have an impact:

- Impacts in terms of the number of trips are likely to be the largest for work trips (10% of those who have used the Internet at some time; 28% of those who think it will have an impact on travel).
- Impacts in terms of where or how people travel are likely to be largest for social / entertainment trips and lowest for shopping trips (figure 4.50).

Figure 4.49  Impact of Internet, Email and Computers on Your Travel and Ways to Access
Key Conclusions on Communications and "Virtual" Accessibility

- Access to computers and the Internet has grown rapidly in the 1990's, but is still far from universal. In terms of who is using the internet and how often:
  - Around 64% of males, and 63% of females in the survey had used the internet and / or sent emails. This was highest for the 15-19 year olds (around 90%) but fell significantly after the age of 54, to only 22% of male and 13% of females in the 65-74 age group.
  - The percentage of users was highly correlated with availability of computers in the home, with income, location (highest in Willoughby, lowest in Liverpool) and with qualifications.
  - For those who are users, however, there was no significant difference by age in frequency of use, although frequency of use among users was positively linked with income, and was higher among males than females.
  - Male users also spent more total hours per week on the Internet / emails than did female users, but there were no differences by location, number of computers at home, age or qualifications.

- Of those answering the question (50%), the average user accesses the Internet around 38 times per month, or a little over once per day.
  - Social / entertainment activities accounted for almost half the use.
  - Looking up information of a personal interest accounted for 22%.
  - Working from home accounted for 14%.
  - Trading shares (9%), and paying bills (5%) were also quite common.
Shopping online and looking up public transport information were relatively uncommon, accounting for around 1% each.

- The impact of the Internet on making friends or social communication was higher for those with three or more computers at home, and was also linked to qualifications, but not to age, gender, personal income or local government area.
  - Generally the impact involved widening the circle of friends.
  - Nearly as common was taking up time otherwise spent on in-home activities.
  - Much less common was taking up time spent on out-of-home activities.

- In terms of impact on travel patterns
  - 17% of those who had used the Internet thought it had definitely made a difference, 18% thought it might, 58% thought no difference with 7% unsure.
  - 7% of those who had used the Internet at some time thought it would impact on where or how people would travel for social/entertainment.
  - 10% of those who had used the Internet at some time thought it would impact on the number of trips people would make to work.

- Overall, therefore, there is evidence that the Internet, emails and computers have or will make some impacts on people's use of time outside the home and their travel patterns. However any net impact on reducing travel is likely to be limited, given that some impacts (such as widening the circle of contacts) may increase travel.
4.6 ACCESS DIFFICULTIES

Introduction

Section 4.4 examined how much importance different people place on being able to access different types of activities or opportunities. This chapter considers what access problems people have, including:

- What problems do they have in using different modes?
- What other access problems do people experience?
- How do these problems vary for different people?

Access Problems for Different Modes

Question 35 of the questionnaire asked people to nominate any particular problems in using particular modes (walking, cycling, taxi, bus, train, car and ferry). With regard to walking, whilst one-third of respondents indicated that they had no problems, almost as many indicated traffic and pedestrian safety was a problem/restriction, and just over one quarter indicated that lack of lighting/personal safety was an issue. A significant proportion (16%) also indicated lack of good footpaths was a problem/restriction, while just under 10% indicated that they had physical difficulties or mobility problems with walking (see figure 4.51):

Figure 4.51 Problems with Walking

![Figure 4.51 Problems with Walking](image)

Only around one in five of the survey participants indicated no problems with using a bicycle. The most common problem (nearly half the sample) was lack of a bicycle. As with walking, traffic and the dangers it presents was a significant problem or
restriction, nominated by almost a quarter. There were also a wide range of other problems such as physical difficulty, lack of safe parking, distances too great, and fumes/pollution, which are seen as factors restricting people from cycling.

Figure 4.52 Problems with using a Bicycle

For mass transport (buses, trains, and ferries), the potential factors causing access difficulties were similar, but the importance of each varied across the specific modes.

Figure 4.53 Problems with using Mass Transit
In particular:

- For ferries, by far the most important problem is that ferry terminals are too far away, as might be expected given the location of the sample population.
- For trains, distance from the station was also a major problem, as was personal security, particularly at night, lack of park and ride facilities, and poor connecting services (buses).
- For buses, the major problems were frequency of service, reliability and indirect routes.

The survey thus confirmed what would be expected given the characteristics of the specific modes, such as their geographic spread, frequency, vehicle type and surveillance etc.

For taxis, by far the main problem was the high fares, being nominated by over half the sample. Other significant issues concerned reliability, taxis being hard to get / inconvenient, and taxi drivers being rude / unfriendly or not knowing their way around.

**Figure 4.54 Problems with Using Taxis**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don't feel safe travelling on taxis or waiting for a taxi, especially at night</td>
<td>11.7%</td>
</tr>
<tr>
<td>Taxi drivers rude / unfriendly or don't know their way around</td>
<td>15.1%</td>
</tr>
<tr>
<td>Haven't got good information on the taxi service</td>
<td>4.5%</td>
</tr>
<tr>
<td>Not reliable enough - often late or don't turn up</td>
<td>21.1%</td>
</tr>
<tr>
<td>Taxi fares too high</td>
<td>51.1%</td>
</tr>
<tr>
<td>Taxis hard to get / inconvenient</td>
<td>16.6%</td>
</tr>
<tr>
<td>Taxi ranks too far away</td>
<td>9.1%</td>
</tr>
<tr>
<td>Physical difficulty using taxis</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

Finally, the problems or difficulties seen by the sample in using cars are shown below. The most commonly mentioned problem was the cost and availability of parking, followed by the cost of tolls and of running the car.
Combining data on all the modes, the figure below shows the most commonly mentioned problems, while Table 4.12 shows the frequencies for all problems and categorizes them by the mode affected and type of problem.
<table>
<thead>
<tr>
<th>Mode</th>
<th>Aspect causing problem/difficulty in using mode</th>
<th>%</th>
<th>Physical</th>
<th>Cost</th>
<th>Availability</th>
<th>Quality</th>
<th>Information</th>
<th>Safety</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxi</td>
<td>Taxi Fares too high</td>
<td>51%</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-too far away</td>
<td>47%</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Dont have a bicycle</td>
<td>46%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>Walk-Too much traffic / not safe as a pedestrian</td>
<td>30%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Station too far away</td>
<td>28%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Don't feel safe travelling or at stations, especially at night</td>
<td>27%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>Walk-Lack of lighting / don't feel safe</td>
<td>26%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus services too infrequent / inconvenient</td>
<td>25%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Too much traffic / too dangerous</td>
<td>24%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Cost of parking too expensive</td>
<td>22%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-Not reliable enough - often late or don't turn up</td>
<td>21%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Not reliable enough - often late or don't turn up</td>
<td>19%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Routes too indirect / too many changes required</td>
<td>19%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Lack of cycle paths</td>
<td>18%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Difficult to park at destination</td>
<td>18%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Train anywhere to park car safely to park and ride</td>
<td>18%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Fares too high</td>
<td>17%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Connecting bus services too infrequent</td>
<td>17%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-Need to go to/ inconvenient</td>
<td>17%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Cost of tolls too expensive</td>
<td>17%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>Walk-Lack of good footpaths</td>
<td>16%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Haven't got good information</td>
<td>16%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Cost of running a car too expensive</td>
<td>16%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-Drivers rude / unfriendly or don't know their way around</td>
<td>15%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Don't own a car / can't get access to a car</td>
<td>13%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Don't feel safe travelling on or at stops, especially at night</td>
<td>13%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Not reliable enough - often late or don't turn up</td>
<td>13%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Buses too high</td>
<td>12%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Cause too much pollution and not good for the environment</td>
<td>12%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-Don't feel safe travelling on or waiting, especially at night</td>
<td>12%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Need too much traffic /Don't feel safe travelling on or waiting, especially at night</td>
<td>12%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Routes too indirect / too many changes required</td>
<td>11%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Nowhere to park / could get stolen</td>
<td>10%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Physically difficult / can't ride a bike</td>
<td>10%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Physically difficult / can't ride a bike</td>
<td>10%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Physical difficulty / can't ride a bike</td>
<td>10%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Fares too high</td>
<td>10%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Vehicles or stations not clean / comfortable</td>
<td>10%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Haven't got good information on services</td>
<td>10%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Too much traffic to make it convenient</td>
<td>10%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Too slow / distances too great</td>
<td>9%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>Walk-Physical difficulties</td>
<td>9%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Too much pollution / fumes</td>
<td>9%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-Ranks too far away</td>
<td>9%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Service too infrequent / inconvenient</td>
<td>9%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>Walk-Too far to walk / distances too great</td>
<td>8%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Stop too far away</td>
<td>8%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Just don't feel comfortable riding a bike</td>
<td>8%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Not well lit - don't feel safe</td>
<td>8%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Nowhere to park car safely to park and ride</td>
<td>8%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Connecting trains too infrequent</td>
<td>8%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>Cycle-Too hot - nowhere to shower after arriving</td>
<td>7%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Haven't got good information on services</td>
<td>7%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Nowhere to park car safely to park and ride</td>
<td>6%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Don't feel safe driving on busy roads</td>
<td>6%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-Not clean / comfortable</td>
<td>5%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Vehicles or stops not clean / comfortable</td>
<td>5%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Difficult to park near home</td>
<td>5%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Difficult to get lifts with people when I need them</td>
<td>5%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Bus-Physical difficulty using buses</td>
<td>5%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-Haven't got good information on the taxi service</td>
<td>4%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Train-Physical difficulty using train or stations</td>
<td>4%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Physical difficulty using ferries or wharves</td>
<td>3%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Routes too indirect / too many changes required</td>
<td>3%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Services too infrequent / inconvenient</td>
<td>3%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Don't feel safe travelling on ferries or at wharves,</td>
<td>3%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Connecting buses too infrequent</td>
<td>2%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td>Car-Physical difficulty in driving / being a passenger</td>
<td>2%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>Taxi-Physical difficulty</td>
<td>2%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Not reliable enough - often late or don't turn up</td>
<td>2%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferry</td>
<td>Ferry-Vehicles or wharves not clean / comfortable</td>
<td>2%</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Other Aspects of Access Problems

The questionnaire also included a number of other questions about the access problems people experienced (Q21, 25, 29, 33, 49, 50). These focused on problems experienced in relation to certain specific trip purposes, and included certain issues such as the hours which facilities are open in addition to characteristics of the transport system itself. Responses to these questions are covered below.

Problems accessing Education

Altogether some 81 people surveyed were engaged in part- or full-time study. Of these, three refused to answer question 21 on access problems. For the remainder, the figure below indicates the percentages experiencing different kinds of access problems.

Figure 4.57 Problems with Accessing Main Place of Study

While the number of respondents is not large, this suggests that about half have no particular problems, with public transport issues (availability and time taken) affecting more people than car-related problems (parking / traffic). Less than 3 percent indicated that hours of opening were an issue.

It is worth noting here that the sample in the population only included people aged 16 or over, and hence does not include a significant number of high school students, and no primary school children. Consequently the results should be applied only to tertiary education or adult education.
Problems accessing shops

A similar question was asked in relation to access problems for shopping, differentiating between local shops, major regional shopping centres, and specialty shops. As shown in the figure below:

- Ignoring those who refused, did not know or for whom the question was not relevant, some 60 – 80% of the sample indicated that they had no particular problems accessing shops.
- As might be expected, larger percentages of people expressed difficulty accessing major regional shopping centres, followed by specialty shops, followed by local shops.
- In terms of the nature of problems experienced, public-transport availability and travel time rated similarly to traffic congestion and parking problems.
- Another problem of particular relevance to shopping is the need to carry shopping home. This was a problem for around 16% of people for shopping at major regional shopping centres, compared with 9% for people shopping at local / specialty shops.
- Hours of opening appears to be only a relatively minor problem, affecting only around 3% of people in the case of local shops, 4% for major regional shopping centres, and 7% for specialty shops.

Figure 4.58 Problems Accessing Shops

Compared with tertiary education, shopping is a more universal activity, and accessing shopping is a more significant potential problem. However the percent of shoppers experiencing problems with access appears to be somewhat lower than for those undergoing tertiary / adult education. This reflects retail trends over the last decade or two in Sydney, which have seen a growth in the number of regional shopping centres, and in specialised shopping complexes catering to particular product categories, such as computers; furniture and homewares; toys; hardware etc. For example, since the first
shopping centre in Australia opened in Brisbane in 1957, Australia’s shopping centres have grown rapidly. There are now 918 such centres nationally, accounting for 25% of Australia’s retail outlets, 1.8 billion shopping visits, 44% of retail spending, and employing over 475,000 people. (Fagg, 2001).

Unfortunately while the growth of these shopping centres has brought retail closer to the customers in suburbia, the sheer size of some of these centres means that they generate substantial car traffic and local congestion.

**Overall Mobility and Accessibility**

Question 49 sought to explore how people felt overall about transport and accessibility in Sydney. It asked people to describe how they felt about transport in Sydney and the ease or otherwise of getting access to things, both for the respondent personally, and for the city as a whole. The results indicate that:

- Only a small percentage refused to answer the question or did not have an opinion (1.5% in the case of personal feelings, and 5.8% for Sydney as a whole), indicating that people have fairly clear views as to the issue.
- At a personal level, access is not a problem for just under half (45%) of the sample. Most of those for whom it is a problem, indicate it is "sometimes a problem", and just under 10% of the total population indicate it is "a major problem for me" or "the major problem I face".
- People, however, indicate that they consider transport and access a more significant problem for Sydney as a whole. Less than 20% felt this was "not an issue" for Sydney, while 31% indicated it was "a major issue for Sydney" or "the major issue facing Sydney".

**Figure 4.59 Overall Feelings about Transport and Access in Sydney**
This would appear to support other recent survey data (Warren Centre, 2001; Planning Research Centre, 2002), which indicate that people are concerned at a range of transport related issues including congestion and environmental impacts. The lower ratings for people in relation to their own transport and access needs, compared to the issue for Sydney as a whole, has a number of possible explanations:

- People believe their own situation to be better than that of others.
- The sample represented people with lower than average access problems.
- People see that at a city-wide level, issues such as greenhouse gas emissions, road congestion etc are serious, even though they are caused by the very same behaviour (e.g. using the car to go to the shops rather than the bus) which maximises individual accessibility.

**Access Problems for Particular Groups**

As discussed in Chapter 2, there are three major categories of accessibility disability (usually referred to as transport disability):

- **Geographic location.** In general, people in outer suburbs have lower access to most services, employment etc than those in middle suburbs, who in turn have lower accessibility than those in inner suburbs, by both private car and by alternative means. For example walking distances to reach local shops, schools, entertainment facilities etc become longer in outer suburbs, and public transport services become less frequent, with longer journeys required and higher fares. Similarly, people who live considerable distances from major rail lines or public transport nodes have lower public transport access than those living close to such facilities.

- **Access to cars.** Given that private cars provide superior access to the alternatives of walking, cycling, or public transport for most trips, those experiencing the most significant disadvantage are those unable to drive or access a car by reasons of age, income, physical disability etc.

- **Physical Condition / Disability.** A proportion of the population experiences mobility, sight, hearing or other disabilities which affect their ability to use various modes of transport, and hence to access services and facilities.

In addition, those on low incomes have to spend a higher proportion of their income on transport to achieve a given level of accessibility, than those on high incomes do. They are less likely to own a car or have access to a car (other things being equal) and less able to afford taxis.

These various forms of transport or access disability can be compounded – for example low-income people living in an outer suburb, without access to a car and having a disability, which affects their mobility. It was therefore decided to test the hypothesis that transport disadvantage, as classically measured, correlates with access difficulty (as expressed in the survey results).
**Geographic Location**

As expected, the percentage of people indicating that transport/access problems were a major problem/the only problem was highest (12%) in Liverpool, and considerably lower in Willoughby (5%), which is a higher income area. However there was no significant difference in average ratings across LGA's.

**Table 4.13  Transport / Access Problems by Local Government Area**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Extent of Problem</th>
<th>Liverpool</th>
<th>S Sydney</th>
<th>Willoughby</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not a problem</td>
<td>47%</td>
<td>48%</td>
<td>52%</td>
<td>49%</td>
</tr>
<tr>
<td>2</td>
<td>Sometimes a problem</td>
<td>41%</td>
<td>43%</td>
<td>42%</td>
<td>42%</td>
</tr>
<tr>
<td>3</td>
<td>A major problem / the major difficulty</td>
<td>12%</td>
<td>10%</td>
<td>5%</td>
<td>9%</td>
</tr>
<tr>
<td>Total</td>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Average Rating</td>
<td>1.66</td>
<td>1.62</td>
<td>1.53</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Similarly, there was no significant relationship with public transport access (significance = .218), with similar average ratings for people from low and medium, but a lower rating for those in areas with high public transport access, measured as distance from the nearest station.

**Table 4.14  Transport / Access Problems by Public Transport Access**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Extent of transport / access problems</th>
<th>Public Transport Access</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>1</td>
<td>Not a problem</td>
<td>87</td>
<td>93</td>
</tr>
<tr>
<td>2</td>
<td>Sometimes a problem</td>
<td>81</td>
<td>96</td>
</tr>
<tr>
<td>3</td>
<td>A / the major problem</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>185</td>
<td>208</td>
</tr>
<tr>
<td></td>
<td>Average Rating</td>
<td>1.62</td>
<td>1.64</td>
</tr>
</tbody>
</table>

**Car Availability**

A significant relationship was found between the degree to which transport/getting access to things was a problem, and the number of cars available to the household (Chi-squared = 13.3, df=6, sig. = .039).

However as shown below, the results were not straightforward. For example 4% of people from one-car households indicated that transport and access was either a major problem or the major problem for them, compared with 16% of people from households with three cars available. Clearly other factors besides car ownership are also playing a role here. This could include the size of the household, and the perceived travel needs of different individuals and households.
Physical Condition or Disability affecting use of Transport

On the other hand, there was a very strong relationship as expected with the presence of a physical condition or disability affecting the use of transport (Chi-squared = 24.4, df=2, sig=.000).

Figure 4.61 Transport / Access Problems Versus Disability-Related Difficulty

Transport / access problems versus disability-related difficulty
As expected, those people who indicated that they had a difficulty in using any form of transport (13%) were much more likely to express the view that transport and getting access to things was a major problem, or the major problem they face, than were those without any physical difficulties.

**Income**

The analysis with personal income found no significant relationship – as shown below, the response to Question 49 from a personal perspective shows no clear relationship with income. Perhaps surprisingly, the income group with the highest percentage (14%) claiming that transport / access is a major / the major problem is the highest income group (> $1000 per week), possibly indicating that they have more complex travel needs or greater time pressures.

**Figure 4.62 Transport / Access Problems versus Personal Income Group**

More detailed breakdowns by income group reveal an interesting picture. Although the sample size is insufficient for statistical significance, the data suggest that the most significant access problems occur for the lower income groups, although access is also considered more of a problem (relative to their other problems) for very high income groups than middle income groups. This could however be because other problems (such as housing affordability) may be considered more significant for the latter groups. (See figure below).
Other Factors

Further analysis was undertaken to explore the underlying causes which might explain people's perceived access problems, including whether this was a combination of factors. The table below summarises the results.

Table 4.15 Results from Tests of Other Possible Factors

<table>
<thead>
<tr>
<th>Cross-tab</th>
<th>DF</th>
<th>Chi-squared</th>
<th>Significance</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Group * Problem / No Problem</td>
<td>8</td>
<td>0.000</td>
<td>**</td>
<td>See Discussion below</td>
</tr>
<tr>
<td>Cars at HH * Problem / No Problem</td>
<td>4</td>
<td>0.056</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental Status * Problem / No Problem</td>
<td>1</td>
<td>0.887</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income Group * Problem / No Problem</td>
<td>8</td>
<td>0.472</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income * Problem / No Problem for each Local Government Area</td>
<td>&gt;0.05</td>
<td></td>
<td>No significant relationships for any of the LGAs</td>
<td></td>
</tr>
<tr>
<td>Workforce Status * LGA * Degree of Problem</td>
<td>15</td>
<td>0.055</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In general, there were few relationships which were statistically significant, although as shown in the figure below, there was a highly significant relationship with age. The percent of people having transport/access problems at least some of the time peaks for the 17-19 year old group, and falls rapidly thereafter, though with some evidence of a rise for the over 75-year olds.
Figure 4.64  Transport / Access Problems versus Age

The lack of apparent simple relationships with income, LGA and car ownership is likely to arise because of the complex inter-relationships and trade-offs involved. For example car ownership and age characteristics vary with LGA.

Figure 4.65  Household Cars Available by LGA
Thus Willoughby has higher car ownership (which one would expect would reduce access problems), while South Sydney has a low proportion of teenagers, which would reduce the proportion of people expressing problems with access. When access problems are weighted by the degree of severity, however, clear differences emerge between LGA's, as shown below.
Key Conclusions on Access Difficulties

- There are major differences in the nature and extent of accessibility problems by mode in Sydney, with the nature of the problems / difficulties being highly mode-specific.

- The high cost of using taxis emerged as the most commonly mentioned problem across all modes. This is interesting given the relative lack of attention to taxis as a mode of transport, but possibly reflects the fact that taxis are the only real alternative to the car in terms of door-door convenience.

- Safety and security issues emerged as a major issue. The survey results reinforce results from a range of other surveys here (for example Warren Centre, 2001; PRC 2001).

- Physical difficulty is a relatively infrequently mentioned issue across the overall population. However for the people affected, it is a major issue.

- For people over 18 and engaged in education, approximately half of the respondents indicated they had problems in accessing their place of study, with public transport availability and travel times being more important than car-related problems (traffic and parking).

- Access for shopping trips appears to be less of an issue in general, with problems accessing regional shopping centres being more frequently mentioned than problems accessing local shops or specialty shops.

- Overall, almost half of the survey recipients indicated that transport and access issues were not a problem for them personally. However 40% indicated it was “sometimes a problem,” 6% “a major problem,” and 3% “the major difficulty they face”.

- People appear to be more concerned about Sydney’s transport and access problems as a whole – only 19% thought it was “not a problem” while 7% felt it was the major problem or issue facing Sydney.

- In terms of how access problems vary across individuals it was found that:
  - There was no significant relationship with household car accessibility, geographic location or personal income.
  - There was however a highly significant relationship with the presence of a physical condition or disability which affected travel, and with age group.

- The survey data therefore support the need to consider physical disability as well as broad measures of transport accessibility when considering policies or measures to address access problems.
4.7 SUMMARY

Survey Details and Main Findings

The purpose of the survey was to gather up-to-date information on accessibility and related issues in Sydney. A total of 583 completed questionnaires were collected from three Local Government Areas (South Sydney, Liverpool and Willoughby), providing a broad cross section of spatial, socio-economic and demographic groups in Sydney. The table below summarises the main findings of the survey analysis.

<table>
<thead>
<tr>
<th>Area</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel Behaviour</td>
<td>• No relationship between work or education trip frequency and accessibility</td>
</tr>
<tr>
<td></td>
<td>• Significant relationships between mode for work trips and LGA</td>
</tr>
<tr>
<td></td>
<td>• Significant relationships between frequency of many “discretionary” trips and LGA</td>
</tr>
<tr>
<td></td>
<td>• Consistent with concept of travel time budget</td>
</tr>
<tr>
<td>Housing Choice</td>
<td>• Accessibility largest single factor in housing choice, ahead of affordability, quality of local street/suburb, features of the home, ability to own home, and amount of private outdoor space</td>
</tr>
<tr>
<td></td>
<td>• Relative importance of different factors varies however with socio-economic and demographic variables</td>
</tr>
<tr>
<td></td>
<td>• Pressure of those wanting to move out for more countered to a significant extent by some people electing to move closer to the city</td>
</tr>
<tr>
<td></td>
<td>• Significant relationships with age – e.g. over 55’s less likely to move out of Sydney</td>
</tr>
<tr>
<td>Activity and Time Use</td>
<td>• Significant differences in weighting placed on access to different types of opportunities by some locational, socio-economic and other factors</td>
</tr>
<tr>
<td></td>
<td>• Age by far the most important influence. However gender, qualifications, income were generally not important in this</td>
</tr>
<tr>
<td></td>
<td>• Local Government Area also important in relation to weighting placed on access to key recreational opportunities and to the CBD</td>
</tr>
<tr>
<td>Virtual Accessibility</td>
<td>• Percent of population who have ever used the Internet / email related to age, availability of computers at home, income, location, qualifications</td>
</tr>
<tr>
<td></td>
<td>• Amongst users, however, frequency and amount of use does not appear to be that dependent on these variables</td>
</tr>
<tr>
<td></td>
<td>• The Internet is leading to widening of social contacts and replacement of in-home rather than out-of-home activities</td>
</tr>
<tr>
<td></td>
<td>• Some impacts on travel likely to occur but net impact on overall travel demand likely to be small</td>
</tr>
<tr>
<td>Access Difficulties</td>
<td>• Major differences in the nature and extent of accessibility problems by mode, with most commonly mentioned being cost of taxis</td>
</tr>
<tr>
<td></td>
<td>• Safety and security are key issues.</td>
</tr>
<tr>
<td></td>
<td>• Physical difficulty is a major issue for those people affected</td>
</tr>
<tr>
<td></td>
<td>• Access to (higher) education, particularly by public transport is an issue.</td>
</tr>
<tr>
<td></td>
<td>• Overall, 40% indicated that transport and access issues were “sometimes a problem”; 6% “a major problem” and 3% “the major difficulty they face”</td>
</tr>
</tbody>
</table>

Chapter 4 examined some of the factors underpinning accessibility in some depth. The following Chapter complements and extends the above analysis by examining accessibility patterns across the whole of Sydney, highlighting the spatial dimension, using extensive data on both transport networks and opportunities.
CHAPTER 5: ACCESSIBILITY PATTERNS IN SYDNEY

5.1 INTRODUCTION

As discussed in Chapter 3, one of the research objectives for this thesis was to explore the spatial patterns of accessibility across Sydney, and how they vary for different activities and modes. This is important given that there have been extensive changes in land use patterns and transport systems in Sydney since the most recent comprehensive study of such patterns by Black (1977), a quarter century ago. This Chapter therefore develops accessibility indicators at a relatively fine geographic scale, to enable these patterns to be analysed and to provide a basis for the analysis of accessibility issues in later Chapters.

Selection of Accessibility Indicators

The accessibility indicators used are those developed in Section 3.5, in particular Equivalent Travel Time (ETT) and Relative Travel Time (RTT). These were selected as they are easy to understand and interpret, are able to distinguish between different groups in the community, reflect changes in land use and transport systems, and are robust. In addition, as explained in Section 5.2 below, they were found to be more straightforward than measures utilising travel costs.

Selection of Key Opportunities

People in urban areas seek access to a wide range of potential opportunities, including jobs, education, shopping, entertainment, parks, beaches, friends and relatives, health facilities and so on. The information gathered in the accessibility survey in Chapter 2 was used to rank the importance people place on these. The results are shown below.

Figure 5.1 Relative Importance of accessing different opportunities
As discussed in the Introduction, this thesis focuses on accessibility at a regional scale, rather than a local scale. It was therefore decided to limit the analysis of accessibility patterns to the most important of those opportunities for which region-wide access is likely to be important, and for which data would be likely to be available.

This Chapter therefore provides an analysis of accessibility patterns to the five most important of these attractions, specifically employment, hospitals, retail/shopping, friends and relatives, and education. More specifically, the particular variables which are used to measure these opportunities are described below, together with the reason for selecting them.

Table 5.1 Specific Opportunities and Reasons for Selecting Them

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Specific Variable Used</th>
<th>Reason for Selecting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Job</td>
<td>Total Employment</td>
<td>Data is available on total employment at a zonal level. However this does not distinguish between jobs which are a &quot;main job&quot; or &quot;second job&quot;</td>
</tr>
<tr>
<td>Hospitals and Health Facilities</td>
<td>Public Hospitals</td>
<td>Public Hospitals are key components of the health care system. Private Hospitals are also important, but access to them is limited by issues of health insurance. More basic facilities such as doctor's surgeries are very widely spread and more of interest in terms of local accessibility issues.</td>
</tr>
<tr>
<td>Shopping</td>
<td>Retail Centres</td>
<td>Retail centres account for the large majority of retail floor-space and shopping turnover. Local shops (&quot;corner stores&quot;) are very numerous but mainly of interest in terms of local accessibility issues.</td>
</tr>
<tr>
<td>Friends and Relatives</td>
<td>Population</td>
<td>While people seek access to specific individuals such as friends and relatives, there is no way in which data on this could be recorded on a general basis. However data on the distribution of the overall population is available, and reflects the overall access people have to social contacts at a regional scale.</td>
</tr>
<tr>
<td>Education</td>
<td>Universities</td>
<td>Primary schools are widely dispersed across Sydney, and most student attend a local school (although this is changing), so access to primary schools is mainly a matter of local accessibility. This is also true to a lesser extent for high schools, although the accessibility to the limited number of selective high schools and private schools is an issue. However access to university was selected as a topic of interest for regional accessibility issues, given the importance, limited number and wide catchments of such facilities.</td>
</tr>
</tbody>
</table>
Structure of Chapter

The remainder of this Chapter is structured as follows:

- Section 5.2 discusses in more detail the data and measurement issues involved, including key data sources, the selection of the Study Area for which accessibility is measured, the selection of the specific impedance measures used, and the measures used to estimate the attractiveness of different opportunities.
- Section 5.3 briefly describes the key road and rail transport infrastructure in Sydney from a regional perspective.
- Sections 5.4 to 5.8 analyse accessibility patterns to employment, hospitals, shopping, the population and universities. Each section describes the characteristics and distribution of the underlying opportunity, maps the accessibility patterns for both car and public transport, and compares the relative accessibility between the different modes to that opportunity.
- Section 5.9 compares the characteristics of the accessibility patterns by mode and opportunity, highlighting some issues for land use and transport policy.
- Section 5.10 summarises the key findings from the analysis.

5.2 DATA AND MEASUREMENT ISSUES

Key Data Sources

In order to develop accessibility indicators for Sydney, a database was established, using data from a variety of sources. This data includes:

- Detailed estimates of travel times by car and public transport from each zone in the Sydney Region to every other zone. This data was obtained from the NSW Transport Data Centre. Specifically, the following data were available for the year 2001, as well as for 2021:
  - Travel "skims" or shortest travel times by car between each pair of zones. This included separate travel times for the morning peak period, the weekday off-peak period, the afternoon peak period, and the evening off-peak.
  - Travel "skims" or shortest travel times by public transport for the morning peak period, and between each pair of zones. These included separate estimates of the walking time, waiting time, in-vehicle travel time, and number of transfers.
- Data on the spatial distribution of population and employment across Sydney. This is based on census data for periods up to 1996, and forecast data up to the year 2021, developed by the NSW Transport Data Centre, for over 800 travel zones in the Sydney area.
- Estimates of the number of beds, separations, staff levels and hours of intensive care service provided, for each of the public hospitals in the Sydney area.
- Estimates of the retail floor-space, turnover, car parking spaces and pedestrian movements for more than 230 retail centres in Sydney.
- Estimates of the number of university enrolments by university campus.
Geographic Coverage

In all cases, the STUDY AREA chosen is the Sydney Statistical Division, minus the SLA’s of Blue Mountains, Gosford and Wyong. While there are always problems associated with selecting boundaries for study areas, the rationale for excluding these areas was that they are essentially outside the Cumberland Plain. In addition, Gosford and Wyong are physically separated by the Hawkesbury River and national parks and are influenced by the Hunter Region to the North.

Limiting the measurement of accessibility to the above study area also helped reduce the data management task (which increases with the square of the number of zones). Even with these limitations, the data files for travel skims were substantial – around 80MB – necessitating considerable computing power.

Selection of Impedance Measures

Whilst data on travel costs was also available, it was decided to limit this study to travel time data for several reasons:

- Travel costs for private vehicles can vary substantially with the actual vehicle used, including its price, age, fuel consumption etc. In addition there are large differences between out-of-pocket costs, perceived costs, actual total variable costs, and actual average costs.
- Travel costs for public transport also vary significantly according to the availability or otherwise of concession fares (for example pensioners’ and student discounts) and use of periodic tickets as opposed to single tickets.
- The use of travel costs also raises questions of whether absolute costs or costs in relation to incomes should be used when calculating accessibility indices.
- Were travel costs to be included, then there is also the question of the perceived cost of travel time. It is known from extensive research that the value people place on travel time varies as a function of income, trip purpose, trip length, and other parameters. For example Waters (1993) reviewed evidence on the link between income and the value of travel time, finding that VTTS (value of travel-time savings) increases with income, but less than proportionately.

For all of these reasons, developing a broadly acceptable measure of impedance based on costs was considered difficult if not impossible, with the likelihood that a wide range of measures would be needed to cover the effects of car ownership, access to concession fares, travel time values etc. By contrast, travel time data is relatively less complex, varying principally by mode, origin, destination and time of day. Accordingly, the measures used here are based on travel times as discussed below.

For car travel, separate measures were available for travel times in the AM peak, the day off-peak, the PM peak and the evening, for weekdays. Examination of the detailed zone-zone skim data shows that travel times are, as expected, longer in the peaks than in the off-peaks. The differences vary somewhat across Sydney according
to levels of congestion on the road network, although other factors, such as the availability of clearway lanes in peak periods also influence the results.

Analysis of travel data by time of day indicated that most weekday travel is undertaken between 6.30am and 6.30 pm (NSW Transport Data Centre, 2002). Furthermore, roughly two-thirds of that occurs in the two peak periods of 6.30 – 9.30 am and 3.30 – 6.30 pm, although the exact proportion varies by trip purpose. It also showed that while total travel has increased strongly between 1991 and 2000, and there is some evidence of a trend to increased travel in the latter part of the evening peak period, there has been little change overall in the share of travel at different times of day. There is thus only limited evidence of "peak spreading" during weekdays.

Figure 5.2  Trips in Sydney by Time of Day, 1991 and 2000

Accordingly a simplified approach was taken to car travel times. These were defined as the average of the AM peak, day off-peak and PM peak travel times, plus 5 minutes to allow for walking at both ends of the trip and any time taken to find a parking space and to park the vehicle. For transit travel times, the measure used was total time taken (in-vehicle plus waiting and access times).

Intra-zonal travel times

Data was not available on intra-zonal travel times. Whilst intra-zonal trips are a relatively small proportion of overall trips, the impact on accessibility from neighbouring opportunities (ie ones in the same zone as the resident) can be significant, since these are more heavily weighted in accessibility indices than opportunities which are more remote. For example Zone 432, Parramatta CBD, happens to have the highest number of employees in 2001 of any zone in Sydney.
Accordingly estimates of intra-zonal travel times for car and public transport were calculated from the detailed zonal database, which includes the area of the zone, by estimating average intra-zonal trip lengths and converting these to times based on travel speeds. A minimum of 5 minutes was assumed since even with car-based trips there is always some time spent in walking to/from the car and for parking it, even for short trips.

**Measures of Attractiveness of Opportunities**

From this data a range of primary accessibility indicators from each origin zone can be calculated for both car and public transport to each of the key opportunities identified (Employment, Public Hospitals, Retail Centres, Population and Universities). These in turn could also be used to generate secondary accessibility indicators, which weight the accessibility from a given zone according to the importance placed on access to different activities by particular groups, for example by older adults, or by the extent to which particular modes are utilised.

The measures used for the attractiveness of different opportunities are discussed in the following sections. In general a straightforward approach has been adopted, such as the number of jobs, or the number of equivalent student places, since the aim is to produce meaningful indicators which can be readily understood and interpreted.

**Specific Accessibility Measures**

The primary accessibility measures used in this study are ETT (equivalent travel time) and RTT (relative travel time). These are however calculated from AAV (absolute accessibility values) using the inverse square of the travel time as the impedance relationship. As discussed earlier, other forms of impedance function could have been used, but would have made little difference to the ETT and RTT results. Hence the "classic" gravity model was used for simplicity and as it is well understood.

Specifically, the indicators used are:

- **Absolute Accessibility Value for Zone** \( i \)
  \[
  AAV (i) = \sum \left( \frac{A_t}{T_{ij}^2} \right)
  \]

- **Equivalent Travel Time for Zone** \( i \)
  \[
  ETT (i) = \left( \frac{\text{Sum} \,(A_t)}{AAV (i)} \right)^{0.5}
  \]

- **Relative Travel Time for Zone** \( i \)
  \[
  RTT (i) = \frac{ETT (i)}{ETT (average)}
  \]

Each of these indicators is calculated separately for car and for public transport travel times, and for different types of opportunities. These are evaluated based on the relevant attractiveness data for particular types of opportunity, and across the study region using the travel time skims as discussed above. These are also used to calculate the relative travel time between modes for each zone as follows:

- **Relative Travel Time (by Mode)**
  \[
  RTT = \frac{ETT \,(public \,transport)}{ETT \,(car)}
  \]
5.3 TRANSPORT INFRASTRUCTURE IN SYDNEY

The maps below show the key regional road and rail infrastructure in the Sydney area in 2001.

Figure 5.3 Major Road Infrastructure in Sydney

Figure 5.4 Rail Infrastructure in Sydney
It can be seen that the road and rail networks differ in extent and structure. In particular the road network includes circumferential as well as radial routes, and a network of arterials providing cross-suburb links.

By comparison, the rail network is less extensive, and more heavily focussed on the CBD. This has implications for accessibility by public transport compared with the car as discussed later.

A further aspect is that while there has been relatively limited expansion of the rail network in the last twenty years, many new freeways and motorways have been added in that time. These include the M2, M4, M5 motorways, the Eastern Distributor, the M5 East, the Gore Hill expressway, the Harbour Tunnel and the Western Distributor.

It should be noted that the travel time skims were based on the shortest total travel time by public transport taking into account ferries and buses as well as trains. The bus and ferry networks are not shown here, as they are too complex to display at a region-wide scale.

For modelling future accessibility, road and transit networks were also used for 2021, taken from the Transport Data Centre. These are discussed further in Chapter 6.

Unless otherwise stated, the tables, maps and figures are based on calculations or estimates by the author.
5.4 ACCESSIBILITY TO EMPLOYMENT

Distribution of Current Employment in Sydney

The map below shows the pattern of the employed workforce (by location of job) in 2001. As can be seen, the pattern is quite focused, with a high concentration of jobs in an arc from the airport through the CBD and into the lower north shore. There are also significant concentrations in major centres on rail lines such as Parramatta, Liverpool, Hornsby, Penrith, Hurstville, and Bankstown, as well as in areas such as North Ryde, Castle Hill and Mona Vale, which are not near rail lines.

Figure 5.5 Employment Distribution in Sydney, 2001

Accessibility to Employment

For each zone in the study area, the accessibility to employment by car was calculated by measuring the equivalent travel time (ETT by car). The zones were then classified into "very high", "high", "medium", "low" and "very low" categories, so that there were approximately 20% of zones in each category. The "very high" accessibility zones were those with the lowest values of ETT. The results for car are shown in Figure 5.6 A similar exercise was undertaken for travel by public transport, with the results shown in Figure 5.7.
As can be seen:

- The pattern for car resembles concentric circles based on the CBD/Eastern Suburbs, with some effect evident from the impact of the M4 and M5 Motorways
- The pattern for public transport is more complex, with “islands” of higher accessibility around major centres, and “ridges” following the main rail lines and bus transit routes.

However, the scales used to illustrate the patterns were different for the different modes. For example, roughly 20% of travel zones had equivalent travel times of less than 26 minutes by car, and were therefore deemed to be in the "very high" category for car. By contrast, the "very high" category for public transport had equivalent travel times of less than 44 minutes. The table below shows the relevant ranges used for the five categories for each mode.

**Table 5.2  ETT Ranges for Accessibility to Employment by Mode (minutes)**

<table>
<thead>
<tr>
<th>Relative Level of Accessibility</th>
<th>Very High</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>&lt;26</td>
<td>26-35</td>
<td>35-44</td>
<td>44-58</td>
<td>&gt;58</td>
</tr>
<tr>
<td>Public Transport</td>
<td>&lt;44</td>
<td>44-60</td>
<td>60-77</td>
<td>77-110</td>
<td>&gt;110</td>
</tr>
</tbody>
</table>

The use of different scales for car and public transport allows the relative spatial patterns for each mode to be seen more clearly. However, in order to show the relative accessibility by public transport compared with car, several approaches can be used:

- Zones can be mapped according to their ETT (public transport) scores, but using the same scale as that for car.
- Values of Relative Travel Time (ETT Public Transport) / ETT car) can be calculated for each zone, and the resulting patterns mapped.

The result of using the first approach is shown in Figure 5.8 below

**Figure 5.8  Accessibility to Employment by Public Transport, 2001 (car scale)**
As can be clearly seen, accessibility to employment by public transport is significantly lower than by car for almost all zones in Sydney. In particular, there are only a few zones in the study area for which accessibility to employment by public transport is equivalent to the "very high", "high" or "medium" levels by car. These zones are located mostly around the CBD and inner suburbs.

This is further illustrated in the map below, showing the ratio of ETT's for Public Transport to those for Car.

**Figure 5.9 Relative Modal Accessibility to Employment, 2001 (ETT Public Transport / ETT Car)**

This shows that:

- Most zones have ETT's for public transport which are over 1.6 times that by car
- However roughly 20% of the travel zones in the study area have a ratio between 1.3 and 1.6 times, while 20% have ratios between .85 and 1.3.
- There are thus around 20% of travel zones for which public transport gives comparable accessibility to employment with that by car.
- The location of these zones is interesting. Some are located in the CBD, as might be expected. However there are also a number of other zones, mostly in the outer suburbs but located close to key rail stations (such as Campbelltown, East Hills, Sutherland, Strathfield and Hornsby), where this occurs. The reason for this is that express, long distance rail services can be faster than car for trips to major job concentrations such as the CBD.
5.5 ACCESS TO PUBLIC HOSPITALS

Distribution of Opportunities

The Study Area is served by some 25 public hospitals, and these are classified as principal referral, paediatric, acute or major metropolitan by the Health Department. Between them, these hospitals had 8000 beds available, handled 714,000 patients (separations), provided over 2.6 million hours of intensive care and 2.6 million inpatient bed-days and employed some 38,000 equivalent full-time staff in 2001.

Table 5.3 Public Hospitals in Sydney Study Area

<table>
<thead>
<tr>
<th>Category</th>
<th>Facility</th>
<th>DDZ *</th>
<th>Separations **</th>
<th>ICU Hours</th>
<th>Av Beds</th>
<th>Bed Occup Rate</th>
<th>Inpatient Bed Days</th>
<th>EFT Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Referral</td>
<td>Concord Renatriation</td>
<td>209</td>
<td>48011</td>
<td>43659</td>
<td>350</td>
<td>88%</td>
<td>177025</td>
<td>2340</td>
</tr>
<tr>
<td>Principal Referral</td>
<td>Liverpool</td>
<td>368</td>
<td>50505</td>
<td>137556</td>
<td>525</td>
<td>94%</td>
<td>181861</td>
<td>2514</td>
</tr>
<tr>
<td>Principal Referral</td>
<td>Penrith-Nepean</td>
<td>389</td>
<td>35476</td>
<td>98177</td>
<td>378</td>
<td>95%</td>
<td>132145</td>
<td>1972</td>
</tr>
<tr>
<td>Prince of Wales</td>
<td>124</td>
<td>34819</td>
<td>158307</td>
<td>542</td>
<td>91%</td>
<td>179586</td>
<td>2938</td>
<td></td>
</tr>
<tr>
<td>Principal Referral</td>
<td>Royal North Shore</td>
<td>776</td>
<td>57838</td>
<td>207528</td>
<td>569</td>
<td>96%</td>
<td>198861</td>
<td>3412</td>
</tr>
<tr>
<td>Principal Referral</td>
<td>Royal Prince Alfred</td>
<td>34</td>
<td>61418</td>
<td>399056</td>
<td>773</td>
<td>89%</td>
<td>250544</td>
<td>4000</td>
</tr>
<tr>
<td>Principal Referral</td>
<td>St George</td>
<td>259</td>
<td>46495</td>
<td>150892</td>
<td>545</td>
<td>91%</td>
<td>182599</td>
<td>2158</td>
</tr>
<tr>
<td>Principal Referral</td>
<td>St Vincents</td>
<td>52</td>
<td>26164</td>
<td>312352</td>
<td>321</td>
<td>89%</td>
<td>105275</td>
<td>1888</td>
</tr>
<tr>
<td>Principal Referral</td>
<td>Westmead</td>
<td>429</td>
<td>58997</td>
<td>115981</td>
<td>709</td>
<td>94%</td>
<td>241388</td>
<td>3932</td>
</tr>
<tr>
<td>Paediatric Specialist</td>
<td>Sydney Childrens</td>
<td>30</td>
<td>14141</td>
<td>55404</td>
<td>140</td>
<td>83%</td>
<td>41447</td>
<td>620</td>
</tr>
<tr>
<td>Paediatric Specialist</td>
<td>New Childrens Hospital</td>
<td>429</td>
<td>29137</td>
<td>93076</td>
<td>248</td>
<td>96%</td>
<td>86772</td>
<td>1722</td>
</tr>
<tr>
<td>Unergrouped Acute</td>
<td>Royal Hosf for Women</td>
<td>124</td>
<td>14561</td>
<td>0</td>
<td>134</td>
<td>81%</td>
<td>42703</td>
<td>497</td>
</tr>
<tr>
<td>Unergrouped Acute</td>
<td>Sydney/ Sydney Eye</td>
<td>11</td>
<td>7573</td>
<td>0</td>
<td>72</td>
<td>82%</td>
<td>21804</td>
<td>451</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Auburn District</td>
<td>324</td>
<td>13672</td>
<td>108948</td>
<td>145</td>
<td>72%</td>
<td>41760</td>
<td>593</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Bankstown/Lidcombe</td>
<td>322</td>
<td>28787</td>
<td>123355</td>
<td>382</td>
<td>87%</td>
<td>120590</td>
<td>1429</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Blacktown</td>
<td>420</td>
<td>38379</td>
<td>105257</td>
<td>282</td>
<td>90%</td>
<td>99062</td>
<td>817</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Campbelltown</td>
<td>592</td>
<td>23352</td>
<td>113073</td>
<td>206</td>
<td>91%</td>
<td>68681</td>
<td>867</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Canterbury District</td>
<td>234</td>
<td>13353</td>
<td>0</td>
<td>144</td>
<td>95%</td>
<td>49945</td>
<td>550</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Fairfield district</td>
<td>580</td>
<td>15840</td>
<td>42591</td>
<td>167</td>
<td>78%</td>
<td>47940</td>
<td>725</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Hornsbv &amp; Kuring-Gai</td>
<td>650</td>
<td>18155</td>
<td>58772</td>
<td>249</td>
<td>86%</td>
<td>78818</td>
<td>1025</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Manly District</td>
<td>566</td>
<td>13917</td>
<td>43903</td>
<td>180</td>
<td>92%</td>
<td>57907</td>
<td>757</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Mona Vale District</td>
<td>544</td>
<td>12464</td>
<td>32313</td>
<td>147</td>
<td>87%</td>
<td>45738</td>
<td>518</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Mount Druitt</td>
<td>738</td>
<td>18095</td>
<td>26148</td>
<td>137</td>
<td>98%</td>
<td>48558</td>
<td>695</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Ryde</td>
<td>481</td>
<td>11823</td>
<td>101614</td>
<td>156</td>
<td>79%</td>
<td>44783</td>
<td>631</td>
</tr>
<tr>
<td>Major Metropolitan</td>
<td>Sutherland</td>
<td>280</td>
<td>21660</td>
<td>125986</td>
<td>287</td>
<td>89%</td>
<td>92782</td>
<td>963</td>
</tr>
</tbody>
</table>

TOTAL 714632 2653948 7988 2638574 38014

Source: NSW Health Commission website * DDZ = Traffic Zone Code Number ** Separations are the number of patients departing from the hospital. It is similar to the number of admissions.

There is no single measure, which summarises all aspects of health care availability, since this depends on the particular aspect of health care being considered. For example for some purposes, total beds available is important, while for others the number of hours of intensive care provided is more relevant. However as shown below, there is a reasonable correlation between the different measures. For example:

- The nine principal referral hospitals accounted for around 60% of separations, ICU hours and hospital beds available, and around 65% of total effective full time staff, reflecting such factors as their teaching and research roles.
- The major metropolitan hospitals accounted for a further 30-35% of separations, ICU hours and available beds, but 25% of staff resources, with the paediatric specialist and ungrouped acute hospitals accounted for the remaining 9%.

Page 175
Figure 5.10  Public Hospital Characteristics by Type of Facility, 2001

Hence separations has been chosen as the measure to be used for accessibility to public hospital services. The figure below illustrates the spatial distribution of hospital facilities using the measure of total separations (similar to hospital admissions).

Figure 5.11  Distribution of Public Hospitals in Study Area, 2001, by Hospital Separations
Accessibility Patterns

The figures below show accessibility to public hospitals by car and public transport.

Figure 5.12  Accessibility to Public Hospitals by Car, 2001 (ETT, minutes)

Figure 5.13  Accessibility to Public Hospitals by Public Transport, 2001 (ETT, minutes)

Comparison with other attractions (see later discussion) shows that access to public hospital facilities is relatively more even across Sydney than access to either
employment or university enrolments, but less so than access to retail floor-space. Accessibility by car is higher than by public transport, as is the case for other classes of opportunity, though the differences by mode are somewhat less pronounced.

Figure 5.14  Accessibility to Public Hospitals by Public Transport, 2001 (car scale)

Figure 5.15  Relative Modal Accessibility to Public Hospitals, 2001 (ETT Public Transport / ETT Car)
5.6 ACCESSIBILITY TO SHOPPING

Distribution of Retail Centres

The Sydney Study Region considered in this study is served by a large number of retail centres of varying kinds. The Property Council of NSW maintains an extensive database of such centres, which includes a wide range of key information, including the amount and type of retail and other floor-space, annual turnover, parking places provided, pedestrian movements, and history, such as when the centre was originally built or subsequently expanded. (Property Council of NSW, 2002).

Detailed data was obtained from this database and analysed. The table below summarises some of the key information.

Table 5.4 Key Data on Shopping Centres in Sydney 1991 and 2001

<table>
<thead>
<tr>
<th>Year</th>
<th>1991</th>
<th>2002</th>
<th>Change</th>
<th>Change %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Recorded Centres</td>
<td>169</td>
<td>234</td>
<td>65</td>
<td>38%</td>
</tr>
<tr>
<td>Floor Space (Sq.M. Gross Lettable Area)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Major Retail Tenants</td>
<td>1,238,966</td>
<td>1,762,359</td>
<td>523,393</td>
<td>42%</td>
</tr>
<tr>
<td>- Specialty Retail Tenants</td>
<td>834,696</td>
<td>1,382,351</td>
<td>547,655</td>
<td>66%</td>
</tr>
<tr>
<td>- Total Retail</td>
<td>2,073,662</td>
<td>3,144,710</td>
<td>1,071,048</td>
<td>52%</td>
</tr>
<tr>
<td>- Office and Other Tenants</td>
<td>539,437</td>
<td>1,027,551</td>
<td>488,114</td>
<td>90%</td>
</tr>
<tr>
<td>Total</td>
<td>2,613,099</td>
<td>4,172,261</td>
<td>1,559,162</td>
<td>60%</td>
</tr>
<tr>
<td>Car parking Spaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Open</td>
<td>46,254</td>
<td>69,688</td>
<td>23,434</td>
<td>51%</td>
</tr>
<tr>
<td>- Closed</td>
<td>43,884</td>
<td>68,896</td>
<td>25,012</td>
<td>57%</td>
</tr>
<tr>
<td>Total</td>
<td>90,138</td>
<td>138,584</td>
<td>48,446</td>
<td>54%</td>
</tr>
</tbody>
</table>

Source: Property Council of NSW, 2002

In particular:

- The number of centres in the database has grown by 38% in that time, with a 52% increase in retail floor-space and a 60% increase in total floor-space including offices, cinemas etc.
- The number of car parks provided by the centres has grown by 54%, with closed spaces (multi-storey car parking facilities) growing slightly faster than open car parking spaces.

The 2002 database includes additional information on gross moving annual turnover (including GST) for some 88 of the centres. This amounted to $11.9 billion for such centres, which accounted for 65% of total floor space. Similarly, the 2002 database recorded pedestrian movements at some 142 of the centres - in total, this amounted to 725 million people for such centres, which accounted for 80% of gross floor-space. This suggests that total retail turnover for the centres in the database was of the order of $18 billion in 2001/2, while such centres attracted approximately 900 million visits in the same year.

The Property Council categorised retail centres in its current database as follows:
• **CBD Centres** - this includes 38 shopping complexes and arcades in Sydney CBD, North Sydney and Parramatta.
• **Super-Regional** – this includes the four largest shopping centre complexes in Sydney (Warringah Mall and Westfield at Hornsby, Miranda and Parramatta).
• **Major-Regional** – these are the next ten largest shopping centres, each with at least 50,000 sq.m. of total gross lettable area for retail (GLAR).
• **Regional** - eight other large centres, each with at least 20,000 sq. m. GLAR.
• **Sub-Regional** – some 30 smaller centres, each with 12 – 20,000 sq. m. GLAR.
• **Neighbourhood** – local centres with less than 10,000 sq. m. GLAR.
• **Themed** – six specialty centres (such as Birkenhead Point or the Sydney Fish Market) which have a particular focus.
• **Showroom** – the large standalone centres typically specialising in furniture, homeware, office equipment or other bulky goods.

The scale of the largest centres can be gauged from the statistics for Westfield Parramatta Centre, the second largest in Sydney (by floorspace) and one of the largest in the world since its expansion in the mid-1990’s. In 2001, this centre:

- Attracted 17.8 million visitors – almost Australia’s population
- Had over 4300 car parking spaces
- Had a total turnover of over $500 million
- Provided 114,000 sq. m. of retail floor-space, with an additional 8,000 sq. m. of cinemas and other spaces

The tables and graph below illustrate the characteristics of the centres by centre type:

- The 124 “Neighbourhood” centres account for over half of all centres, but for less than 20% of retail and other space. By contrast, the fourteen “Super-Regional” and “Major Regional” centres accounted for over a third of all retail/other space.
- The 38 “City Centre” facilities located in Sydney, North Sydney and Parramatta (mostly shopping arcades) accounted for almost 7% of retail and other space, but 85% of the office space which was incorporated in such retail centres.
- The “major retail tenants” (the large chains such as Grace Brothers, Woolworths etc) are heavily concentrated in the “Super Regional” and “Major Regional” centres. By contrast, “Specialty Retail” space is concentrated in the City Centres and the Neighbourhood level centres.

**Table 5.5 Floor-space by Category of Retail Centre (2001)**

<table>
<thead>
<tr>
<th>Category of Centre</th>
<th>No of Centres</th>
<th>Gross Lettable Area (Sq. M.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Major Retail</td>
</tr>
<tr>
<td>City Centre</td>
<td>38</td>
<td>64263</td>
</tr>
<tr>
<td>Super-Regional</td>
<td>4</td>
<td>270317</td>
</tr>
<tr>
<td>Major Regional</td>
<td>10</td>
<td>421329</td>
</tr>
<tr>
<td>Regional</td>
<td>8</td>
<td>201719</td>
</tr>
<tr>
<td>Sub-Regional</td>
<td>30</td>
<td>397373</td>
</tr>
<tr>
<td>Neighbourhood</td>
<td>124</td>
<td>259293</td>
</tr>
<tr>
<td>Themed</td>
<td>6</td>
<td>19114</td>
</tr>
<tr>
<td>Showroom</td>
<td>14</td>
<td>128951</td>
</tr>
<tr>
<td>TOTAL</td>
<td>234</td>
<td>1762359</td>
</tr>
</tbody>
</table>

*Source: Property Council of NSW, 2002*
Figure 5.16  Retail Floor-space by Category of Centre, Sydney, 2001

![Retail Floor-space by Category of Centre, Sydney, 2001](image)


Table 5.6  Other Characteristics of Retail Centres by Category (2001)

<table>
<thead>
<tr>
<th>Category of Centre</th>
<th>Pedestrians (million)</th>
<th>Car Parking</th>
<th>Turnover Sm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open</td>
<td>Closed</td>
<td>Total</td>
</tr>
<tr>
<td>City Centre</td>
<td>198</td>
<td>0</td>
<td>5314</td>
</tr>
<tr>
<td>Super-Regional</td>
<td>43</td>
<td>5334</td>
<td>11708</td>
</tr>
<tr>
<td>Major Regional</td>
<td>126</td>
<td>16437</td>
<td>16401</td>
</tr>
<tr>
<td>Regional</td>
<td>68</td>
<td>3867</td>
<td>12419</td>
</tr>
<tr>
<td>Sub-Regional</td>
<td>130</td>
<td>18959</td>
<td>10596</td>
</tr>
<tr>
<td>Neighbourhood</td>
<td>141</td>
<td>18526</td>
<td>8997</td>
</tr>
<tr>
<td>Themed</td>
<td>13</td>
<td>1106</td>
<td>1385</td>
</tr>
<tr>
<td>Showroom</td>
<td>7</td>
<td>5459</td>
<td>2076</td>
</tr>
<tr>
<td>TOTAL</td>
<td>725</td>
<td>69688</td>
<td>68896</td>
</tr>
</tbody>
</table>

Source: Property Council of NSW, 2002

The level and type of provision of car parking provided varies somewhat by type of retail centre, as shown below.
In particular:

- On average, some 40 car parking spaces per 1000 sq. m. gross lettable area for retail and other space is provided, divided almost equally between open car parks and closed car parks.
- City Centres provide no open car parking spaces, and hence a significantly lower overall provision of parking, reflecting the high cost of land in CBD’s and the availability of public transport.
- “Themed” centres and showroom centres also provide lower rates of car parking space per square metre of retail and other floorspace. This reflects the large amount of space required for furniture and bulky goods, and the locations of many of the “themed” centres.
- There is little difference in the overall level of car parking provided for other types of centres, although the proportion of closed and open spaces varies, reflecting the cost of land. For example sub-regional and neighbourhood centres (mostly in lower density suburban environments) provide most of their car parking space in open car parks, while regional and super regional centres provide most of their space in closed multi-storey car parks.

A number of measures could be used to construct accessibility indices for retail facilities. The measure used in this study is the amount of floor-space for major retail tenants, specialist retail and other tenants (excluding offices). This was selected since:

- Data on retail turnover was incomplete, being available for only 88 of the 234 centres. Furthermore this would bias results towards wealthy areas which have higher retail expenditure per capita than low income areas.
- Data on pedestrian movement was also incomplete, being available for only 142 of the 234 centres. Furthermore the data for City Centre facilities indicated much
higher pedestrian movement – 198 million of the 725 million recorded, reflecting the many city arcades which act as thoroughfares for pedestrian movement as well as shopping centres.

- Data on office space was excluded since it is more relevant to access to employment rather than retail opportunities. However data on “other floor-space” which includes cinemas and community facilities was included as these are now very much integrated into shopping centres and form part of their overall attractiveness.

The figure below shows the spatial distribution of retail centres by retail and other floor-space.

Figure 5.18 Distribution of Retail Centres in Study Area by Retail and Other Floor-space.

It is clear that:

- Retail centres are widely dispersed across the urban area
- Most of the really large-scale centres are located in the outer suburbs, while older centres in the inner suburbs tend to be closer together but somewhat smaller.
- Most retail centres are located close to the rail network. This reflects the historical importance of the rail system in serving and creating the major centres such as Parramatta, Chatswood, North Sydney, Liverpool, Hurstville etc, which then became natural locations for major shopping centres as well. However there have also been major retail facilities built in stand-alone locations well away from major public transport routes. Examples include Roselands in the SW suburbs,
one of the first of Sydney's car-oriented shopping centres; showroom facilities like Moore Park Super Centre, and major centres in northern Sydney such as Macquarie Centre in North Ryde, Warringah Mall, and Castle Hill.

Accessibility to Shopping

The maps below show accessibility to shopping by car and public transport, measured by Equivalent Travel Times.

Figure 5.19  Accessibility to Shopping by Car, 2001 (ETT, minutes)

Figure 5.20  Accessibility to Shopping by Public Transport, 2001 (ETT)
The patterns show a much more even pattern of accessibility than was the case for employment, reflecting the greater decentralisation of shopping centres. However as shown below, accessibility by public transport relative to car is poor.

Figure 5.21  Accessibility to Shopping by Public Transport, 2001 (car scale)

Figure 5.22  Relative Modal Accessibility to Shopping, 2001 (ETT Public Transport / ETT Car)
5.7 ACCESSIBILITY TO THE POPULATION

Population Distribution

The figure below shows the population distribution in Sydney in 2001.

Figure 5.23 Population Distribution in the Study Area, 2001

As can be seen, the population density is somewhat higher in the inner suburbs near the CBD, parts of the Eastern Suburbs, and near railway lines such as the Bankstown line. Population also follows the rail corridors generally, though in recent years there has been increasing growth in the western Fairfield / Liverpool and Baulkham Hills areas which are not well served by rail at present.

Accessibility Patterns

The following maps show the patterns of accessibility to the population by car and public transport, measured by Equivalent Travel Time for each mode. Note that the ETT ranges for car are different than those for public transport, as shown in the table below.
Table 5.7  ETT Ranges for Accessibility to the Population by Mode (minutes)

<table>
<thead>
<tr>
<th>Relative Level of Accessibility</th>
<th>Very High</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>&lt; 31.7</td>
<td>31.7 - 35.6</td>
<td>35.6 - 42.5</td>
<td>42.5 - 53.2</td>
<td>&gt; 53.2</td>
</tr>
<tr>
<td>Public Transport</td>
<td>&lt; 56.0</td>
<td>56 - 69</td>
<td>69 - 84</td>
<td>84 - 113</td>
<td>&gt; 113</td>
</tr>
</tbody>
</table>

Figure 5.24  Accessibility to the Population by Car, 2001 (ETT, minutes)

Figure 5.25  Accessibility to the Population by Public Transport, 2001 (ETT, minutes)
The impact of the rail network can be clearly seen. As shown below, only a few zones have accessibility by public transport in the medium or above range by car, and most zones have ETT’s by public transport which are 1.6 times that of car or greater.

Figure 5.26 Accessibility to the Population by Public Transport, 2001 (car scale)

Figure 5.27 Relative Modal Accessibility to the Population (ETT Public Transport / ETT Car)
5.8 ACCESSIBILITY TO UNIVERSITY

Distribution of Opportunities

Sydney’s five major universities (Sydney, NSW, Macquarie, Western Sydney and University of Technology, Sydney) had almost 150,000 enrolled students spread across 18 campuses in 2001.

Figure 5.28 University Enrolments by Institution and Campus, 2001

Source: Enrolment data from individual Universities, personal correspondence, 2002

Not all students are full-time, with EFTS (effective full-time student) loads being approximately 78% of total enrolments. However total enrolments is considered the most useful indicator of opportunity for university study since not all students wish to study full-time, and not all courses are offered in that format.

The figure below shows the spatial distribution of enrolments across the Sydney region. The concentration in the CBD and eastern suburbs can be seen, with almost 60% of enrolments at the major campuses of the University of Sydney, the University of Technology, Sydney, and the University of New South Wales. Some 18% of enrolments were in the northern campuses (Macquarie University, and UTS St Leonards and Kuring-gai) while 25% were in the western suburbs, at the various campuses of the University of Western Sydney and at the Cumberland campus of the University of Sydney.

Whilst a number of the campuses have reasonable rail access, some (such as UNSW, Kuring-gai and Macquarie) do not. Other campuses such as UWS Macarthur and UWS Nepean are located close to rail lines, but are at the extremities of the urban area, meaning long commuting distances even for those students in the western suburbs.
Another factor is parking, which is heavily restricted for students near the major inner city campuses.

**Figure 5.29 Distribution of University Enrolments by Campus, 2001**

![Image of distribution of university enrolments by campus, 2001](image)

**Accessibility Patterns**

The figures below show the accessibility to university by car and public transport, measured by equivalent travel times.

It can be seen that:

- The patterns of accessibility to university by car shows a strongly concentric pattern centered on the CBD/eastern suburbs, but with some impact from Macquarie University in North Ryde.
- Public transport accessibility to university also shows a strong focus on the large university campuses in the CBD and Eastern Suburbs, but the impact of the rail network and of the campuses of Western Sydney University are more apparent in terms of relative accessibility.
- However, despite the establishment of University of Western Sydney, accessibility patterns are more heavily focused on the east than was the case for employment or shopping, reflecting the higher level of concentration of university places in that region.
As shown below, when accessibility by public transport is mapped using the same scale as for car, the higher level of accessibility generally by car is clearly evident. However, the difference between car and public transport access is not as pronounced as was the case for employment or shopping. This reflects the impact of traffic.
congestion and the lengthy road travel times from much of Sydney to the CBD and eastern suburbs.

Figure 5.32  Accessibility to University by Public Transport, 2001 (car scale)

Figure 5.33  Relative Modal Accessibility to University, 2001 (ETT Public Transport / ETT Car)
5.9 MODE, LOCATION AND OPPORTUNITY

In order to further explore the differences in accessibility patterns, an analysis was undertaken of the equivalent travel time (ETT) values for each travel zone to see how they varied across Sydney for the different modes and classes of opportunity. Figure 5.34 below shows the mean ETT's for inner, middle and outer suburbs in the study area, with ETT scores for each zone weighted by the 2001 population in that zone. Figure 5.35 shows the ratios of ETT scores between public transport and car for the inner, middle and outer suburbs and for the different classes of opportunity.

Figure 5.34 Average ETT Scores for Inner, Middle and Outer Ring Suburbs by Mode and Opportunity

Figure 5.35 Ratio of ETT Scores between Public Transport and Car for Inner, Middle and Outer Ring suburbs by Opportunity.
This shows that:

- In general, ETT values by public transport are approximately 1.6 to 2 times that of car, though the ratios are generally slightly higher in outer than in inner suburbs.
- ETT's in outer suburbs are typically 50 - 60 minutes by car and 90 -105 minutes by public transport. These are slightly more than double those of the inner suburbs, which are 20-30 minutes by car and 40-50 minutes by public transport.
- Thus accessibility by public transport in the inner suburbs is actually somewhat higher than accessibility by car in the outer suburbs, on average.
- The extent of variability between inner and outer suburbs is not uniform across the different opportunities. For example in the inner suburbs, university accessibility is the highest of all the opportunities (ie has the lowest ETT scores for both car and public transport), whereas in the outer suburbs it is lower than the accessibility for all other opportunities (highest ETT scores). By contrast, the differences between inner and outer suburbs in accessibility to shopping is relatively small.
- There are also some difference in the relative accessibility patterns by mode between the different opportunities. For example for accessibility to retail, the ratio of ETT (public transport) to ETT (car) varies from 1.6 in the inner suburbs to 2.0 in the outer suburbs, whereas for access to university it is 1.8 across the whole of Sydney.

Some further analysis of accessibility patterns was undertaken, by measuring the standard deviation of the ETT scores at travel zone level by mode and opportunity (see figure below).

**Figure 5.36 Standard Deviation of ETT Scores by Mode and Opportunity**
This highlights some other characteristics. In particular:

- The standard deviation of ETT by car scores vary significantly depending on the opportunity. For example it is very low for population (17.5) and for employment (21.1), both of which are relatively widely dispersed. By contrast, it is quite high for public hospital (67.6) and university (65.9), both of which are concentrated into a relatively small number of facilities. In the case of university facilities, these are also heavily focused in one part of the Study area.
- By contrast, the standard deviation in ETT scores by public transport is uniformly high for all opportunities.

In essence this is because:

- Cars provide two-dimensional freedom, with a highly connected road network and no need to change mode. Accordingly, accessibility by car from a given zone to a class of opportunities is primarily determined by:
  - the broad location of the origin zone in relation to the entire urban area
  - the extent to which the opportunities in that class are spread across the region.
- Hence the degree of variability in accessibility by car is much higher for university (which is focused on a few locations) than for employment (which is much more uniformly distributed).
- Public transport provides access which is essentially linear. For example fast trains can provide high levels of access from certain locations to other specific locations. However the need to change modes or vehicles to achieve two-dimensional mobility is a major factor. Accessibility by public transport from a given zone to a class of opportunities is therefore primarily determined by:
  - the precise location of the zone in relation to the public transport network, which determines the access time by walking, and the number and quality of services available
  - the extent to which the opportunities in that class are well located in relation to the key nodes on the public transport network.
- In particular, zones located at the intersection of a number of high quality public transport routes will have much higher accessibility to any type of opportunity than zones located remotely from the main public transport routes.

Thus the accessibility patterns reflect both the different land use distributions of the different opportunities, and the different characteristics of the different modes.

This raises important policy issues, and dilemmas. In particular decentralising and dispersing activities will in general increase overall levels of car-based accessibility, and reduce the extent of variability in access by car, which might be considered desirable from an equity perspective (if not an environmental perspective).

However this will reduce accessibility by public transport, and also increase the extent of variability in public transport accessibility, which would generally be considered undesirable both from an equity perspective and from an environmental perspective.
5.10 OVERALL ACCESSIBILITY PATTERNS

The previous analysis has looked at accessibility to specific classes of opportunity. In order to create an overall measure of accessibility, it is necessary to weight the importance of access to these different types of activity.

In order to explore this question, data from Chapter 4, which provides estimates of the relative importance people place on access to different opportunities, was used. The table below shows the weights for the five most important classes of activity or opportunity (employment, hospitals, shops, the population and education), which coincide with the opportunities already discussed, where the weights sum to a value of one.

Table 5.8 Relative Weights Ascribed to Different Types of Opportunity

<table>
<thead>
<tr>
<th>Type of Opportunity</th>
<th>Weight Used in Overall Accessibility Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>0.215628</td>
</tr>
<tr>
<td>Hospitals</td>
<td>0.211741</td>
</tr>
<tr>
<td>Shops</td>
<td>0.209781</td>
</tr>
<tr>
<td>Population</td>
<td>0.186181</td>
</tr>
<tr>
<td>Education</td>
<td>0.176669</td>
</tr>
</tbody>
</table>

Source: Author

An overall weighted ETT value for each zone was then calculated using the ETT values derived earlier for employment, public hospitals, retail centres, the population and universities, weighted using the above factors. Separate values were obtained for car-based and for public transport-based access.

While no weighting system could be considered perfect, the approach does utilise survey-based information rather than an arbitrary allocation of weights, and allows a measure of overall accessibility to be constructed.

The 823 zones in the study area were then ranked separately by levels of overall accessibility by car, and classified into five bands – very high, high, medium, low, very low, each with approximately 20% of the zones (see figure 5.37). This shows a broadly concentric pattern focussed on the CBD.

A similar ranking exercise was undertaken, based on overall accessibility by public transport, again with 20% of zones allocated to each of the very high, high, medium, low and very low accessibility bands (see figure 5.38). The pattern here is somewhat more complex than for car-based access, with the effects of local concentrations of opportunities and the impact of major public transport corridors being clearly evident.

This analysis reinforces the earlier discussion as to the geographic variability across the study area and also the differences in those spatial patterns by mode.
Figure 5.37  Overall Accessibility by Car, 2001 (Equivalent Travel Times)

Figure 5.38  Overall Accessibility by Public Transport, 2001 (Equivalent Travel Times)
5.11 SUMMARY

Developing Accessibility Indicators for Sydney

In order to illustrate patterns of accessibility across Sydney, a study area was chosen consisting of the Sydney Statistical Division, minus the Statistical Local Areas of the Blue Mountains, Gosford and Wyong. Detailed data was then collected on key factors underpinning accessibility to key opportunities, including

- Travel times by car and public transport between each pair of the 823 travel zones in the study area
- Population and employment for 2001 and also for forecast years up to 2026, for each travel zone in the study area
- A variety of information on Sydney’s 25 public hospitals, including the number of patients treated (separations), the number of hours of intensive care, average available beds, inpatient bed days and staffing numbers.
- Information on some 234 retail shopping centres in Sydney, including floor-space, turnover, pedestrian movements, car parking and dates for opening or subsequent expansion
- University enrolments for the eighteen major campuses of Sydney’s five universities

Regional Accessibility Patterns

Calculation and mapping of accessibility to five key opportunities revealed the following regional patterns:

Access to Employment

The pattern of employment in Sydney is more focused than population, with a high concentration of jobs evident in an arc from the airport through the CBD and into the lower north shore. There are also significant concentrations in major centres such as Parramatta, Liverpool, Hornsby, Penrith, Hurstville and Bankstown, which are on the rail network, and North Ryde, Castle Hill and Mona Vale which are not.

Accessibility to employment by car shows a very clear pattern of concentric circles with the highest levels (lowest ETT's) in the CBD, eastern suburbs and lower north shore. The pattern by public transport is also broadly a concentric pattern centred on the CBD, but with "islands" of higher accessibility around major centres such as Parramatta, Liverpool and Chatswood, and "ridges" of higher accessibility along the rail lines and the major bus route serving the Warringah peninsula.

When compared with other attractions, the pattern of accessibility to jobs by public transport is similar to that for accessibility to the population. However the relative accessibility to jobs by public transport compared with car is better than is the case for population, showing the importance of the job concentrations in the CBD with its strong radial public transport system. Similarly, there are clear locations in the study area, such as Campbelltown, Hornsby and Strathfield where the availability of express
rail services to the CBD means that they have similar overall levels of access to jobs by public transport to that available by car.

**Access to Public Hospitals**

The Sydney Study Region is served by some 25 public hospitals, of which the nine principal referral hospitals account for roughly 60% of hospital beds, patients and services.

The spatial distribution of public hospitals through the region is significantly more decentralized than is the case for universities, but not as much as is the case for retail centres. In particular the effect of shifting hospital beds to the western suburbs from the traditional concentration on inner city and eastern suburbs hospitals is apparent.

This is reflected in accessibility patterns. For example accessibility to public hospitals shows a zone of relatively high accessibility extending from the Eastern suburbs along the Parramatta River out to Westmead and beyond, with accessibility levels falling to the north and south of that area. Accessibility by public transport shows the impact both of the rail and public transport network, and the location of key hospital facilities.

Similarly, the pattern of public transport accessibility relative to car for hospitals shows a somewhat different pattern to that found for other attractions, with some areas in western Sydney showing up as having less relative public transport disadvantage in this respect. This reflects both the general distribution of hospitals and the fact that many are relatively close to major rail stations, such as Liverpool and Westmead.

**Access to Shopping**

There were some 234 major shopping centres in the study area in 2001, a 38% increase from 1991, with an estimated turnover of $18 billion and attracting some 900 million visits. These centres contained over 3.1 million sq. m. of retail floor-space as well as 1 million sq. m. of office and other space, and included over 138,000 car parking spaces, approximately half of which were enclosed.

The centres ranged from the typical neighbourhood centre with around 5,000 sq. m. of retail space, up to the “super-regional” facilities such as Westfield Parramatta. This includes 114,000 sq. m. of retail space, 8,000 sq. m. of cinemas and 4300 car parking spaces, attracted some 17.8 million visitors in 2001 and had a retail turnover of over $500 million.

Retail centres are widely dispersed throughout the study area. Most of the really large centres are in the outer suburbs, while the older centres in the inner suburbs tend to be closer together but somewhat smaller. Most major retail centres are located in town centres on rail lines, though there are some in stand-alone locations such as Roselands in the SW suburbs, or the showroom facilities such as Moore Park Supa Centre.

Accessibility to shopping by car shows a distinctly different pattern to that for population and employment, with the impact of the major regional centres in particular being clearly evident, and a much more uniform level of accessibility.
apparent across the region. This reflects the more decentralised nature of shopping facilities.

Similarly the relative accessibility patterns by public transport shows the effect of the many shopping centres. However public transport accessibility, relative to that by car, is lower than was the case for population or jobs.

**Access to the Population**

Sydney’s population distribution in 2001 shows a pattern which continues to reflect the historical urban development corridors which followed the rail lines to the west, south-west, south and north, with somewhat higher population densities in the inner suburbs and along some inner rail corridors. However recent population growth has also occurred in the western Fairfield/Liverpool and Baulkham Hills areas which are not well served by public transport at present.

The relative accessibility pattern by car shows the highest levels of accessibility in the eastern, inner western and inner northern suburbs, with accessibility generally declining in concentric circles. There is some evidence of the effect of the M4 and M5 motorways to the west and south-west.

The relative accessibility pattern by public transport is more complex. Whilst the general pattern is similar, the relative range between high and low accessibility is greater, and the impact of the rail network and of higher density population zones in centres is more evident. In general, accessibility patterns show “fingers” of higher accessibility along the rail lines and “nodes” around the major centres of Parramatta, Liverpool, Campbelltown, Blacktown, the Lower North Shore, Hornsby and Mona Vale.

Accessibility to the population by public transport is, however, significantly lower than that by car across the whole study area, with only a few zones having levels of public transport accessibility which reach the medium level achieved by car.

**Access to University**

Sydney has some 150,000 students enrolled in 18 campuses of the five major universities in 2001. Student places are however heavily concentrated in the CBD and eastern suburbs, with the three major campuses of University of Sydney, University of NSW and University of Technology, Sydney accounting for almost 60% of enrolments. A further 18% were at Macquarie University and UTS St Leonards and Kuringgai in the northern suburbs, with the remainder in the various campuses of the University of Western Sydney and at the Cumberland Campus of Sydney University.

The location of the campuses is reflected in accessibility patterns. Accessibility by both car and public transport show broadly concentric patterns centered on the CBD, with some impact from Macquarie University in the form of a secondary node centered on North Ryde.

Accessibility by public transport to university relative to that by car is however somewhat better than was the case for population or retail. This reflects the relatively
poor road accessibility to the major campuses in the CBD and eastern suburbs, rather than very high levels of public transport access.

**Overall Accessibility**

In order to calculate overall patterns of accessibility, data from the survey in Chapter 4 on the importance of access to specific types of opportunity was used to provide relative weights. These were then applied to the ETT values for access to employment, hospitals, shops, the population and universities, separately for car-based and public transport-based access.

The resultant weighted ETT scores for each zone were then mapped to show the patterns across Sydney. In the case of car-based access, the pattern shows a broadly concentric series of circles centred on the CBD, with declining accessibility (increasing ETT values) with distance from the CBD.

The pattern for public transport-based accessibility was more complex however, with the influences of sub-centres such as Parramatta, Liverpool, Blacktown etc as well as ridges of higher accessibility along major rail lines and public transport corridors.

**Overall Comment**

The patterns of accessibility to a range of opportunities were plotted for both car and public transport, using data for 2001 on the spatial distribution of those opportunities, and on travel times by different modes.

The patterns revealed the joint importance of both land use and transport infrastructure. While the latter was the same in all cases, and its influence is clearly apparent, the particular spatial distributions of different types of opportunity varied, and these effects were also apparent. For example:

**Accessibility by mode**

- Because of the extent of the road network and the ability of the car to provide “anywhere-anywhere” travel flexibility, *accessibility patterns by car* tend to show a broadly concentric pattern with the highest levels around the CBD and eastern suburbs. The partial exceptions to this was for access to shopping and access to public hospitals, where the impact of major retail centres and hospitals throughout the region tends to produce a more uniform and multi-centered pattern.

- *Accessibility patterns by public transport* reflect the impact of the major public transport corridors quite clearly in all cases, with “ridges” of high accessibility along the rail lines in particular, together with generally declining accessibility away from the CBD. However the patterns were more complex than was the case for accessibility by car, with the impact of sub-centres and major facilities more apparent in terms of “nodes” of relatively high accessibility. This indicates the importance of local public transport in servicing centres, and of locating major attractions in those centres.

- Generally for most zones in Sydney, equivalent travel times by public transport are at least 1.6 times that by car, with the ratio for zones remote from major public
transport corridors being at least 2.5 times. There are only a few zones where the ratio is less than 1.6, and these occur in the CBD or at key locations on major rail or bus routes where express trains or buses are available.

**Differences in Accessibility Patterns between Land Uses**

- The five opportunities considered - employment, public hospitals, shopping, population and universities - have somewhat different spatial distributions, which is reflected in the nature of their accessibility patterns.
- The two most evenly distributed across the study area are population and shopping (retail centres). Accordingly accessibility patterns for these opportunities show less relative spatial variation than for the other opportunities.
- Employment is somewhat more concentrated around key centres and zones, including the band from the airport through the CBD to Chatswood. Public Hospital facilities are relatively dispersed with major hospitals at Westmead, Liverpool, Nepean etc as well as the older hospitals near the city. However university places are the most highly concentrated, with 60% of enrolments in the three main campuses near the city or in the eastern suburbs (University of Sydney, University of Technology, Sydney and University of NSW).
- Accordingly accessibility to university shows the greatest difference between eastern / inner Sydney and Western Sydney, notwithstanding the establishment of the University of Western Sydney.

**Implications**

- The patterns of accessibility reveal two main inequalities:
  - A spatial inequality across Sydney, with the inner and eastern suburbs having significantly higher accessibility to all major opportunities than the western / outer suburbs
  - An inequality between modes, with car-based accessibility being significantly higher than that by public transport.
- This suggests two strategies for reducing inequalities in accessibility:
  - Increasing the share of activities / opportunities located in western / outer Sydney
  - Improving public transport (or reducing car-based accessibility through car parking restrictions, or allowing congestion levels to rise)
- The analysis of accessibility patterns also suggests that in some cases there may be a trade-off between these objectives:
  - Locating more opportunities (such as jobs, hospitals facilities, university places etc) away from the historical CBD and in the western suburbs may reduce the spatial imbalance in accessibility between east and west, but will tend to worsen the gap between car-based and public transport accessibility, since the CBD is the most accessible part of the region by public transport.
  - Conversely, concentrating activities back into the CBD will exacerbate the spatial imbalance but reduce the mode imbalance.
- This issue is illustrated in the case of access to university places, where the gap between eastern and western Sydney is greatest, but the gap between car-and public transport accessibility is least.
CHAPTER 6: APPLICATIONS OF ACCESSIBILITY

6.1 INTRODUCTION

As discussed in Chapter 2, accessibility is a key concept in understanding cities. The previous Chapter analysed accessibility patterns in the Sydney Region. This Chapter explores a number of possible applications of accessibility to a range of policy questions relating to urban planning:

- Section 6.2 examines urban consolidation and the compact city
- Section 6.3 considers employment distribution and centres policy
- Section 6.4 explores the distribution of urban services such as education
- Section 6.5 analyses transport investment policies and their impacts
- Section 6.6 reviews accessibility for people with a disability
- Section 6.7 summarises some of the key issues and implications.

Unless otherwise specified, the maps, tables and graphs are based on calculations by the author.

6.2 URBAN CONSOLIDATION AND THE COMPACT CITY

Policy Issues

A key issue in urban planning policy in recent years has been the policy thrust to encourage urban consolidation and the "compact city". This has been officially supported for some time through the Department of Infrastructure, Planning and Natural Resources and its predecessor departments (see for example, NSW Department of Urban Affairs and Planning, 1998). Such policies have also been widely debated in the professional literature - see for example Troy (1996), Planning Research Centre (1998), Daly (1998), Holliday (2000), Healy and O'Connor (2001) and Bunker and Holloway (2001). They have also been debated in the popular press. For example the Sydney Morning Herald's edition of Saturday 30 November 2002 carried a number of articles examining the policy and its implications (Totaro and Nicholls 2002, and Farrelly 2002).

The "Compact City" concept, however, is far from limited to Sydney. Similar policies have been adopted around Australia (Gleeson and Low, 2000), while in the United Kingdom, planning policies now advocate "intensification", "densification", or "consolidation" in preference to car-oriented "urban sprawl" (Burton, 2000). In the United States, there has been a major move to encourage the concept of "Smart Growth" and "transit-oriented development" in preference to continued low-density car-oriented urban forms (Cervero, 2001). Similar moves have begun in Australia, even in outlying areas where "new urbanism" has begun to be attempted (McMahon, 2002). De Roo and Miller (2000) provide an international perspective on the concept of Compact Cities and Sustainable Urban Development.
The major stated goals which the "compact city" and its close cousins, "transit oriented development", "new urbanism", "smart growth" and "urban consolidation" aim to achieve include:

- better environmental outcomes, through lower energy consumption, air and water pollution and greenhouse gas emissions, and by reduced consumption of fringe urban land, including natural bushland.
- greater housing choices, and a wider mix of housing types, including apartments and smaller homes, to match falling household sizes and an ageing society
- greater accessibility, in particular to public transport, and reduced reliance on cars.

In this context, it is often assumed that the closer integration of land uses will automatically lead to shorter trips and hence a reduction in travel (see for example Australian Greenhouse Office, 1999). However as Banister (2000) points out, a considerable proportion of travel is now for leisure purposes, and indeed forms part of the leisure experience. Hence not all travel is seen by the travelling public as a "cost" to be minimised.

However it is almost certainly true that the "compact city" increases the potential for choosing shorter trips, or to make more trips by public transport, walking and cycling, and this "choice" issue is the one most often stressed in the US approach to "smart growth" (Cervero, 2001; Levine, 1999). Similarly, evaluation of transit projects by the Federal Transit Administration in the United States takes into account factors such as the degree to which urban containment and growth management policies to minimise urban sprawl are in place (Gyulavary, 2000).

Compact cities with higher densities should also lead to higher load factors for public transit services (measured as pass-km / seat-km) which improves their productivity (Hensher 1987), even without any positive impacts on mode shares.

Another goal underlying the pursuit of the "compact city", less often stated publicly but probably as important to the Treasury in NSW, has been savings on the cost of extending and amplifying urban infrastructure and services. These services include physical infrastructure such as water and sewer, roads, public transport, electricity and gas, as well as schools, hospitals, childcare centres, police, recreational facilities and other social infrastructure (Australian Urban and Regional Development Review, 1995).

The State Government’s urban consolidation policy has been seen to be successful, in that there has been a significant turnaround in urban growth patterns in Sydney during the 1990’s. For example, the number of dwellings constructed in inner and middle suburbs of Sydney has risen strongly since the early 1990’s, lessening the pressure on the outer suburbs despite increasing rate of population growth.

As a result, population in the inner and middle suburbs has started to increase since 1991, growing by 34,000 between 1991 and 1996, after decades of population decrease. By 1997-98, 54% of new dwellings were multi-unit dwellings, a significant increase from 27% a decade earlier and well on the way to the government’s targets of 65% (NSW Department of Urban Affairs and Planning, 1998).
In fact, as Bunker, Gleeson, Holloway and Randolph (2002) point out (page 147),

"in terms of residential building completions, higher density development overtook separate houses as the dominant housing form in the early 1990's in Sydney. The trend has been maintained ever since and does not look like reversing in the near future. The suburban expansion of low density outer suburban housing stock on the fringe of Sydney during the 1970's and 1980's was clearly balanced by the expansion of the higher density housing stock after this time".

Taking into account demolitions, the growth in total housing stock clearly now favours other dwellings over detached houses, as shown below. The extent to which the these trends have been the result of deliberate policies favouring urban consolidation, or the emergence of new preferences in the housing market, is difficult to state, since both factors have been essential in producing the changed outcome.

In this context, Bunker et. al. (2002) chart the history of changes in planning policies, and in a detailed case study analysis of Campbeltown, Hurstville and Sutherland, show that both the policies and the style of urban consolidation varies across Sydney. Hence local planning controls and market conditions have also been important in shaping the nature of urban consolidation in Sydney.

However, it is not clear how much longer these trends can continue given the potential for an over-supply in apartments on the one hand, and the declining stocks of inner and middle suburban land suitable for redevelopment into higher density housing on the other. Certainly there are some writers who claim that the trend will prove to be temporary, and that Sydney will again need to rely mostly on growth in outer suburbs and new release areas in the future.
There has also been significant public disquiet as to the consequences of urban consolidation at the neighbourhood level. These consequences include increased traffic generation, loss of privacy and increased pressure on open space and existing services.

Figure 6.3  
Attitudes to Changes in Housing Density in Sydney

Source: Warren Centre, 2001
This was evident, for example, in surveys conducted by the Warren Centre’s project on “Sustainable Transport for Sustainable Cities” (Warren Centre, 2001 - see above). Overall, 46% of the survey expressed concern with over-development and its impact on the character of the neighbourhood, compared to 23% who were in favour of increased density for the benefits it might bring in terms of increased activity and land values.

However when faced with choosing between alternative strategies to house Sydney’s future population growth, the attitudes expressed in the same survey were quite different. Here people were asked to choose a preferred future scenario for Sydney, from among certain choices. Each scenario involved a combination of different housing, transport, employment and pricing options. The three housing futures were:

(a) Mixed - Some medium to high-rise housing across Sydney plus further low density housing in outer suburbs. Some loss of bushland

(b) Medium to High Density - Most new developments would be medium – high-rise apartments in inner suburbs and near railway stations, but retention of natural bushland

(c) Low Density - Most new developments are low-density housing in outer areas, with significant loss of natural bushland

The results indicated positive support for the first two options, involving consolidation, and negative support for the first option of continued low-density development on the fringe (see figure 6.4).

Figure 6.4 Preferences for Alternative Housing Strategies for Sydney

<table>
<thead>
<tr>
<th>Choice of future possible scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
</tr>
<tr>
<td>Med-High density</td>
</tr>
<tr>
<td>Low density</td>
</tr>
</tbody>
</table>

% change in choice of that scenario as preferred future Sydney

Source: Warren Centre (2001)

These results reinforce the results in Chapter 3, which emphasised the complex trade-offs people need to make at the individual level when choosing housing location, housing type and housing affordability. Similar findings emerge from other types of
research. For example, Dunphy (1998) examined the relationship between land values, housing costs and accessibility in Portland, USA. He estimates a decline in residential land value of $5,600 for each mile extra distance from the CBD, concluding that (page 15):

"The key point, confirmed again, is that being close costs money for housing but saves transportation cost and time...there obviously is considerable support for limiting sprawl and increasing densities in order to preserve the region's quality of life. At the same time, there seems to be an understanding that insensitive controls on available land development could contribute to pushing housing costs beyond the range of many people, a consequence that is unacceptable".

This leads to another policy issue concerned with urban consolidation - its relationship with housing affordability and social equity. Burton (2000) examines this question using UK data on some 25 medium-sized cities. Using a variety of measures of density or "compactness" and of social equity, she concluded that higher urban densities might be positive for some aspects of social equity, but negative for others (see table below).

Table 6.1  Evidence for Compact City Claims Related to Social Equity

<table>
<thead>
<tr>
<th>Compact city claim</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better access to facilities</td>
<td>*?</td>
</tr>
<tr>
<td>Poorer access to green space</td>
<td>*?</td>
</tr>
<tr>
<td>Better accessibility to jobs</td>
<td>?</td>
</tr>
<tr>
<td>Better public transport</td>
<td>*</td>
</tr>
<tr>
<td>Greater opportunities for walking and cycling</td>
<td>ns</td>
</tr>
<tr>
<td>Reduced domestic living space</td>
<td>* ns</td>
</tr>
<tr>
<td>Poorer health</td>
<td>* ns</td>
</tr>
<tr>
<td>Reduced crime</td>
<td>ns</td>
</tr>
<tr>
<td>Reduced social segregation</td>
<td>*</td>
</tr>
<tr>
<td>Lack of affordable housing</td>
<td>*</td>
</tr>
</tbody>
</table>

* = supports claim; ns = contradicts claim; * ns = claim supported in some respects but not others; ? = evidence is ambiguous; *? = evidence is weak but tends to support claim. Source: Burton, 2000.

Examination of this issue in Sydney is complicated, as the literature identifies at least four processes related to urban consolidation and the housing market:

- The process of "gentrification" of the inner suburbs, whereby middle – high income professionals and others, often in two income households with small families, have tended to displace working class households. Frequently this process does not involve increasing the population density – indeed household occupancy rates can fall. However it does involve substantial investment in the housing stock, addition of extra rooms and general upgrading, particularly where older style 19th century terraces are involved. This has occurred right through Sydney's inner suburbs over the last thirty or more years, starting in areas such as Paddington and now occurring in the inner western suburbs such as Marrickville.
- The process of conversion of old industrial, manufacturing and warehouse sites to housing. Often this involves the construction of large-scale apartment complexes, adding substantially to population numbers in particular neighbourhoods. This process does not directly displace older residents in those
neighbourhoods, but may be associated with significant increases in land values, and hence housing prices for existing dwellings. This process has occurred mainly since the mid-1980’s, and has been particularly evident in South Sydney and along the Parramatta River, where everything from power stations to steel fabrication plants have been replaced with housing. Two particular concentrations are Ultimo-Pyrmont and Green Square.

- **The replacement of low density housing** stock with significantly higher density housing – typically apartments but in some cases town houses. This process is usually associated with rising land values (on a per sq. m. basis, but not necessarily per dwelling unit), and with the displacement of any lower income households directly affected by the redevelopment. It can also lead to wider displacement of lower income households in the general region, as a result of land value and other impacts. This process is occurring continuously via a large number of mainly small-scale developments, again throughout the inner and increasingly the middle and even outer suburbs.

- **The refurbishment / upgrading of public housing.** This process occurred in Woolloomooloo and Glebe in the 1970’s and 1980’s, and more recently in parts of Redfern and Erskineville in the 1990’s. In some cases some of the stock has been sold to tenants but generally it has been retained as public rental housing.

As shown below, these four processes have different impacts on population density, land prices, housing prices and affordability.

<table>
<thead>
<tr>
<th>Process</th>
<th>Impact on local population density</th>
<th>Impact on land prices per Sq. M.</th>
<th>Impact on Land Prices per dwelling unit</th>
<th>Impact on Housing Prices for established dwellings</th>
<th>Impact on availability of affordable housing</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Gentrification”</td>
<td>Generally reduction</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase</td>
<td>Reduction</td>
</tr>
<tr>
<td>Redevelopment of Industrial Sites</td>
<td>Significant increase</td>
<td>Increase</td>
<td>Not clear</td>
<td>Increase unless redevelopment is of very low quality</td>
<td>Potential increase, if supported by policy action</td>
</tr>
<tr>
<td>Redevelopment of existing Housing</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase</td>
<td>Probable Reduction</td>
</tr>
<tr>
<td>Refurbishment of Public Housing</td>
<td>Little impact</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase</td>
<td>Maintain level if retained in public ownership</td>
</tr>
</tbody>
</table>

All of them have been occurring in the last decade, in some cases all in the same suburb (Redfern and Ultimo-Pyrmont are good examples). Sometimes the term “gentrification” is applied more generically. For example Ley (1996) writing about similar experience overseas, notes that (page 3):

"over the past decade, however, many authors, more attentive to changes in housing class than to those in the housing stock in the inner city, have broadened gentrification to include both sides of the middle-class housing market, the renovation
of old properties and the redevelopment of new units, with both conceived as part of the broader restructuring of the city”.

Badcock (2001) examined processes of gentrification in Adelaide’s inner suburbs since 1966, and notes that it is a widespread phenomenon in Europe and elsewhere. However, a narrower definition of “gentrification” has been applied here to allow the processes to be conceptually separated.

**Urban Consolidation and Accessibility**

The precise unraveling of the impacts listed in Table 6.2 is beyond the scope of this thesis, but the data and analysis on accessibility can be used to explore several questions of interest:

- Is urban consolidation having an impact on accessibility?
- Is future population growth in Sydney occurring mainly in areas of high or low accessibility?

As shown in Figure 6.5 below, population growth in the next 25 years is expected to occur both in outer suburbs (including areas in SW and NW Sydney which are relatively remote from major public transport corridors) as well as in inner and middle Sydney. As can be seen, a significant proportion of the growth is expected to be near major centres and in areas close to the rail network, including the CBD and Parramatta, and along the Illawarra, Bankstown, Main Western and North Shore lines.

**Figure 6.5 Patterns of Expected Population Growth, 2001-2026, Sydney**

In order to show the relationship more clearly between population growth and accessibility, the estimated population growth anticipated between 2001-2006, and between 2001 – 2026 was then calculated for each of the five accessibility bands.
estimated in Section 5.10. The results are shown in figures 6.6 and 6.7 below for car and public transport accessibility. The analysis indicates that:

- Over half of current population growth (ie expected to occur in the 2001-2006 period) is occurring in areas of Sydney with low or very low relative accessibility, although a significant proportion (around 33%) is occurring in areas with high or very high levels of accessibility. The remaining 14% is occurring in areas with medium accessibility.
- In the next 25 years, these patterns will remain broadly constant, though the proportion occurring in areas with very low accessibility will rise and the proportion in areas with low accessibility will fall.

Figure 6.6  Population Growth Expected 2001-06 by Overall Accessibility

![Figure 6.6](image)

Figure 6.7  Population Growth Expected 2001-26 by Overall Accessibility

![Figure 6.7](image)
Overall accessibility levels are likely to fall, therefore, compared with the current situation, assuming no changes to transport infrastructure or to distributions of employment, hospitals, universities and other opportunities. (Note that it is not expected that these will remain constant, but their impacts will be examined later).

However the fact that there is expected to be significant population growth in areas of high and very high accessibility indicates that the policies of urban consolidation are making, and are expected to continue to make, a significant contribution to maintaining accessibility levels. Were such growth to be stopped in favour of reliance on development in the outer suburbs and new release areas alone (as was essentially the case between 1970 and 1986) then it could be expected that there would be a significant fall in accessibility levels.

6.3 EMPLOYMENT DISTRIBUTION AND CENTRES POLICY

Government and Private Determinants of Job Location

In recent decades, government planning policy for Sydney has attempted to encourage employment growth into selected centres with good public transport access, particularly to centres in Western Sydney such as Parramatta, Liverpool, Bankstown, Blacktown and Penrith. This has been aimed at the twin objectives of increasing the mode share of work trips by public transport, and of reducing the historical imbalance in the distribution of population and jobs between Sydney's east and west.

At the same time, the primary aim of governments has been to encourage job creation generally, and issues such as the location of those jobs has been of secondary importance. Accordingly, a number of employment zones have been created to encourage firms in high-technology industry sectors to establish in Sydney. Such zones include North Ryde, the Norwest Estate, Terry Hills, and Huntingwood to name a few which are located well away from high quality public transport links. In addition, in recognition of the rising cost of land in the Central Industrial Area, a number of large industrial estates have been created in such locations as Ingleburn, Wetherill Park, Chullora and parts of Blacktown for manufacturing, warehousing and transport/logistics related activities.

However while governments at State and Local levels have sought to influence the location of employment to some extent through zoning and land development policies, the prime determinant of job location has always been the private sector. In this regard, employers take into account many factors when making location decisions, including:

- the nature of the firm and its workforce, including its size, potential for growth, skills requirements
- the density of jobs per hectare of land, and specific requirements such as building form and storage
- availability of car parking for staff and customers
- the importance of proximity to the port, airport, major warehouse facilities, freight transport routes and high capacity communications lines
- the importance of access to staff, customers and suppliers
any particular environmental factors such as air or water quality requirements
the availability and cost of land and/or buildings of appropriate size.
the “image” of the site and the area concerned, including exposure to major roads, prestige of the address etc

Accordingly a range of specific sub-markets have developed for prime and secondary office space, retail space (of various types), light and heavy industrial space etc.

Research into Job Location

There has been considerable research into the factors underpinning job location in cities, and their implications for access to employment. For example:

- O’Conner and Blakely (1989) argued that there was a symbiosis between the growth of the central city and the suburbs, with the latter providing much of the economic vitality of the metropolitan area, which in turn stimulates the development of the CBD. Consequently the CBD and suburbs are not simply in competition with each other, as assumed in traditional rent-gradient models.

- Petrakos (1992) examined the relationship between urban concentration and economic growth using a sample of 49 countries. He noted that most researchers looking at the concentrations of economic activity in the cores of cities associate it with urban agglomeration economies (such as scale economies, economies of scope and specialisation). He found that the external agglomeration economies have been exhausted, and that policies favouring the development of smaller cities in the peripheries of large metropolises would favour the development of smaller-scale, less capital intensive enterprises in the economy.

- Archer and Smith (1993) analysed the dual characteristics of suburbanization and clustering of office space. Using data from Orlando, Florida, they demonstrated that office space is more clustered than retail space, and went on to examine possible factors which could lead to such clustering. In particular they concluded that the traditional rationale based on the importance of face-face communication is not convincing in itself, and that other factors such as image, prestige, and the ability to benefit from concentrations of services, need to be taken into account.

- Freestone and Murphy (1998) identified a wide range of sub-specializations within the “high technology” market in Sydney.

- Filion (2001) examined the success or otherwise of suburban mixed-use centres in Toronto in encouraging a shift to public transport. He found that although there was evidence of the success of the centres in attracting development and attaining levels of transit use, pedestrian movement and inner synergy exceeding that of the typical suburban area, they were not as distinct as intended, and fell short of their planning goals. He concluded that a strategy combining the creation of high intensity mixed use nodes with high population density, transit-oriented corridors within the suburban environment would be more effective.

- Shen (2001) undertook a spatial analysis of job openings and access in Boston, examining not merely total employment levels but job turnover and hence the number of job offers available. She focused particularly on jobs suitable for less-educated workers, and found that most job openings come from turnover rather than “new” jobs, and hence the importance of the CBD, which has been growing more slowly than the suburban areas in terms of employment, has been underestimated. She also found significantly higher accessibility to job openings.
by those with a car than those reliant on transit, and that the extent to which central city or suburban housing locations provided accessibility advantages depended on the willingness to travel and access to a car.

- Geurs and van Eck (2002) examined accessibility to employment in the Netherlands and applied the results to separating the influences of land use changes, infrastructure projects and congestion. They also highlighted the importance of incorporating job competition and the match between educational and job levels in the analysis of job accessibility.

- Batty (2001) examined the degree of resilience and persistence in urban settlement structures, arguing that the creation of “edge cities” and poly-nucleated urban landscapes are entirely consistent with trends and forces apparent over the last 100 years, rather than being some new phenomenon. He analysed empirical evidence on the rank size of cities in the UK showing how early settlement patterns are gradually reinforced by positive feedback. This process produces “log-normally distributed settlement structures that are characteristics of city systems in developed countries.”

- Raskall (2001) examined the growth of Sydney City, noting that employment began to rise in the CBD in the 1990’s after previously falling in the 1980’s. Factors influencing this turnaround included the emergence of Sydney as Australia’s “world city”, with the resultant increase in international firms locating their Asia-Pacific headquarters in the city; the growth in high order legal, accounting and other services, most of whom preferred to locate in the CBD; the growth in business and conference tourism and in five star and other hotels, partly associated with the Olympic Games; and the regeneration of CBD-based retail.

The research highlighted above suggests a number of conclusions on the evolution of employment distribution patterns in Sydney:

- The trend to a more multi-centered city is expected to continue
- Employment in centres is likely to grow at least as strongly as employment overall, since most new jobs are expected to be in business and property services, retail, and tourism and hospitality rather than in manufacturing, transport and storage sectors, which tend to be located in industrial zones.
- Employment in industrial zones as a whole is likely to grow more slowly than population, though specific zones may see significant increases. For example Wetherill Park could experience densification as warehouse and manufacturing activities are gradually displaced by more office-intensive activities.
- Dispersed employment, including people working from home and small-scale enterprises, is likely to grow only at around the rate of population growth.
- The CBD proper (the inner part of Sydney LGA between Circular Quay, Central Station, Darling Harbour and Hyde Park) is likely to continue to grow in employment, but more slowly than the region as a whole, as it continues to specialize in high-end firms.
- However near-CBD centres (Bondi Junction, the Green Square – Airport – Wolli Creek area, Ultimo-Pyrmont, and North Sydney – St Leonards – Chatswood) are likely to see further significantly increased employment levels. This will be driven by their high levels of accessibility generally, their close proximity to the CBD for essential business links, and lower land and rental prices than the CBD proper.
- The key established Western Sydney centres (Parramatta, Liverpool, and Blacktown in particular) are likely to grow strongly, driven by the expanding

Page 214
population base in northwest and southwest Sydney. This will be further enhanced by improved transport connections.

- There will also be relatively fast growth in employment, but from a low base, in outer areas such as Norwest Estate, Castle Hill, Penrith and Campbelltown.
- Growth in the remaining parts of the study area (smaller scale suburban shopping centres and industrial estates) are likely to be relatively slow, though in inner parts of Sydney this will be driven by urban consolidation and gentrification, which are increasing population densities and disposable incomes, and hence consumer spending. This is already evident in the growth in restaurants, cafes etc in many of these centres.

**Employment Growth and Changes in Accessibility**

The Transport Data Centre has developed estimates of future employment distributions for Sydney, covering each of the zones in the study area, for five-yearly intervals to 2026. The pattern of expected employment growth in Sydney over the 2001-2026 period is shown below.

**Figure 6.8 Pattern of Expected Employment Growth, 2001 - 2026**

This shows significant clusters of growth in the key centres of the CBD, Parramatta, Liverpool, Blacktown, and Penrith, with smaller growth at Chatswood, Bankstown, Hurstville, Hornsby and Sutherland. There will also be growth in dispersed employment, including areas such as the North-West sector, which currently has very little employment, compared with its population.

The impact of this in terms of accessibility to employment has been estimated, assuming no change in inter-zonal travel times for car or public transport, using Estimated Travel Times (ETT). The following figures illustrate the change in relative
accessibility, with red areas showing a fall in relative accessibility (rise in ETT), and the yellow and green areas a rise in accessibility (fall in ETT).

Figure 6.9  Change in Equivalent Travel Times to Jobs by Car, 2001 - 2026 (due to change in employment growth only)

The patterns are similar, indicating that the western half of the study area will benefit by increased relative accessibility by both car and public transport (ETT will fall),
while the eastern half of Sydney will experience a small loss of relative accessibility (ETT will rise). This is a result of the assumption in the TDC figures of a relatively rapid growth in employment in the western half of the region. It is interesting to note, however, that the gains for car in Western Sydney are greater than for Public Transport. This suggests that there is likely to be some tendency for a mode shift away from public transport and towards car as a result of the change in employment distribution. This reflects the relatively poor public transport access compared with car for jobs, except for jobs located in the CBD.

In order to explore this issue further, an analysis was undertaken of changes in employment by accessibility level. Each of the 823 zones in the study area was classified as “very high”, “high”, “medium”, low” or “very low” according to its level of accessibility to employment in 2001, with separate classifications for car and public transport. The anticipated change in employment between 2001 and 2026 for each class of accessibility was then calculated based on the Transport Data Centre Forecasts (see figure 6.11). The results suggest that:

- Overall the shares of employment growth anticipated in Sydney between 2001 and 2026 will be relatively evenly split between areas of “very high”, “high”, “medium”, “low” and “very low” accessibility, based on current transport infrastructure and travel speeds.
- There is therefore limited net impact on accessibility levels as a whole from anticipated changes in employment distribution alone.
- This follows from the canceling out of two effects –
  - Increased accessibility arising from the strong growth in employment in centres as opposed to dispersed locations
  - Reduced accessibility arising from faster growth in Western Sydney (which currently has lower levels of accessibility than Eastern Sydney).

**Figure 6.11 Shares of Expected Employment Growth by Relative Accessibility Level**
6.4 DISTRIBUTION OF URBAN SERVICES

The patterns of current accessibility to university in Sydney were discussed in Section 5.8, where they were found to be highly skewed in favour of the inner and eastern suburbs.

Recent reports from WSROC show an increasing proportion of Western Sydney residents are attending university (WSROC, 2002), highlighting the need to expand university places closer to the growing populations in the western suburbs.

Accordingly, an analysis was undertaken to examine what differences in accessibility patterns to university might result from two alternative future scenarios:

(a) Expand university places at all university campuses proportionally to their 2001 enrolments, by 25%.
(b) Expand university places overall by 25%, but limit this to campuses in western, southwestern, and northern suburbs. This would require an almost 60% increase in enrolments at these campuses.

The table below highlights what this would imply in terms of enrolment numbers.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Campus</th>
<th>DDZ (Traffic Zone)</th>
<th>Enrolments 2001</th>
<th>Enrolments Scenario A</th>
<th>Enrolments Scenario B</th>
<th>Growth for Scenario B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney</td>
<td>Main</td>
<td>34</td>
<td>28816</td>
<td>36020</td>
<td>28816</td>
<td>0%</td>
</tr>
<tr>
<td>Sydney</td>
<td>Cumberland</td>
<td>322</td>
<td>4609</td>
<td>5761</td>
<td>7326</td>
<td>59%</td>
</tr>
<tr>
<td>Sydney</td>
<td>College of Arts</td>
<td>179</td>
<td>620</td>
<td>775</td>
<td>620</td>
<td>0%</td>
</tr>
<tr>
<td>Sydney</td>
<td>Cons of Music</td>
<td>17</td>
<td>619</td>
<td>774</td>
<td>619</td>
<td>0%</td>
</tr>
<tr>
<td>Sydney</td>
<td>Law</td>
<td>11</td>
<td>1510</td>
<td>1888</td>
<td>1510</td>
<td>0%</td>
</tr>
<tr>
<td>Sydney</td>
<td>Dentistry</td>
<td>35</td>
<td>361</td>
<td>451</td>
<td>361</td>
<td>0%</td>
</tr>
<tr>
<td>UTS</td>
<td>Broadway</td>
<td>24</td>
<td>20089</td>
<td>25111</td>
<td>20089</td>
<td>0%</td>
</tr>
<tr>
<td>UTS</td>
<td>Kuring-gai</td>
<td>511</td>
<td>3873</td>
<td>4841</td>
<td>6156</td>
<td>59%</td>
</tr>
<tr>
<td>UTS</td>
<td>St Leonards</td>
<td>776</td>
<td>499</td>
<td>624</td>
<td>793</td>
<td>59%</td>
</tr>
<tr>
<td>UWS</td>
<td>Bankstown</td>
<td>301</td>
<td>4395</td>
<td>5494</td>
<td>6986</td>
<td>59%</td>
</tr>
<tr>
<td>UWS</td>
<td>Blacktown</td>
<td>612</td>
<td>3057</td>
<td>3821</td>
<td>4859</td>
<td>59%</td>
</tr>
<tr>
<td>UWS</td>
<td>Campbelltown</td>
<td>591</td>
<td>5187</td>
<td>6484</td>
<td>8245</td>
<td>59%</td>
</tr>
<tr>
<td>UWS</td>
<td>Hawkesbury</td>
<td>396</td>
<td>2596</td>
<td>3245</td>
<td>4126</td>
<td>59%</td>
</tr>
<tr>
<td>UWS</td>
<td>Parramatta</td>
<td>442</td>
<td>7483</td>
<td>9354</td>
<td>11894</td>
<td>59%</td>
</tr>
<tr>
<td>UWS</td>
<td>Penrith</td>
<td>811</td>
<td>8565</td>
<td>10706</td>
<td>13614</td>
<td>59%</td>
</tr>
<tr>
<td>NSW</td>
<td>Kensington</td>
<td>123</td>
<td>28830</td>
<td>36038</td>
<td>28830</td>
<td>0%</td>
</tr>
<tr>
<td>NSW</td>
<td>Paddington</td>
<td>41</td>
<td>3426</td>
<td>4283</td>
<td>3426</td>
<td>0%</td>
</tr>
<tr>
<td>Macquarie</td>
<td>Macquarie</td>
<td>784</td>
<td>21789</td>
<td>27236</td>
<td>34634</td>
<td>59%</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>146324</td>
<td>182905</td>
<td>182905</td>
<td></td>
<td>25%</td>
</tr>
</tbody>
</table>

Source: Author's calculations

Scenario A would leave the relative accessibility patterns found in Section 4.8 unchanged (assuming no change in transport infrastructure and travel times). By contrast, the accessibility patterns by car and public transport under scenario B are shown below:
In comparison with figures 5.30 and 5.31 (based on the current distribution of university enrolments), it can be seen that there is a more even spread of accessibility under scenario B. This is further shown below, where the change in accessibility from
In comparison with figures 5.30 and 5.31 (based on the current distribution of university enrolments), it can be seen that there is a more even spread of accessibility under scenario B. This is further shown below, where the change in accessibility from
scenario A to scenario B is illustrated, clearly showing the gains in Western Sydney and the losses in Eastern Sydney.

Figure 6.14  Difference in Equivalent Travel Times to University by Car: Scenario B - Scenario A

Figure 6.15  Difference in Equivalent Travel Times to University by Public Transport: Scenario B - Scenario A
6.5 TRANSPORT IMPROVEMENT STRATEGIES

Introduction

The patterns of accessibility discussed in Chapter 5 highlight significant differences in accessibility. In particular:

- Accessibility is generally much higher in inner and eastern suburbs than in the outer and western suburbs.
- Accessibility by car is generally much higher than by public transport.

Previous sections in this report have highlighted the potential changes to accessibility patterns from expected future changes in population and employment, and from a scenario to increase university enrolments at campuses in the western and northern suburbs. These have shown in each case:

- A lessening of potential accessibility differences between the outer (western) suburbs and inner/eastern suburbs.
- Little change in the relative patterns of car versus public transport accessibility.

This section examines how accessibility patterns might change through the impact of changes to the transport system.

(a) Planned Changes

Action for Transport 2010 (NSW Department of Transport, 1998) set out a range of proposed improvements to both roads and public transport in Sydney. These have been included in a new transport network for road and public transport for 2021. The key elements are listed below:

<table>
<thead>
<tr>
<th>Type</th>
<th>Details</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>Western Orbital</td>
<td>Under construction</td>
</tr>
<tr>
<td></td>
<td>Lane Cove Tunnel</td>
<td>Currently being finalised</td>
</tr>
<tr>
<td></td>
<td>Cross City Tunnel</td>
<td>Under construction</td>
</tr>
<tr>
<td></td>
<td>F3 – M2 Connection</td>
<td>Under Discussion</td>
</tr>
<tr>
<td></td>
<td>M4 “Missing Link”</td>
<td>Under Discussion</td>
</tr>
<tr>
<td></td>
<td>F6 Corridor</td>
<td>Now proposed as public transport link</td>
</tr>
<tr>
<td>Rail</td>
<td>Chatswood – Epping Line</td>
<td>Under Construction</td>
</tr>
<tr>
<td></td>
<td>Epping – Parramatta Line</td>
<td>Planning (*)</td>
</tr>
<tr>
<td></td>
<td>Epping – Castle Hill Line</td>
<td>Planning</td>
</tr>
<tr>
<td></td>
<td>Quadruplication of E Hills Line</td>
<td>Under construction</td>
</tr>
<tr>
<td></td>
<td>Glenfield – SW Rail Link</td>
<td>Planning</td>
</tr>
<tr>
<td></td>
<td>Hurstville – Parramatta</td>
<td>Under consideration</td>
</tr>
<tr>
<td></td>
<td>Sydney – Newcastle Line High Speed Upgrade</td>
<td>Significant planning completed</td>
</tr>
<tr>
<td>Bus</td>
<td>Liverpool – Parramatta Transitway</td>
<td>Under construction</td>
</tr>
<tr>
<td></td>
<td>Blacktown – Castle Hill Transitway</td>
<td>Planning</td>
</tr>
<tr>
<td></td>
<td>Parramatta – Rouse Hill Transitway</td>
<td>Planning</td>
</tr>
<tr>
<td></td>
<td>General improvement in bus frequencies</td>
<td>To be investigated</td>
</tr>
</tbody>
</table>

*recently cancelled as a rail corridor. Source: NSW Department of Transport (1998) and author.
In addition, traffic is anticipated to increase significantly throughout the network by 2021. The impact of these changes in infrastructure, services and traffic conditions on accessibility to employment by car and by public transport is illustrated in the tables below, based on a new set of travel time skims provided by the Transport Data Centre.

Figure 6.16  Change in Equivalent Travel Times to Employment by Car, 2001-2021 (planned transport improvements only)

Figure 6.17  Change in Equivalent Travel Times to Employment by Public Transport 2001-2026 (planned transport improvements only)
As can be seen:

- There are only slight changes in accessibility by car - mostly a small decrease or small increase, depending on location.
- For public transport, the planned improvements to public transport will result in improvements to accessibility to jobs (shown by reduced ETT scores) across most of the middle and western suburbs, with a slight worsening in accessibility in the eastern suburbs. The zones showing the greatest improvements are across the northern and north-western suburbs (where the Chatswood - Epping and Epping - Castle Hill rail lines are expected to be built) and in the south-western suburbs (where the improvements will come from the Liverpool - Parramatta transitway and the Glenfield - SW rail link).

Consequently the proposed transport improvements should help reduce the imbalance in accessibility between Eastern and Western Sydney, and between cars and public transport, although the changes are relatively small.

(b) Other Potential Changes to Public Transport

There have also been a large number of other potential improvements to public transport networks and services in Sydney, which have been suggested by various authors. For example:

- State Rail (2001) developed a 50 – year strategic plan for the rail system in Sydney. In addition to the extensions, amplifications and upgradings included in Action for Transport 2010, the plan included:
  - A number of new “metro” lines serving the Warringah peninsula, the F6 corridor to Sutherland, and a “River Line” between Parramatta, the CBD and the south-eastern suburbs. These would use single-deck rollingstock and operate similarly to metros overseas, and would extend the coverage of the rail system to areas not currently served.
  - Additional investment in the heavy rail network to overcome current bottlenecks and allow faster services, including an additional link through the CBD between Central and St Leonards, quadruplication on the Illawarra Line, duplication on the Cronulla and Richmond lines etc.

- Savage and Bishop (2002) outline the Austrans ultra-light rail system being developed in Sydney, and identify how it could be used to address some of Sydney’s transport needs.

- Glazebrook (2002) identified a number of potential improvements including
  - Acceleration of rail services through improvements to the rail network to reduce bottlenecks and the resultant “recovery time” incorporated in current timetables, expansion of express services from outer suburbs, and introduction of single-deck rolling stock to allow higher accelerations and decelerations and shorter dwell times at stations.
  - Increased frequency of rail services through introduction of a simplified timetable with most peak services operating at 6 services per hour compared with 4 services per hour at present.
- A new light rail network centered on the CBD
- A series of new “ultra-light rail lines” serving the Warringah peninsula and parts of the north shore of Sydney, including new cross-regional routes
- Introduction of demand-responsive services by mini-buses and maxitaxis to provide feeder and cross-suburb services (see also Glazebrook and Subramaniam, 1997, and Cervero, 1997 for discussion of demand-responsive and paratransit services).

Thorpe (2002) proposed the introduction of the “Sydney Overland”, with new networks of high frequency bus services providing numerous opportunities for interchange. These would also be designed in a “grid” pattern rather than the current radial pattern, allowing easier cross-suburban movement. This concept is similar to suggestions by Mees (2000) in his comparison of Melbourne and Toronto.

In order to evaluate the general impact of improvements in public transport on accessibility, a simplified approach has been taken, by assuming an across-the-board 20% reduction in in-vehicle and waiting times (but not walk access times), to explore how this might improve accessibility by public transport. The results are shown below:

Figure 6.18 Accessibility to Employment with Improved Public Transport Scenario (using current ETT scale for public transport)
Comparing these maps with Figure 5.7 and 5.8 respectively, illustrates the improvement in relative accessibility compared with the current situation. The results are further detailed in the tables below.

Table 6.5  Comparison of Equivalent Travel Times for Current and Improved Public Transport Scenario (using current ETT by public transport scale)

<table>
<thead>
<tr>
<th>Level of Accessibility to Jobs</th>
<th>ETT (PT) - 2001</th>
<th>No of Zones in that Range</th>
<th>Change in Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Current(2001)</td>
</tr>
<tr>
<td>Very low</td>
<td>110</td>
<td>708</td>
<td>175</td>
</tr>
<tr>
<td>Low</td>
<td>77</td>
<td>110</td>
<td>149</td>
</tr>
<tr>
<td>Medium</td>
<td>60</td>
<td>77</td>
<td>165</td>
</tr>
<tr>
<td>High</td>
<td>44</td>
<td>60</td>
<td>160</td>
</tr>
<tr>
<td>Very High</td>
<td>14</td>
<td>44</td>
<td>174</td>
</tr>
<tr>
<td>Average ETT (minutes)</td>
<td>84.4</td>
<td>73.2</td>
<td>-11.20</td>
</tr>
</tbody>
</table>
Table 6.6 Comparison of Equivalent Travel Times for Current and Improved Public Transport Scenario (using current ETT car scale)

<table>
<thead>
<tr>
<th>Level of Accessibility to Jobs</th>
<th>ETT (Car) - 2001</th>
<th>No of Zones in that Range Current(2001)</th>
<th>Change in Distribution Improved PT</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very low</td>
<td>58</td>
<td>708</td>
<td>512</td>
<td>412</td>
<td>-100</td>
</tr>
<tr>
<td>Low</td>
<td>44</td>
<td>58</td>
<td>137</td>
<td>179</td>
<td>42</td>
</tr>
<tr>
<td>Medium</td>
<td>35</td>
<td>44</td>
<td>65</td>
<td>85</td>
<td>20</td>
</tr>
<tr>
<td>High</td>
<td>26</td>
<td>35</td>
<td>60</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>Very High</td>
<td>13</td>
<td>26</td>
<td>49</td>
<td>67</td>
<td>18</td>
</tr>
<tr>
<td>Average ETT (minutes)</td>
<td></td>
<td></td>
<td>84.4</td>
<td>73.2</td>
<td>-11.20</td>
</tr>
</tbody>
</table>

This shows that:

- Average equivalent travel times across the study area decline from 84.4 minutes to 73.2 minutes, or by 13.3%.
- When using the current ETT by PT scale, the percentage of zones with “very high” and “high” accessibility to jobs by public transport rose by 33% and 25% respectively, while the number of zones with “medium”, “low” or “very low” accessibility fell significantly.
- When using the current ETT by car scale, the number of zones with very low accessibility fell by around 20%, while the number of zones with “low”, “medium”, “high” or “very high” accessibility rose by at least 30%.
- However accessibility to jobs by public transport even with a 20% cut in in-vehicle and waiting times remains significantly below that by car, which has an average ETT of 43.2 minutes.

The analysis of the planned improvements to public transport, together with the hypothetical scenario with improved public transport travel times, indicates that significant improvements are required to the public transport system to make it more competitive with the car in terms of travel times and accessibility.
6.6 ACCESSIBILITY AND DISABILITY

Sections 2.7 and 4.6 discussed accessibility problems, identifying three broad groups in society who have relative access difficulties:

- Those living in areas of low accessibility
- Those without access to a car or on low incomes
- Those with a disability or other difficulty which affects mobility.

The first two difficulties have been considered already by examining spatial patterns in relative accessibility, and by comparing accessibility levels by car and public transport.

However in all the analysis and mapping of accessibility patterns to date, it has been assumed that everyone can access public transport (or local facilities) with the same walking speed. In reality, there are many people in the community who have physical or other disabilities which affect the ability and speed with which they can walk or otherwise access public transport. Such people include those in wheelchairs, those using other mobility aids (such as walking frames), those with sight, hearing or intellectual disabilities, and the increasing aged population who simply have some difficulties walking.

Whilst such difficulties are specific to particular groups, and cover a variety of conditions, a general indication of their effects on accessibility can be gained from modelling accessibility by public transport, using a different function for travel time.

The function used for accessibility calculations to date has simply been the total travel time – the sum of access, in-vehicle and waiting time. For this exercise, a weighting of 3 has been applied to walking time to reflect the lower speed and greater effort involved for people with mobility-related difficulties.

The results are shown below, using the example of access to employment:

- Firstly showing the relative pattern of accessibility across Sydney for people with such disabilities
- Secondly relative to the scale used earlier for access by public transport.

The results show that

- Overall geographic patterns are similar to those for people without a mobility handicap (i.e. using the same ETT scale)
- Compared with the general population, most areas of Sydney have very low or low accessibility for people with a mobility problem. (compare map 6.23 with map 5.7)

This highlights the importance of strategies to address the particular needs of this group within the community at all levels of government (see for example Willoughby City Council, undated, for an example of action at local level), especially in geographic areas which already experience lower than average accessibility.
Figure 6.20  Relative Accessibility to Employment by Public Transport for People with Mobility Difficulties, 2001

Figure 6.21  Accessibility to Employment by Public Transport for People facing a Mobility Handicap (using the ETT by public transport scale for people without a disability)
6.7 SUMMARY

Accessibility has a wide range of applications in the analysis of urban dynamics and the evaluation of urban and transport trends and policies. Five particular applications are explored here, including:

- Urban consolidation and the Compact City
- Employment Distribution and Centres Policy
- Distribution of Urban Services
- Transport Improvement Strategies
- Accessibility and Disability

Other applications could include analysing accessibility patterns for specific groups, such as the aged, or those without access to a car. This would be done by weighting the importance of access to particular opportunities using the specific weights which apply to those groups.

Urban Consolidation

Urban consolidation has been one of the key urban planning issues in recent years, not only in Sydney, but also across Australia, Europe and North America. Governments are increasingly adopting a range of policies to encourage greater land use - transport integration, increase public transport mode shares and reduce low-density "urban sprawl". These policies go under a variety of names, including "consolidation", "the compact city", "densification", "smart growth" and "transit-oriented development", but are in reality closely related.

In the case of Sydney, there has been a significant turnaround in urban growth patterns during the 1990's compared to earlier decades, with a large rise in housing approvals in inner and middle suburbs. This has reduced the pressure on the outer suburbs despite the acceleration in Sydney's overall population growth, which has occurred in the last decade. Population growth has begun rising again in inner suburbs after many decades of decline, and the share of dwelling approvals accounted for by apartments and town houses has risen significantly.

These trends have been due to a combination of planning policies and market forces. At the same time, there has been significant public concern as to the effects of such policies on local traffic generation and neighbourhood amenity. However research into community values indicate that, unpopular as consolidation has become, the public do not see unfettered urban sprawl as the answer, instead preferring a combination of medium-high rise development near rail stations and lower density development on the fringe.

The relationship between urban consolidation and housing affordability is complex. In Sydney at least four distinct, but linked, processes have influenced housing affordability, particularly in the inner suburbs:

- "gentrification" or the displacement of inner-city working class households by middle-upper income households
• conversion of old industrial sites to housing
• replacement of low density housing with higher density apartments and townhouses
• refurbishment of public housing estates

The combined impact of these processes has been a substantial increase in land prices measured on a per square meter basis. The impact on availability of affordable housing is more complex, although the net effect is likely to have been a reduction.

However the impact on accessibility is relatively clear, given the significantly lower accessibility in the outer suburbs than in the inner and middle suburbs. An analysis of the current (2001-2005) and expected future (2001-2026) population growth patterns in Sydney was undertaken, classifying growth into areas of very high, high, medium, low or very low relative accessibility. This was done separately for cars and for public transport, and using a weighting of access to the population, jobs, shops, university and hospitals based on the detailed survey results in Chapter 4.

The results showed that just over half of both current and future expected population growth will occur in areas of low or very low accessibility, around 33% in areas of high or very high accessibility, and the remaining 14% in areas of moderate accessibility.

This suggests that overall accessibility levels will fall, ignoring the impacts of changes to the transport system (which is addressed later). However the fall would be much greater were it not for the effects of urban consolidation which is increasing population in inner suburbs and areas close to major centres and the major public transport routes.

**Employment Distribution and Centres Policy**

In recent decades, government planning policy for Sydney has attempted to encourage employment growth in key centres, particularly in Western Sydney. This has been aimed at increasing public transport use and reducing the job imbalance between Sydney’s east and west.

However the prime determinant of job location is the private sector. Employers take into account a wide range of factors when making location decisions, and a range of specific sub-markets have developed for different types of employment-land, including primary and secondary office space, retail space of various types, “high technology” space and light and heavy industrial space.

Examination of the literature on job location in cities suggests that Sydney’s job location patterns will show:

• a continued trend to a more multi-centered city
• stronger growth in centres than in industrial zones
• growth in the CBD proper but slower than population
• high growth in near-CBD centres and in the major established centres in Western Sydney
relatively fast growth (but from a low base) in the newly developing outer areas such as the North-West Sector

An analysis of expected employment growth over the 2021 – 2026 period was undertaken to identify likely changes in accessibility to jobs. This showed that future job growth is likely to be relatively evenly distributed between areas of very high, high, medium, low and very low accessibility. Accordingly the pattern of job growth, on its own, is unlikely to lead to significant change either way in accessibility. This follows from the canceling out of two effects:

- increased accessibility arising from the strong growth in centres compared with dispersed employment
- reduced accessibility (overall) arising from faster growth in Western Sydney

The expected strong growth in centres such as Parramatta, Liverpool, Blacktown and Penrith, and the growth elsewhere in Western Sydney, is expected to lead to a slight improvement in relative accessibility in Western Sydney and a slight decline in eastern Sydney. However this will still leave the latter with substantially higher levels of access to jobs.

Distribution of Urban Services

Of all the opportunities for which accessibility has been examined (population, jobs, shops, universities and public hospitals), the most unequal pattern between western and eastern Sydney is access to university. This reflects the fact that despite the expansion of the University of Western Sydney in the last decade, almost 60% of all current enrolments are close to the CBD or in the eastern suburbs.

Recent reports indicate an increasing proportion of Western Sydney residents are attending university, highlighting the need to address this imbalance. Accordingly an analysis was undertaken to examine accessibility patterns under a hypothetical scenario, where total enrolments were assumed to grow by 25%, but with all growth occurring in campuses in the western and northern suburbs.

It was found that the areas with the highest accessibility to university would still remain the eastern, inner western and inner northern suburbs, however the scenario would significantly reduce the current imbalance between the Eastern and Western Parts of the region.

Transport Improvement Strategies

Action for Transport 2010 (NSW Department of Transport, 1998) proposed a range of enhancements, upgrades and extensions of Sydney’s road and public transport networks. Some of the most significant of these include:

- the Cross-City tunnel, the Lane Cove Tunnel, and the Western Sydney Orbital
- the Parramatta – Chatswood, Epping – Castle Hill and Glenfield – Edmonson Park Rail lines, and capacity enhancements on the East Hills, Illawarra and Richmond lines.
• a series of Busways in Western Sydney

At the same time, it is anticipated that traffic levels will continue to increase in coming years, affecting travel speeds on the existing as well as new elements of the road network.

The Transport Data centre provided detailed travel time skims for hypothetical new road and public transport networks for 2021, based on estimated travel demand at that time. These were used to calculate new accessibility patterns for work, based on the TDC's estimates of the employment distributions for 2021.

These patterns were compared with the current situation, and showed:

• a slight general decline in accessibility by car (with the impact of rising traffic outweighing the increased road space from new projects)
• some improvements in accessibility by public transport, particularly in south-western and north-western Sydney, resulting from the key rail and transitway investments.

The overall effect if Action for Transport 2010 projects were completed would be for a reduction in the accessibility imbalance between western and eastern Sydney, and between public transport and the car, although the changes would be relatively small.

In addition to the transport improvements identified in Action for Transport 2010, there have also been other improvements suggested by other writers, especially for public transport. These include proposals for:

• a 50 year strategic rail plan, developed by State Rail
• light rail, ultra-light rail and demand-responsive services
• increasing the speed and frequency of existing rail services
• the “Sydney Overland”, designed to increase the frequency and coverage of bus routes.

While there are too many proposals to test individually, a scenario was developed involving an across-the-board 20% reduction in travel and waiting times for existing public transport, but with no change was assumed in walking access times. This scenario was tested for its impact on accessibility to employment by using the current (2001) distribution of employment and comparing the resultant accessibility patterns with those for the current public transport system.

As might be expected, the scenario produced significantly improved accessibility as measured by equivalent travel times, particularly in areas close to the existing rail network. In particular, the Equivalent Travel Time to employment dropped from an average of 84.1 minutes to 73.2 minutes, an improvement of 13.3%. However this was still well above that for access to jobs by car (43.1 minutes)
Accessibility and Disability

In addition to people living in areas with low accessibility, and those without access to a car, the third group in the community with access difficulties are those with a disability which affects their mobility.

There is a large number of people so affected, including people in wheelchairs or who require other mobility aids, and people with a hearing, sight or mental disability. These have a particular impact on the ability of people to use public transport vehicles and infrastructure and the speed and difficulty with which they can access mainstream public transport services.

Accessibility maps were therefore produced assuming that access times were three times those normally applied, to illustrate how this would influence relative accessibility patterns. The results showed that:

- overall geographic patterns are similar to those for people without a mobility-related disability
- most areas of Sydney had low or very low accessibility for people with a mobility problem.

Overall Conclusions on Applications of Accessibility

This chapter has highlighted the potentially significant use of accessibility to shed new light on a range of urban policy questions. For example:

- Whether population trends will increase or reduce overall accessibility, and whether urban consolidation policies are influencing this trend.
- The impact of attempts by government to influence the distribution of employment
- Whether the current distribution of universities, hospitals or other services is producing inequity across the urban area in access to those facilities
- The likely impact of changes to transport infrastructure or services on accessibility.

The measures used in this study allow these issues to be analysed and the complex interaction of land use and transport systems illustrated. This can help analysis of the questions facing urban policy makers.
CHAPTER 7: CONCLUSIONS

7.1 RESEARCH QUESTIONS AND HYPOTHESES

Introduction

Accessibility is a key concept in urban and regional research. The classical approach to accessibility defines it as “some measure of spatial separation of human activities. Essentially it denotes the ease with which activities may be reached from a given location using a particular transport system” (Morris, Dumble and Wigan, 1979, Page 1).

As such, accessibility provides a key link between land use, transport infrastructure and travel patterns, influencing short-term decisions such as travel behaviour. Over the longer term, it also influences land values and land development, as well as transport infrastructure and investment, since these respond to travel patterns. Accordingly, accessibility has been widely used in urban and regional analysis, particularly in relation to transport systems.

More recently, however, the growth of the internet has led to the concept of “virtual accessibility” in which face-face contact and physical connection is replaced with communications links and “virtual” connections. This has led some writers to question the validity and relevance of the classic concepts of accessibility, and in one case, to forecast the “death of the city” (McLuhan, 1967).

A number of writers have also drawn attention to the social dimension of accessibility, by focusing on issues such as the impact of gender on travel and activity patterns and the use of time. Indeed there has been a growing body of research into time and activity modelling, which embed travel patterns in wider frameworks.

Finally, there has been a growing interest in recent years in access difficulties for people with a disability. This has been led to the term “accessible transport”, meaning vehicles, roads, footpaths and other infrastructure which can be accessed and used by the whole community, including those in wheelchairs or with other mobility aids, as well as people with sight, hearing, or other disabilities which affect their mobility.

For this study, the following definition of accessibility has been used:

Accessibility to a class of opportunities is a measure of the ability to reach or otherwise access those opportunities or the facilities which provide them. It thus incorporates the attractiveness or appeal of those opportunities or facilities and the time or other costs involved in accessing them. In turn, these will depend on:

- the nature of the opportunities or facilities
- their spatial arrangement in relation to residential areas
- the transport and communications systems linking them
- the characteristics of persons desiring access.
Study Focus and Key Research Questions

Accessibility, then, is a large and somewhat nebulous concept. This study has therefore adopted the following focus:

- Urban accessibility, rather than rural or regional access issues
- Activities outside the home (and not with activities inside the home, except where they can substitute for activities outside the home, such as home banking)
- Accessibility for the whole of the population, rather than the more specific issue of accessibility for people with a mobility-related disability
- Accessibility in its wider social as well as physical and economic context
- Accessibility at the metropolitan – wide scale, rather than at a very local scale
- Use of a specific city (Sydney) to test a number of hypotheses and allow practical application of the concepts developed.

The key research questions examined in this thesis are:

Question 1:

How valid is the “classic” concept of accessibility in a contemporary urban context, and does it be modified to take account of social factors and of the concept of “virtual access”?

Question 2

What are the patterns of accessibility in Sydney, and how do these vary for different locations, activities and modes?

Question 3

What are the accessibility problems facing particular individuals or groups?

Question 4

How can accessibility be improved, both overall or for those people with particular access problems? Which transport investment strategies, planning policies or other measures are likely to be the most effective in this regard?

A number of specific hypotheses were also developed and tested, using original data gathered for the thesis, in particular in areas concerned with:

- The relationships between accessibility and travel behaviour
- The relationships between accessibility and housing choices
- The extent to which accessibility is linked to time use and activity patterns
- The significance of communications and virtual accessibility
- The causes and nature of access difficulties
Research Methodology

The research methodology adopted for the thesis involved the following steps:

- **A literature review** to examine the relationships between accessibility and related topics such as land use, housing choices, travel patterns, the use of time and virtual access, and to identify knowledge gaps and hypotheses for testing using original data sources.
- The design, conduct and analysis of a survey on accessibility in Sydney. This survey was based on face-face interviews conducted in three local government areas in inner, northern and western Sydney. It focused on the importance of accessibility, access problems, use of the Internet and the relationships between accessibility and housing choice, lifestyles, and a range of socio-economic and demographic variables.
- The development and mapping of accessibility indicators for key opportunities in Sydney, including access to employment, public hospitals, shopping, the population and university. These were found from the survey to be representative of the five most important opportunities to which people seek access. This enabled a detailed picture of region-wide variations in accessibility by both cars and public transport to be developed.
- The application of the accessibility indicators and mapping techniques to examine potential future changes in accessibility patterns, to identify where the greatest access problems exist, and to explore how they might be addressed by changes to land use, transport infrastructure and services.
- Identification of a range of directions for future research in this area.

7.2 CONCLUSIONS FROM THE RESEARCH

Q1: How useful is the “Classic Concept” of Accessibility

**The Social Dimension**

Analysis of the literature suggests that there is an important social dimension to how different people utilise their time, the activities they seek to be involved in, the constraints they have to operate under, and the travel patterns which that generates. Trip patterns, including modes used and trip purposes, vary significantly with age, as well as gender and income (to a lesser extent). Similarly housing and other choices have a strong socio-economic basis. Accordingly, there should be a social dimension to accessibility.

The survey analysis conducted in Sydney was able to shed some light on the significance of this dimension. The research supports the contention that there are social, economic and demographic dimensions to accessibility, and in particular to the importance placed on access to different opportunities. The most consistently significant factor was found to be age, which closely relates to a person’s stage-of-life and helps determine characteristics such as participation in the labour force or schooling, or the need for health care. By contrast, income, gender and lifestyle...
preferences were found to be less significant in explaining variation in accessibility-related variables.

In addition, the research was able to provide some basis for weighting the importance of access to different activities or opportunities, enabling overall accessibility indicators to be developed.

Virtual Access

The literature on the subject of communications technology and its potential impact on cities ranges from the extreme view that it will lead to "the death of the city" to the view that it will make relatively little impact on overall lifestyles and travel patterns.

While it is too early to be definitive, the survey data examined here suggests that the reality may be closer to the second of the two extremes. Use of the Internet appears to impact more on in-home rather than out-of-home activities, and seems unlikely on balance to result in a major reduction in travel demand.

While broadband applications to the home have yet to be fully developed, at this stage the data supports the conclusion that "virtual access" is unlikely to replace "physical access" in the near future, if at all. Consequently the classic concepts of accessibility remain relevant.

Development of Accessibility Indicators

There have been a wide variety of indicators used in the literature for measuring accessibility, including the classical "Spatial Indicators", utility-based measures, and the spatial-temporal indicators developed by Hagerstrand (1975) and others. There are a number of properties, which such indicators should ideally possess. Specifically, they should:

- have an intuitive meaning
- be able to formulated for specific sub-groups in the population
- reflect any changes in land use patterns or transport systems
- be robust and able to be widely used for different cities, opportunities or time periods without having to be specially re-calibrated.

A review of the literature found that there are a number of measures which could be used for measuring accessibility patterns at the metropolitan scale, including:

- "Threshold" indicators, which measure the number of opportunities which can be reached within a given time or distance
- "Absolute Accessibility Indicators", which measure the sum of access values to all the opportunities in a region, weighted by an appropriate impedance function based on the travel time or cost to reach those opportunities.
- "Relative Accessibility Indicators" which convert absolute indicators by dividing by the average value for the region.

None of these were found to be ideal. Accordingly a new indicator, "Equivalent Cost / Travel Time" was developed. This is defined as follows:
"Equivalent Cost (EC) or Equivalent Travel Time (ETT) is the Cost or Travel Time, which if applied to all opportunities in a region, would lead to the same overall accessibility level".

From this other indicators can be derived, such as "Relative Cost" and "Relative Travel Time" (RC/RTT)

An analysis of the EC / ETT and RC/RTT indicators was undertaken using a simplified 5-zone model of a city, to explore how they reflected changes in land use, transport and the choice of transport impedance functions. It was found that they were more robust than the standard "Absolute Accessibility Indicators" and also had the advantage of an intuitive meaning. Analysis of data availability and interpretation issues led to the selection of the Equivalent Travel Time indicator (ETT) as the most appropriate for use in mapping accessibility patterns in Sydney at a regional scale.

Q2: What are the Patterns of Accessibility in Sydney?

An extensive analysis was undertaken of regional accessibility patterns by both car and public transport to five types of opportunity - employment, public hospitals, retail centres, the population and universities. The study area covered the Sydney Region, minus the LGA's of Blue Mountains, Gosford and Wyong.

The analysis was undertaken using the "Equivalent Travel Time" indicator. The key overall findings were that:

- The CBD and inner suburbs remain easily the most accessible part of Sydney, notwithstanding some decentralisation of services such as hospitals, the creation of Western Sydney University, and some decentralisation of employment.
- This pattern is as true of car access as it is of public transport access. Indeed while the range in relative accessibility between inner and outer suburbs is greater in the case of public transport, the patterns are more complex, reflecting the impact of the rail system in particular and of local sub-centres away from the CBD.
- Overall accessibility levels by car are significantly higher than for public transport, to all opportunities, and from virtually all locations in Sydney.
- However the spatial variation across Sydney means that public transport accessibility from inner ring suburbs in Sydney is generally higher than car-based accessibility in outer ring suburbs.
- Of the five types of opportunity examined, access to university remains the most uneven spatially, being focused heavily on the inner and eastern suburbs. A major shift in the location of new university places is needed to even partly redress this imbalance. Of the other opportunities examined, retail facilities, and to a lesser extent hospitals, are the most evenly accessible across the study area.

Q3: Access Difficulties

Access problems can be experienced by people:

- living in areas with low accessibility, particularly in outer suburbs
- with no, or limited, access to a car
• with a physical or other disability which limits their mobility

Some individuals may experience more than one type of access disadvantage, and some types of disadvantage may be closely linked to factors such as low incomes.

The analysis of regional accessibility patterns confirmed the three types of access difficulties:

• most areas of low or very low relative accessibility occur in the outer suburbs
• accessibility by car is generally at least 1.3 times higher than by public transport. In areas remote from the rail network, the ratio is 2.5 or more times. On average, accessibility by car is approximately 1.8 times higher (ETT times are 1.8 times lower) than by public transport.
• when the assumed walking speed was reduced to simulate the problems faced by people with mobility difficulties, there was a considerable reduction in overall accessibility levels.

However the survey results showed that access problems are more complex. For example there was a relationship between car ownership and reported access difficulties, but not a simple one. Similarly income and LGA were not significantly related to people's reported access problems. There was however a very clear relationship with mobility related difficulties. This suggests that strategies to address access difficulties will need to focus on:

• improving accessibility for people with disabilities which affect their mobility
• improving public transport accessibility relative to car-based accessibility
• addressing geographic accessibility problems, particularly by public transport in outer areas.

Q4: Future Trends and Strategies to Address Access Difficulties

Future trends in population growth are likely to lead to a small decline in overall accessibility levels. However the impact of urban consolidation is significantly reducing this effect from what it would otherwise have been, with one-third of future population growth expected to occur in areas with high or very high relative accessibility.

Future trends in employment distribution suggest little impact overall on accessibility to employment. However they will tend to reduce the current imbalance between eastern and western Sydney to some extent.

An analysis was undertaken on the likely impacts of planned transport improvements to both the road and public transport systems. This showed that:

• Accessibility by car is likely to decline slightly, as growth in traffic volumes outweigh the planned road improvements.
• Accessibility by public transport is likely to improve slightly, particularly in north/north-western and south-western Sydney, a result of new bus transitways and rail lines.
The net effect appears to be desirable from both an equity and environmental perspective, in that the gap between eastern and western Sydney will decline as will the gap between car-based and public-transport-based accessibility. However the changes are relatively small and the current differences will largely remain.

A further analysis of an across-the-board improvement in public transport travel and waiting times by 20% (but with no change in walk access times) showed an improvement of 13% in accessibility. This would be a significant improvement but would still leave access by public transport significantly lower than by car.

Finally an analysis was undertaken of a policy shift which would see 25% increase in total university places, but with all future growth confined to universities in the western and northern suburbs. This would require a 60% increase in enrolments at those campuses, and would significantly improve the current regional accessibility imbalance, though accessibility patterns would still significantly favour the inner and eastern suburbs.

7.3 DISCUSSION

Overall, the survey confirmed many of the findings from the literature review, and was generally consistent with the analysis of regional accessibility patterns. However there were some surprises and some interesting results. For example:

**Travel Behaviour**

In relation to travel behaviour, the data suggests that a distinction between “discretionary” and “non-discretionary” travel, though not absolutely clear-cut, is nevertheless useful. Non-discretionary trips to work or higher education tend to be made if required, irrespective of where people live, but the mode chosen varies significantly with this factor. Hence the importance of locating employment centres and higher education facilities in close proximity to major public transport nodes.

On the other hand, people living in more accessible locations appear to make more “non-discretionary” trips, lending support to the concept of a “travel time budget” and possibly undermining attempts to reduce the number of trips by “travel demand management” (though such measures might influence the mode used).

**Housing Choices**

In relation to housing choices, many of the expected results were confirmed. However, some surprises included the lack of significant relationship between the importance placed on accessibility and housing type (detached houses versus other dwellings). Similarly, no significant relationship was found between parental status and the importance placed on home ownership, in making housing choices.

The survey confirmed the complexity of housing choices which people make, but also showed how this varies across the lifecycle and how important overall accessibility is. If anything, it may have become more important than was the case a decade earlier in
the ABS survey (ABS, 1992), although it is not possible to make any clear deductions about this.

The other factor of interest is the low relative weighting given to private outdoor space, indicating that the housing choices being made available through urban consolidation may well be better meeting individual housing preferences despite the growing chorus of objection to densification by local residents affected by developments.

Activities and the Use of Time

The picture with regard to activities and time use highlighted that age is by far the most important socio-economic and demographic variable in influencing the importance placed on access to different opportunities – far more so than gender, income, qualifications, parental status and the like. This reinforces the findings with regard to housing preferences, suggesting that a (highly) simplified model based on four life “Spiral” stages might be appropriate for those people having children (see figure 7.1).

Given the ageing of society generally, coupled with the fall in the birth rate, the “Life Spiral” would suggest that the importance of accessibility vis-à-vis space is likely to increase slowly over time.

Figure 7.1 Simplified Life "Spiral".

Virtual Accessibility

The pattern of Internet usage and its significance suggests a number of conclusions:

- The key issue is whether (or when) people become familiar with the technology. Once they are, their patterns of use seem to depend more on their own individual preferences rather than overall characteristics such as age, gender, income etc.
- While there are some changes in behaviour, there appears to be little likelihood at present that the internet will simply substitute for major shopping or social –
recreational trips, although some small reduction in commuting might seem probable. Overall there is not strong evidence that the Internet will lead to a significant reduction of travel.

Access Difficulties

Finally, the survey indicated that there are significant access difficulties in the community, particularly for people with mobility-related disabilities. However some of the expected relationships were not found – for example the link between LGA and extent of access difficulties, or car ownership and access difficulties. There are a number of possible explanations for this:

- People in low accessibility areas may have different expectations as to accessibility, having made their tradeoffs (for example with housing affordability)
- People may adjust their car ownership so as to compensate for access difficulties – for example households in areas of low general and public transport accessibility tend to have higher car ownership levels. In this case, "access" problems are converted into "travel cost" problems. Or they may have lower travel requirements. This would also fit to some degree with the concept of a travel time budget. However more research would be needed on this issue.

7.4 DIRECTIONS FOR FURTHER RESEARCH

There are many possible areas of further research on accessibility. Brief comments on some of the possibilities are offered below.

Accessibility and Travel Behaviour

The discussion in Chapters 2 and 4 highlighted some interesting findings, including some support for the concept of a constant travel time budget. In other words people in more accessible areas 'spend' some of the travel time they save by being able to make shorter trips, by increasing their trip rates.

If true, this has some interesting implications for travel demand management strategies, and for the ability of land use planning strategies to influence overall passenger-kilometres of travel. Even if true, however, it is also possible that one explanation could be that those people who are more "active" seek to live in more accessible locations in order to minimise their travel time.

Accessibility and Land Values

The link between accessibility and housing choice has been explored in this research. Some reference was also made to the links between accessibility and land values. However a detailed examination of this area was beyond the scope of the current work.
The development of accessibility indices for both road and public transport, and for a number of key classes of opportunity, would allow such analysis to be undertaken by using a combination of cross-sectional and time series data analyses. In order to take this work further, detailed land value information would need to be obtained in a format suitable for amalgamation into aggregate data at a traffic zone level.

This would involve substantial statistical analysis, given that different land uses (residential, commercial, industrial, recreational etc) tend to have different land values, and these depend in turn on zoning and other controls incorporated into Local Environmental Plans and other planning instruments. In particular, density controls, car-parking requirements and other factors could be expected to influence land values.

In addition, land values also reflect environmental factors, such as the proximity of local bush or parkland, or proximity to the harbour or beaches, which have not been included in the accessibility modelling to date. Ideally accessibility indices would be needed to be developed for these and other “environmental goods”, as well as any “environmental bads” such as microclimate, bush-fire risk etc.

However in principal, a suitable database on land values could be developed. This could then be used, in conjunction with the accessibility indices used in this research to analyse the relationships between the two. In principal this would be expected to reflect a number of relationships:

- Other things being equal, land values and accessibility should be positively correlated. (Note: it is necessary to recognise that other things are not always equal. For example, as discussed in Black, Westerman, Blinkhorn and McKittrick (1988) properties located on arterial roads may have high levels of regional accessibility but they also experience high levels of noise and other deleterious impacts from the traffic volumes involved).
- The correlation should reflect the cost of overcoming inaccessibility – i.e. travel costs. Hence the higher the travel cost, the higher the “land value gradient” as a function of accessibility levels.
- Changes in relative accessibility over time between different areas should be reflected in changes in land values. However the extent to which this is linear, and the extent of any time lags, would need to be evaluated.

As can be imagined, this could be a highly valuable area of research to investigate, given that changes in accessibility from changes to land use patterns and improvements in transport infrastructure can be calculated. Some of the policy issues which could be explored using such analysis include:

- The extent to which special land taxes or other mechanisms might be used to capture the increase in land value arising from particular transport improvements.
- The overall benefit arising from transport infrastructure or service enhancements and the impact on benefit-cost studies.
- Relationships between accessibility, environmental quality and land values.
Accessibility and Housing Affordability

The steep rises in housing costs in Sydney, particularly inner Sydney, in recent decades have given rise to concerns regarding housing affordability. These price increases may well partly reflect changes in accessibility caused both by changes in land use and by transport investment in projects such as the Harbour Tunnel, Gore Hill Freeway, M5 East, and Airport Rail line. They could also be expected to be related to the gentrification and other urban consolidation processes discussed in Section 6.2.

This issue could be studied by:

- Estimating changes in accessibility due to changes in employment distribution, population, university enrolments, hospitals and retail facilities over the same periods. This would require development of spatial databases for these opportunities covering those time periods.
- Estimating the change in accessibility due to changes in the socio-demographic and income mix of households (using dis-aggregated census data).
- Estimates of housing and unit prices for the inner suburbs and for Sydney as a whole.
- Examining the relationships between the various components of accessibility and housing prices.

The issue of unit prices would prove somewhat difficult since there were relatively few units in existence in some parts of the inner suburbs 20 years ago, whilst other factors such as interest rates, unemployment, income growth, migration etc also significantly influence housing prices. Such a study would need to control for these factors as far as possible, by techniques such as comparing housing prices for the inner suburbs with overall housing price indices for Sydney.

Another related issue, which could be explored further, is the extent to which the total expenditure by households on housing and access is a constant (as a share of income) - in other words people trade off location for price within a fixed total budget. If so, then strategies to increase housing affordability by providing cheap land on the fringe of the city may do little overall to improve social equity, and may even reduce it since increased travel incurs time and other non-monetary costs. In the United States, some home lending institutions provide "location efficient mortgages" which permit people to borrow more to purchase houses in more accessible areas, in recognition of the reduced call on the household budget to cover transport costs. (Cervero 2001, p35)

Accessibility, Employment and Transport

Chapter 6 briefly explored the impact on accessibility to jobs from expected changes in job location as well as transport infrastructure and traffic levels, and from a scenario involving an across-the-board improvement in public transport travel times.
However as indicated, there are many other changes to employment, transport infrastructure or services which could be examined in terms of their impacts on accessibility. These would require making the necessary changes to the Transport Data Centre’s land use and/or network models.

Such analysis could examine, for example:

- Changes in accessibility patterns from investment in the last decade, to see if it has reinforced the high levels of accessibility in inner Sydney or tended to reduce the historical dominance of this area.
- Changes to employment location over the last decade, and whether this has tended to reduce or increase public transport accessibility relative to car-based accessibility.
- Future alternative employment policies, such as a highly centralised option (focussing heavily on the CBD), a multi-centered option (focusing much of the growth in selected centres), or a dispersed option (with a lower share of growth in centres).
- Future transport infrastructure investment or service enhancements, such as the impact of a high-speed rail network similar to the Paris RER system.

Access to Local Opportunities

This study has focused on accessibility at the scale of the Sydney Region (minus outlying areas of the Blue Mountains and the Central Coast), and hence at a large scale. This was considered appropriate given the size of the zonal structure for which travel time and other data, such as employment, was available, and for the opportunities which were being analysed (population, jobs, universities, retail facilities, public hospitals).

However for other opportunities such as local parks and recreation areas, local services such as local shops or general practitioners, primary schools or child care, a smaller scale analysis would be more appropriate, given the fact that most travel to these will be strictly local.

In order to model accessibility to such local opportunities, detailed street layouts and local public transport routes would need to be analysed, using more differentiated tools for estimating travel times and distances, since there is likely to be significant variation in accessibility to such services within a given zone.

Similarly the simplified approach to intra-zonal travel used in this study would need to be replaced with a more sophisticated approach. In fact, smaller zones would be required, with actual locations for specific opportunities plotted, and detailed information such as location of bus stops, pedestrian links etc utilised.

This sort of analysis would therefore have a different focus and require different data sets. However similar principles to that used in this survey could be used. For example accessibility to local opportunities could be calculated:
• By mode (walk only, cycling, public transport (including access mode), car)
• For different purposes (child care, primary school, local shops, local park, swimming pool, nearest rail station etc)
• For people with a disability affecting mobility versus those without

These could be used to examine such questions as:

• Variability within zones
• Relationships to land values / housing prices
• Relationships to mode of travel
• Access barriers and ways to minimise these

### Accessibility and Mobility – Related Disability

This subject was touched on briefly in Section 6.6. However as indicated above, small-scale accessibility analysis and mapping is needed to address this issue adequately. Specific topics which could be explored include:

• The impact of provision of wheelchair – accessible taxi services on accessibility levels. This would need to consider fares (and taxi subsidy scheme arrangements) as well as travel time issues.
• The impact of upgrading stations to make them fully accessible
• The impact of increasing the share of the bus fleet which is fully accessible
• The relationship between accessibility for people with a mobility-related handicap and their travel patterns
• The combined impact of geographic and mobility – related accessibility problems.
• The impact of the ageing of society on accessibility.

### 7.5 FINAL COMMENTS

#### Importance of the Research

As Gough Whitlam remarked some three decades ago, access to jobs, services and transport is a key factor in determining quality of life. This remains as true today, as it was then, notwithstanding the impact of modern communications and the world-wide web. Intimately linked with accessibility are issues of land prices and housing affordability, transport investment, and travel patterns.

Despite much research in the area of accessibility, the complexity and range of possible indicators has reduced the extent to which the concept has been used in urban research. **Thus although accessibility is frequently mentioned in policy documents and planning strategies, it is virtually never used in practice to assess the effectiveness of those strategies.**

This paper proposes a relatively straightforward measure, the **Equivalent Travel Time (ETT)** as a practical and useful measure for examining spatial accessibility patterns, for analysing changes over time, and for comparing accessibility between
different modes. ETT can be defined for every location or zone in a given region, for different types of opportunity (e.g., employment, shopping, hospitals), for different modes, and for different sub-groups in the community.

The measure has been applied to Sydney to examine regional accessibility patterns, and to explore how these change in response to likely trends or potential policy changes. These applications highlight the usefulness of the approach in visualising complex two-dimensional patterns. They also allow the combined impacts of various changes in land use or transport to be assessed.

The detailed spatial databases on employment, population and travel times for calculating this measure exist and are being maintained by the NSW Transport Data Centre, although other information (for example, retail floorspace, university enrolments and public hospital separations) would need to be periodically updated.

It would thus be possible to utilize the ETT measure on a routine basis to evaluate key planning policy choices, such as employment distribution policy, alternative housing policies and alternative transport infrastructure investment strategies.

Original Contribution

This thesis has made a contribution in the area of spatial analysis of urban systems, by

- **Gathering original data** on the meanings of accessibility to different socio-economic groups in the Sydney region, enabling a social dimension to the concept to be added to the land use and transport dimensions.
- **Examining the potential of the Internet** to alter personal travel patterns, concluding that it is likely to make only a very limited impact in cities like Sydney. This implies the continued importance of physical accessibility to urban analysis.
- **Developing a new form of accessibility indicator**, the Equivalent Travel Time, or ETT. This indicator can be easily understood and interpreted; has wide applicability to any city and any set of opportunities; is robust to changes in the precise form of impedance function; reflects changes in the key underlying variables of transport infrastructure and land use; and can be formulated to reflect the accessibility needs or constraints of particular groups, such as older people or people without a car.
- **Applying the ETT and various derivatives of it to the chosen study area** (Sydney minus its most outlying SLA's). This has allowed an analysis of the spatial variation of accessibility across Sydney to five types of opportunities—the employment, public hospitals, shops, the population and university places. These were chosen as representative of the five most important types of opportunity to which people seek access, as identified in the survey data.
- **Using the results of the survey data to produce the weighted average accessibility** across all five types of opportunity. This provides an appropriate way...
of deriving a total accessibility value for each of the 823 travel zones in the study area.

- **Applying the ETT measure to analyse various policy issues.** These include the relative access problems facing those with a mobility-related disability, and to examine the impacts of various trends and policy changes, including the impact of urban consolidation, changes in employment distribution, new options for locating university places and improvements to transport infrastructure and services.

Finally, the thesis also identifies some of the wide range of additional areas to which accessibility analysis can be applied. These include:

- accessibility and land values, for example the extent to which land tax or other mechanisms might be used to capture the accessibility benefits flowing from investment in transport systems
- accessibility and housing affordability, including the concept of total housing and access costs, and how this might vary with accessibility
- accessibility, employment and transport, for example the impact of a future high speed rail system such as the Paris RER system
- local accessibility, including walking and cycling modes
- accessibility and mobility – related disability, including the impact of ageing of society on accessibility and the best ways to improve accessibility for this group.

In conclusion, the research reconfirms the significance and centrality of accessibility in an urban context, notwithstanding the rise of the Internet. It has also created and illustrated the application of some tools for measuring accessibility at a metropolitan scale, and examined how accessibility varies for different locations, modes, opportunities and groups.

The thesis thus provides a range of valuable insights for those involved in urban and transport research:

- It sheds light on the real significance of socio-economic factors in relation to accessibility
- It provides evidence that suggests the role of the Internet and "virtual access" may have been exaggerated in comparison with physical access
- It highlights that classic concepts of accessibility remain highly relevant in understanding the modern city

But the potential of the work goes beyond research. In particular, the approach and techniques developed can provide valuable assistance to transport and urban planners in achieving the goal of more sustainable and equitable access in the future, rather than simply accommodating increased travel demand, as has too often been the focus in the past.
REFERENCES


ABS (1993 a): "Disability and Disabling Conditions". Folio 4433.0.


ABS (1996 b): "Car use". Australian Social Trends. 4102.0 163-166


Liverpool City Council (1999): "Statistical Profile". Report prepared by Community Development Unit.


Page 256


Property Council of NSW (2002): _Retail Centre Database_.


Willoughby City Council: (undated): "Development Control Plan 14 - Access and Mobility".


Good morning/afternoon/evening. My name is ......................... from AGB McNair, the national market research company, and today we are conducting a survey for the University of Sydney about how people get around Sydney. We are conducting the survey in various parts of Sydney, and your house has been selected at random from within one of the areas we are surveying. Would it be possible to speak to ................................ (an adult over the age of 18)?

We are interested in finding out:
  - How different people in Sydney to be able to access or get to their work, education, shopping, recreational and other activities, and how this affects their choice of home
  - what difficulties they might have in using particular forms of transport or in travelling around Sydney generally
  - how much they use the internet and if this is affecting their travel patterns.

I would like to leave this self-complete questionnaire with you, and come back in a little while to collect it. I will be able to help you with any questions you might have on the questionnaire, so I would appreciate if you could attempt to fill it out to the best of your ability.

Thank you for helping with this survey. We expect it will be used to help improve the planning of Sydney so that it will be easier for everyone to access the things they find important to them.

If you have any further questions, please ring us on .........................

CONFIDENTIAL

All work conducted on behalf of AGB McNair is confidential under the Code of Professional Behaviour of the Market Research Society of Australia. The data collected will be used for statistical purposes only and no information on particular individuals will be made available to any persons.
HOUSING CHOICE

Q 1  How long have you lived in your current home? *Please circle one code only.*

- Less than one year ................................................. 1
- 1-2 years .............................................................. 2
- 3-5 years .............................................................. 3
- 6-10 years ............................................................ 4
- 11-20 years ........................................................... 5
- Over 20 years ....................................................... 6

Q 2  Were you involved in the decision to choose your current home? *Please circle the appropriate code, and go on to the appropriate question*

- Yes ............................................................................. 1 Please go to question 3
- No .............................................................................. 2 Please go to question 4

Q 3  When you chose your current home, how important to you were the following factors in making your selection. *Please give a rating out of 5 for each category (1 is not important / not relevant, and 5 is very important) by circling the appropriate code.*

<table>
<thead>
<tr>
<th>Category</th>
<th>Not Important</th>
<th>Importance to You</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Quality of the local street and suburb</td>
<td>1...</td>
<td>2...</td>
<td>3...</td>
</tr>
<tr>
<td>(B) The features of the home itself</td>
<td>1...</td>
<td>2...</td>
<td>3...</td>
</tr>
<tr>
<td>(C) Amount of private outdoor space</td>
<td>1...</td>
<td>2...</td>
<td>3...</td>
</tr>
<tr>
<td>(D) Location and ability to get to things</td>
<td>1...</td>
<td>2...</td>
<td>3...</td>
</tr>
<tr>
<td>(E) Price and affordability</td>
<td>1...</td>
<td>2...</td>
<td>3...</td>
</tr>
<tr>
<td>(F) Ability to own your own home</td>
<td>1...</td>
<td>2...</td>
<td>3...</td>
</tr>
<tr>
<td>(G) Other (please write in)</td>
<td>1...</td>
<td>2...</td>
<td>3...</td>
</tr>
</tbody>
</table>
Q 4  Thinking about your current lifestyle, and how this might change over the next few years, if you were to move home, would you prefer to:  
*Please circle one code only.*

1. Stay in the same general area, but move to a different home that you preferred
2. Move to a more accessible location, even if it meant a smaller house or less private open space
3. Move further from the city if necessary to get a larger house or more private open space
4. Move out of Sydney altogether
5. Can't contemplate moving from my current home
6. Other (please write in)

---

CONVENIENCE AND ACCESSIBILITY

Q 5  How important is it to you to be near good transport links?  
*Please rate each of these out of 5 (1 = not important/not relevant, 5 = very important) by circling the appropriate code.*

<table>
<thead>
<tr>
<th>Category</th>
<th>Importance to You</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not Important/</td>
</tr>
<tr>
<td></td>
<td>Relevant</td>
</tr>
<tr>
<td>(A) Close to a good train service</td>
<td>.....1   .....2   .....3   .....4   .....5</td>
</tr>
<tr>
<td>(B) Close to a good freeway or motorway</td>
<td>.....1   .....2   .....3   .....4   .....5</td>
</tr>
<tr>
<td>(C) Close to a good bus service</td>
<td>.....1   .....2   .....3   .....4   .....5</td>
</tr>
</tbody>
</table>
Q 6  How important to you in your daily life, is being able to get to, or to access, each of the following types of activities or opportunities?  
Please give a rating out of 5 for each category (1 is not important / not relevant, and 5 is very important) by circling the appropriate code.

<table>
<thead>
<tr>
<th>Category</th>
<th>Not Important/relevant</th>
<th>Importance to you</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Your main job (whether full-time or part-time)</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B) Your own or your children’s education (school, TAFE, university, etc)</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(C) Shops and retail outlets</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(D) Hospitals, medical or health-related services</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(E) Friends and relatives</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(F) Entertainment (cinemas, restaurants, cafes, leagues / RSL club etc)</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(G) Personal Interests (e.g. church, voluntary associations, hobby groups etc)</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(H) Local parks, and local sporting facilities, ovals etc</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I) National parks or major areas of bushland</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(J) Major sporting facilities or entertainment complexes *</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(K) Beaches or Sydney Harbour</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(L) Sydney Central Business District including Shops, Opera House etc</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(M) Other – please specify:</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For example Homebush Bay, Darling Harbour, Wonderland, Fox Studios, Moore Park, Penrith Lakes
EMPLOYMENT

Q 7  What is your current work situation? (paid employment only)
Please circle appropriate code and go to relevant question.

I have two or more paid jobs........................................ 1  Please go to question 8
I have one full-time paid job (35 hours per week or more).... 2  Please go to question 8
I have a part-time paid job (less than 35 hours per week)... 3  Please go to question 8
I don't have a job now but I am looking for work............. 4  Please go to question 17
I don't have a job now and am not looking for work......... 5  Please go to question 17
I am retired.............................................................. 6  Please go to question 17
Other (Please specify: _________________________________ 98 Please go to question 17

Q 8  Thinking about your current paid employment, please indicate about how often you engaged in that activity, on average, over the last twelve months? Please circle appropriate code for your main job and for any other job (if relevant)

<table>
<thead>
<tr>
<th>Never or not relevant</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>About three times per week</th>
<th>About four times per week</th>
<th>Five or more times a week</th>
</tr>
</thead>
</table>

(A) Main job
(B) Second job (if any)

Q 9  Where do you normally work in your main job?
Please circle the relevant code and go to the appropriate question.

I mostly work at one location which is different from home (eg office, factory, shop etc)................................. 1  Please go to question 10
I work at a lot of different locations (eg builder, travelling salesperson)...................................................... 2  Please go to question 11
I mostly work at home............................................... 3  Please go to question 13

Q 10  If you answered (a) above, please put the suburb, postcode of your main workplace below, and approximately how far it would be (in metres) to walk from your workplace to the nearest railway station:

Suburb _____________________________________________
Postcode ____________
Approximate Walking Distance to nearest railway station ________ metres
Q 11 How do you normally get to and from your main job? Please circle one code for trips to work, and one for trips home from work.

Most common means of travel

<table>
<thead>
<tr>
<th>Walk/Cycle</th>
<th>Car Driver</th>
<th>Car Passenger</th>
<th>Public Transport (bus, train, ferry)</th>
<th>Both car and public transport</th>
<th>Taxi</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) To Work</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
<td>4..</td>
<td>5..</td>
<td>6..</td>
</tr>
<tr>
<td>(B) From Work</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
<td>4..</td>
<td>5..</td>
<td>6..</td>
</tr>
</tbody>
</table>

Q 12 How much does your starting time or finishing time for work vary on different days of the week or different weeks of the year? Please circle one code for starting times and one for finishing times.

<table>
<thead>
<tr>
<th>Very regular – within 15 minutes or so of the same time every day</th>
<th>Somewhat variable – can vary up to an hour or so on different days</th>
<th>Varies a lot – quite different on different days</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Starting Time</td>
<td>1..</td>
<td>2..</td>
</tr>
<tr>
<td>(B) Finishing Time</td>
<td>1..</td>
<td>2..</td>
</tr>
</tbody>
</table>

Q 13 How much does your mode of travel to / from work (for example car, bus, train, walk etc) vary on different days? Please circle one code for trips to work and one for trips home from work.

<table>
<thead>
<tr>
<th>Method of getting to or from work</th>
<th>Very regular – almost always use the same mode of transport</th>
<th>Usually travel by the same mode, but use a different method perhaps one trip in five</th>
<th>Varies a lot – sometimes use one mode, sometimes another</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Journey to work</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
</tr>
<tr>
<td>(B) Journey from work</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
</tr>
</tbody>
</table>

Q 14 If you normally travel by car rather than by public transport, taxi, walking or cycling, why do you prefer to use the car?

Comments: ________________________________________________________________
______________________________________________________________
______________________________________________________________

Questionnaire Page 6
Q 15  How often (if ever) do you work from home in your current main job?  
*Please circle one code only.*

How often I work from home on average

- Never – don’t work from home .......................................................... 1
- Up to about one day per week .......................................................... 2
- About two or three days per week ................................................... 3
- At least four days per week .............................................................. 4

Q 16  In the future, would you like to be able to work from home more often that at present, about the same as now, or less often?    
*Please circle one code only.*

- (a) More often than now ................................................................. 1
- (b) About the same as now .............................................................. 2
- (c) Less often than now ................................................................. 3
- (d) Not relevant or not able to ....................................................... 4

EDUCATION

Q 17  Are you currently engaged in full-time or part-time education at a school, TAFE, university, business college etc?  
*Please circle the appropriate code, and go on to the appropriate question*

- Yes......................................................................................... 1  
  Please go to question 18
- No.......................................................................................... 2  
  Please go to question 22

Q 18  If you are involved in full or part-time education, please indicate below the institution (s) (school, university, college etc), its location and approximately how many times per week you go there during term.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Suburb</th>
<th>Times per week in term time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q 19  How do you normally get to and from your main study activity (the one you go to most often per week)?

*Please circle one code for trips to education, and one for trips home from education.*

<table>
<thead>
<tr>
<th>Most common means of travel</th>
<th>Walk / Cycle</th>
<th>Car Driver</th>
<th>Car Passenger</th>
<th>Bus, train, ferry</th>
<th>Car and public transport</th>
<th>Taxi</th>
<th>Other</th>
</tr>
</thead>
</table>

(A) To Education

(B) From Education

Q 20  If you normally travel to / from education by car rather than by public transport, taxi, walking or cycling, why do you prefer to use the car?

Comments: ____________________________________________________________

______________________________________________________________________

Q 21  Do you have any particular problems getting to/from your main place of study? *Please circle relevant code.*

Hours of opening make it hard to get there ........................................................................................................ 1
Lack of good public transport when I need it ........................................................................................................ 2
Lack of parking / parking expensive .................................................................................................................. 3
Traffic congestion / amount of driving required ................................................................................................ 4
Time taken to get there by public transport ...................................................................................................... 5
No particular problems / not relevant ............................................................................................................... 97
Other (specify) .................................................................................................................................................. 98
Q 22  Thinking about the most recent time you did some shopping in Sydney (this could have been, for example, at the local shops or a large shopping centre) can you provide some details of when, where, and how you did it? (Please don’t count shopping while on holiday outside Sydney, and ignore on-line shopping over the internet).

(A) Where was this?
- Local shops (suburb) _______________________
- Elsewhere (give location) _______________________

(B) When was this?
1 What day of the week? _______________________
2 Approx time of day _______________________

(C) What did you shop for?
(Please circle all relevant codes)
- Groceries / regular shopping..... 1
- Gift or special item................. 2
- Furniture or bulky goods......... 3
- Window shopping................. 4
- Other - please specify: ......... 5

Q 23  If you made an actual shopping trip (and didn’t shop on-line), how did you travel to and from shopping? Please circle one code for trips to the shops and one for the trip from the shops.

<table>
<thead>
<tr>
<th>Walk / Cycle</th>
<th>Car Driver</th>
<th>Car Passenger</th>
<th>Bus, train, ferry</th>
<th>Car and public transport</th>
<th>Taxi</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) To Shopping</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
<td>4..</td>
<td>5..</td>
<td>6..</td>
</tr>
<tr>
<td>(B) From Shopping</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
<td>4..</td>
<td>5..</td>
<td>6..</td>
</tr>
</tbody>
</table>

Q 24  If you went by car rather than by public transport, taxi, walking or cycling, why do you prefer to use the car?

Comments: ____________________________________________
_____________________________________________________
_____________________________________________________
Q 25  Do you have any particular problems getting to/from local shops, a major regional shopping centre, or specialty shops?  

*Please circle any relevant codes.*

<table>
<thead>
<tr>
<th>Nature of problems (if any)</th>
<th>Local shops</th>
<th>Major regional shopping centre</th>
<th>Specialty shops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t have any particular problems..............................</td>
<td>1</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Hours of opening make it hard to get there.......................</td>
<td>2</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>Lack of good public transport when I need it.....................</td>
<td>3</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Lack of parking / parking expensive..............................</td>
<td>4</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>Traffic congestion / amount of driving required..................</td>
<td>5</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Carrying shopping home...........................................</td>
<td>6</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td>Time taken to use public transport...............................</td>
<td>7</td>
<td>17</td>
<td>27</td>
</tr>
<tr>
<td>Other (specify)................................................................</td>
<td>8</td>
<td>18</td>
<td>28</td>
</tr>
</tbody>
</table>

**SPORTING / RECREATIONAL**

Q 26  Thinking about *the most recent time* you engaged in or watched an actual sporting / recreational activity outside your home (for example playing sport or watching it) can you provide some details of when, where, and how you did? *(Please circle relevant code).*

A What sort of activity was it?  *(Ignore holidays outside Sydney or any Olympics-related activities).*

- Watching a sporting event or match at a major stadium or sporting venue.............. 1
- Watching sport at a smaller venue (eg local school, park, etc).......................... 2
- Engaging in sport or doing sporting practice.................................................. 3
- Going to a national park near Sydney (eg Blue Mountains, Royal, Kuring-gai)...... 4
- Going to Centennial Park, Bicentennial Park, the Harbour or to Sydney beaches.... 5
- Going to the local park...................................................................................... 6
- Going for walks / cycling for recreation in the local area.................................. 7
- Going for walks / cycling for recreation elsewhere in Sydney............................ 8
- None – haven’t been to any sporting / recreational activities........................... 97
- Other (specify)................................................................................................. 98

B Where and when did it take place?

<table>
<thead>
<tr>
<th>Suburb</th>
<th>Day</th>
<th>Approx Time of Day</th>
</tr>
</thead>
</table>

---

*Questionnaire  Page 10*
Q 27 How did you travel to and from the activity?

*Please circle one code for your trip to the activity, and one for the trip from the activity.*

<table>
<thead>
<tr>
<th>Walk/Cycle</th>
<th>Car Driver</th>
<th>Car Passenger</th>
<th>Bus, train, ferry</th>
<th>Both car and public transport</th>
<th>Taxi</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) To the activity</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
<td>4..</td>
<td>5..</td>
<td>6..</td>
</tr>
<tr>
<td>(B) From the activity</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
<td>4..</td>
<td>5..</td>
<td>6..</td>
</tr>
</tbody>
</table>

Q 28 If you went by car rather than by public transport, taxi, walking or cycling, why do you prefer to use the car?

Comments:

__________________________

__________________________

Q 29 Did you have any particular problems accessing sporting or recreational activities, such as hours of opening, locations, poor public transport or lack of parking?

Comments:

__________________________

__________________________

**SOCIAL / ENTERTAINMENT**

Q 30 Thinking about the most recent time you engaged in a social activity or entertainment outside your home in Sydney, can you provide some details of when, where, and how you did it?

*(Please circle relevant code).*

(A) What sort of activity was it? *(Please don't count activities outside Sydney).*

- Visiting friends or relatives at their homes or elsewhere................................. 1
- Going to Darling Harbour, Fox Studios, or Wonderland........................................ 2
- Going to the Cinema, theatre, museum, gallery, or other cultural activity........... 3
- Eating out at a restaurant or cafe, going to the local club, pub etc.......................... 4
- Going to church, or to meeting of hobby or interest groups you are involved in........ 5
- Other (specify)........................................................................................................... 98
(B) Where and when did it take place?

<table>
<thead>
<tr>
<th>Suburb</th>
<th>Day</th>
<th>Approx Time of Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q 31 How did you travel to and from the activity? Please circle one code for the trip to the activity and one for the trip from the activity.

<table>
<thead>
<tr>
<th>Walk / Cycle</th>
<th>Car Driver</th>
<th>Car Passenger</th>
<th>Bus, train, ferry</th>
<th>Both car and public transport</th>
<th>Taxi</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) To the activity</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
<td>4..</td>
<td>5..</td>
<td>6..</td>
</tr>
<tr>
<td>(B) From the activity</td>
<td>1..</td>
<td>2..</td>
<td>3..</td>
<td>4..</td>
<td>5..</td>
<td>6..</td>
</tr>
</tbody>
</table>

Q 32 If you went by car rather than by public transport, taxi, walking or cycling, why did you prefer to use the car?

Comments: ____________________________________________

_____________________________________________________

Q 33 Did you have any particular problems accessing sporting or recreational activities, such as hours of opening, locations, poor public transport or lack of parking?

Comments: ____________________________________________

_____________________________________________________

_____________________________________________________
Q 34  About how often have you visited the following places in the last six months? *(Please do not include any Olympics – related activities)* Please circle appropriate code for each place.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never or not relevant</th>
<th>Less than once a month</th>
<th>At least once a month</th>
<th>Once or twice a week</th>
<th>Three or more times per week</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shopping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the City <em>(Sydney Central Business District)</em></td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parramatta, Liverpool or Chatswood</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other major shopping centres <em>(eg Supa-centre, Parklea market etc)</em></td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local shopping centre or corner store</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Health-related</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to a hospital <em>(yourself, or to visit someone)</em></td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to another health-related service <em>(eg doctor, clinic, etc)</em></td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sporting / Recreation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watching a sporting event at a major stadium or venue*</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watching sport at a smaller venue / local park</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing Golf</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing some other sport</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to a National Park</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harbour, Penrith Lakes / Hawkesbury River</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to Surf Beaches in Sydney</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to the Local Park</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking / cycling in your neighbourhood</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Social / Entertainment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visiting Friends / relatives at their homes</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to Darling Harbour, Fox Studios, Luna Park or Sydney Casino</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to Wonderland</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to movies, museums, galleries, theatres</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to restaurants, cafes, local clubs etc</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Homebush Bay, Sydney Football Stadium, Sydney Cricket Ground, or Parramatta Park
PROBLEMS IN USING DIFFERENT TYPES OF TRANSPORT

Q 35 We are interested in any problems you might have in using different means of transport. 

Please circle the relevant codes below for anything which causes you problems or restricts you from using that means of travel:

Walking
Physical difficulty / mobility problems...................................................... W1
Lack of good footpaths................................................................. W2
Lack of lighting / don’t feel safe.......................................................... W3
Too much traffic / not safe as a pedestrian.............................................. W4
Too far to walk / distances too great..................................................... W4
Other (Specify)...................................................................................... W98

Cycling
Physical difficulty / cant ride a bike.......................................................... Y1
Don’t have a bicycle................................................................................ Y2
Lack of cycle paths ................................................................................. Y3
Too much traffic / too dangerous to ride.................................................. Y4
Not well lit – don’t feel safe................................................................. Y5
Just don’t feel comfortable riding a bike................................................... Y6
Nowhere to park bicycle – could get stolen............................................... Y7
Too hot – nowhere to shower after arriving............................................. Y8
Too much pollution, fumes...................................................................... Y9
Too slow / distances too great............................................................... Y10
Other (Specify)...................................................................................... Y98

Taxi
Physical difficulty using taxis.................................................................... X1
Taxi ranks too far away............................................................................ X2
Taxis hard to get / inconvenient............................................................... X3
Taxi fares too high................................................................................... X4
Not reliable enough – often late or don’t turn up..................................... X5
Haven’t got good information on the taxi services.................................. X6
Taxi drivers rude / unfriendly or don’t know their way around................. X7
Don’t feel safe travelling on taxis or waiting for a taxi, especially at night... X8
Taxis not clean / comfortable.................................................................. X9
Other (Specify)...................................................................................... X98
Please circle the relevant codes below for anything which causes you problems or restricts you from using that means of travel:

**Bus**
- Physical difficulty using buses: \( B1 \)
- Bus stop too far away: \( B2 \)
- Bus services too infrequent / inconvenient: \( B3 \)
- Bus Fares too high: \( B4 \)
- Not reliable enough – often late or don’t turn up: \( B5 \)
- Haven’t got good information on the bus services: \( B6 \)
- Routes too indirect / too many changes required: \( B7 \)
- Don’t feel safe travelling on buses or at bus stops, especially at night: \( B8 \)
- Buses / bus stops not clean / comfortable: \( B9 \)
- Nowhere to park car safely to park and ride: \( B10 \)
- Connecting train services too infrequent: \( B11 \)
- Other (Specify): \( B98 \)

**Train**
- Physical difficulty using train or stations: \( T1 \)
- Station too far away: \( T2 \)
- Train services too infrequent / inconvenient: \( T3 \)
- Train fares too high: \( T4 \)
- Not reliable enough – often late or don’t turn up: \( T5 \)
- Haven’t got good information on the train services: \( T6 \)
- Routes too indirect / too many changes required: \( T7 \)
- Don’t feel safe travelling on trains or at stations, especially at night: \( T8 \)
- Trains / stations not clean / comfortable: \( T9 \)
- Nowhere to park car safely to park and ride: \( T10 \)
- Connecting bus services too infrequent: \( T11 \)
- Other (Specify): \( T98 \)
Q 35 (Continued)..

Please circle the relevant codes below for anything which causes you problems or restricts you from using that means of travel:

**Car**

Physical difficulty in driving / being a passenger................................. C1
Don’t own a car / can’t get access to a car........................................ C2
Can’t drive / don’t have a driver’s licence........................................ C3
Difficult to get lifts with people when I need them............................. C4
Cost of buying a car too expensive.................................................. C5
Cost of running a car too expensive.................................................. C6
Cost of tolls too expensive............................................................... C7
Cost of parking too expensive......................................................... C8
Difficult to park at destination......................................................... C9
Difficult to park near home............................................................... C10
Too much traffic to make it convenient............................................ C11
Don’t feel safe driving on busy roads............................................... C12
Cars cause too much pollution and not good for the environment......... C13
Other (Specify) .................................................................................. C98

**Ferry**

Physical difficulty using ferries or wharves........................................ F1
Ferry too far away ............................................................................... F2
Ferry services too infrequent / inconvenient..................................... F3
Ferry fares too high............................................................................. F4
Not reliable enough – often late or don’t turn up............................... F5
Haven’t got good information on the ferry services........................... F6
Routes too indirect / too many changes required................................ F7
Don’t feel safe travelling on ferries or at wharves, especially at night... F8
Ferries / stations not clean / comfortable......................................... F9
Nowhere to park car safely to park and ride....................................... F10
Connecting bus services too infrequent............................................. F11
Other (Specify) .................................................................................. F98
LIFESTYLE

Q 36 How would you describe yourself in terms of the number and variety of activities you engage in (including sporting, social, voluntary, education, work etc)? Please circle appropriate code

Very Active................................. 1
Reasonably Active........................................ 2
Moderately Active........................................ 3
Fairly Inactive........................................ 4

Q 37 Which of the following statements comes closest to describing your current lifestyle and activity level? Please circle appropriate code.

I’d like to increase the number of activities I’m involved in.......................... 1

I’m quite happy with my current life from the point of the number of things I’m involved in........................................ 2

I feel a bit over-stretched with too many things on and I’d like to lead a calmer life........................................ 3

Q 38 If you answered (1) above, what would be the main reason? Please circle appropriate code.

There’s not much to do around here – I’m a bit bored................................. 1

There are things I’d like to do but I find difficulty getting to them........... 2

There are things Id like to do but I don’t have the money to do them................................. 3

Other reason – please specify:................................. 4

Q 39 If you answered (3) above, what would be the main reason? Please circle appropriate code.

I spend so much time travelling between activities that I don’t have enough spare time to relax............. 1

I tend to get involved in more things than I can handle............. 2

Family and work pressures mean I have lots of things I have to do and not enough time to do them in........ 3

Other reason – please specify___________________________ 4
Q 40 If you had the freedom to choose your ideal lifestyle, with no constraints (such as children, the cost of housing or the location of your job), what sort of location and lifestyle would suit you best? *(Please circle the code closest to your ideal)*

1. I'm a big city person - I like lots of activities, diversity, places to go and the excitement of big cities. I'd like to live right in the city where it's all happening, not out in the sleepy suburbs.

2. I like the excitement of the city, and would like to live in the inner suburbs where I can be close to things but still have some trees and spaces, but not in the city itself.

3. I would like to stay in touch with the city and have access to the harbour, the downtown when I need it, but I prefer living in the lower density suburbs with more open space, more trees, less noise and activities.

4. I'd really like to get out of Sydney or live right on the outskirts - nearer the bush or the country where I feel more comfortable. I find Sydney too big and busy.

5. Other (please specify)________________________

INTERNET

Q 41 Have you ever used the Internet or sent emails?

Yes........................................ 1  Go to question 42

No........................................ 2  Go to question 49

Q 42 On approximately how many days in the last month did you access the Internet?

Number of days last month............... [ ]

Q 43 About how many hours per week do you spend on the Internet on average?

Hours per week........................ [ ]
Q 44 How many times last month did you use the Internet for the following activities?

*Please indicate the approximate number of times in the appropriate box or boxes. (more than one answer may be applicable)*

<table>
<thead>
<tr>
<th>Activity</th>
<th>No of times last month</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) To do home banking or to pay bills</td>
<td></td>
</tr>
<tr>
<td>(b) To trade shares on the stock market</td>
<td></td>
</tr>
<tr>
<td>(c) To look up information on entertainment, or activities to go to in Sydney</td>
<td></td>
</tr>
<tr>
<td>(d) To email friends or relatives or talk on chat programs</td>
<td></td>
</tr>
<tr>
<td>(e) To play computer games interactively with other people</td>
<td></td>
</tr>
<tr>
<td>(f) To look up some topic of interest to you (other than work related)</td>
<td></td>
</tr>
<tr>
<td>(g) To buy groceries or fruit and vegetables on line</td>
<td></td>
</tr>
<tr>
<td>(g) To buy other products on line such as CD’s, books etc.</td>
<td></td>
</tr>
<tr>
<td>(h) To look up information on public transport</td>
<td></td>
</tr>
<tr>
<td>(i) To work from home via email or accessing information, doing research, sending data etc.</td>
<td></td>
</tr>
</tbody>
</table>

Q 45 Has the Internet made any difference to you in terms of making friends or social communications?

*Please circle appropriate code and go to appropriate question.*

Yes, definitely........................................... 1  
Possibly made some difference............................ 2  
No – no difference........................................ 3  
Not sure / Don’t know..................................... 9  

Go to question 46

Go to question 46

Go to question 47

Go to question 47
Q 46 How do you think the Internet has made this difference?

*Please circle appropriate code or codes (more than one answer is possible)*

1. Widened my circle of contacts
2. Taken up time which I would otherwise have used for social activities outside the home
3. Taken up time which I would otherwise have spent on watching TV, reading books or other activities inside the home
4. Other (please specify) _______________________ 

Q 47 Do you think the Internet, email and computers have made any difference so far to your travel patterns or to the way you get access to things?

*Please circle appropriate code and go to appropriate question.*

1. Yes, definitely
2. Possibly made some difference
3. No - no difference
4. Not sure / Don't know

Q 48 How do you think the Internet has made this difference?

*Please circle relevant code or codes (more than one answer is possible).*

1. Changed the number of trips I make for work purposes
2. Changed the time of day when I travel
3. Changed the number of trips for shopping or for medical purposes
4. Changed where or how I travel for shopping or for medical services
5. Changed the number of social / entertainment trips I make
6. Changed where I go or how I travel for social / entertainment activities
7. Changed the number of sporting / recreational trips I make
8. Changed where I go or how I travel for sporting or recreational trips
9. Any other changes? Please specify
OVERALL MOBILITY AND ACCESSIBILITY

Q 49 How would you describe best how you feel about transport in Sydney and the ease or otherwise of getting access to things, both for yourself and the City as a whole?

*Please circle appropriate codes.*

(A) For you personally:

Not a problem for me................................................................. 1
Sometimes a problem for me...................................................... 2
A major problem for me.......................................................... 3
The major difficulty I face......................................................... 4
Other (specify)________________________________________________ 98

(B) For Sydney as a whole:

Not an issue for Sydney............................................................. 1
Sometimes an issue for Sydney.................................................. 2
A major issue for Sydney........................................................ 3
The major issue facing Sydney................................................... 4
Other (specify)________________________________________________ 98

Q 50 Do you have any difficulties using any form of transport, including walking, because of a physical condition or disability of any sort?

Yes.................... 1
No..................... 2

If yes, please describe briefly:

__________________________________________________________________________________________________________
Q 51 What is your opinion on the most important things the government can do to improve accessibility in Sydney from your perspective?  
*Please rate each of these out of 5 (1 = not important / not relevant, 5 = very important) by circling appropriate codes.*

<table>
<thead>
<tr>
<th>Category</th>
<th>Not Important/ Relevant</th>
<th>Importance to you</th>
<th>Very Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Improve the existing train service</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B) Build new train lines</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(C) Build new roads</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(D) Improve parking provision</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(E) Improve the bus services</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(F) Distribute jobs closer to the people</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(G) Build a second Sydney Airport</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(H) Increase housing densities near railway lines</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I) Increase housing densities generally</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(J) Make public transport cheaper</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(K) Improve bicycle and pedestrian facilities</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(L) Reduce traffic congestion by restricting driving</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(M) Putting more emphasis on regional centres</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N) More housing available in the inner city</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(O) Making transport more accessible for the elderly</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(P) Improving access to the train system</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Q) New express buses on dedicated busways</td>
<td>1.. 2.. 3.. 4.. 5..</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q 52  Are there any specific comments you’d like to make on what State or Local Government could do to improve your accessibility to those things of importance to you?

Comment

Q 53  Are there any other comments you’d like to make on this survey?

Comment
**FINALLY, A FEW QUESTIONS ABOUT YOURSELF:**

<table>
<thead>
<tr>
<th>Q 54 Gender</th>
<th>Q 55 Role in Household (Please circle more than one code if appropriate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male........ 1</td>
<td>Parent (with children at home)........................................ 1</td>
</tr>
<tr>
<td>Female...... 2</td>
<td>Carer (of older person / person with medical problems).. 2</td>
</tr>
<tr>
<td></td>
<td>Child................................................................. 3</td>
</tr>
<tr>
<td></td>
<td>Other (Specify)................................................................ 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q 56 Your Age</th>
<th>Q 57 Your own income before tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 - 16........ 1</td>
<td>$0 - $80 / week ($0 - $4,000 / year)......................... 1</td>
</tr>
<tr>
<td>17 - 19........ 2</td>
<td>$80 - $160 / week ($4,000 - $8,000 / year)....................... 2</td>
</tr>
<tr>
<td>20 - 24......... 3</td>
<td>$160 - $300 / week ($8,000 - $15,000 / year).................. 3</td>
</tr>
<tr>
<td>25 - 34......... 4</td>
<td>$300 - $500 / week ($15,000 - $25,000 / year)............. 4</td>
</tr>
<tr>
<td>35 - 44......... 5</td>
<td>$500 - $700 / week ($25,000 - $35,000 / year).............. 5</td>
</tr>
<tr>
<td>45 - 54......... 6</td>
<td>$700 - $1,000 / week ($35,000 - $50,000 / year)........... 6</td>
</tr>
<tr>
<td>55 - 64......... 7</td>
<td>$1,000 - $1,500 / week ($50,000 - $75,000 / year)......... 7</td>
</tr>
<tr>
<td>65 - 74......... 8</td>
<td>$1,500 - $2,000 / week ($75,000 - $100,000 / year)....... 8</td>
</tr>
<tr>
<td>75 or older..... 9</td>
<td>Over $2,000 / week (over $100,000 / year).................... 9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q 58 Qualifications</th>
<th>Q 59 Housework / caring responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Still at school...... 1</td>
<td>Approximate hours spent per week doing housework and looking after children or others in the home</td>
</tr>
<tr>
<td>School Certificate.. 2</td>
<td></td>
</tr>
<tr>
<td>High School Certificate........... 3</td>
<td></td>
</tr>
<tr>
<td>Certificate / Diploma........... 4</td>
<td></td>
</tr>
<tr>
<td>University Degree........... 5</td>
<td></td>
</tr>
<tr>
<td>Higher Degree............ 6</td>
<td></td>
</tr>
</tbody>
</table>

Q 60 Occupation - describe your main job (if appropriate)
Thank you very much for your time, in helping us with this survey. We would also like to be able to get some responses from other members of the household over the age of 12 – could I leave some forms and ask everyone over the age of 12 to fill them out and send them back. They have a self-addressed envelope so it won’t cost you anything.
Many thanks once again.

Could you provide some details on the other members of the household:

Number of people aged 13 or older............... 
Number of forms left..............................

Finally we would like to get a little more information on your household:

(Interviewer to complete)

H1 ADDRESS DETAILS

<table>
<thead>
<tr>
<th>Street (&amp; Apartment) Number</th>
<th>Street Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburb</td>
<td>Postcode</td>
</tr>
<tr>
<td>Home Phone Number</td>
<td></td>
</tr>
</tbody>
</table>

HOUSING AND OTHER DETAILS

<table>
<thead>
<tr>
<th>H2 Communications (ask respondent)</th>
<th>H3 Type of Dwelling (interviewer to tick appropriate box)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Computers (incl. portables)</td>
<td>Separate House</td>
</tr>
<tr>
<td>Phone (Yes / No)</td>
<td>Attached House / Terrace/Town House</td>
</tr>
<tr>
<td>No of Mobile Phones</td>
<td>Low Rise Apartment Block (up to 3 storeys)</td>
</tr>
<tr>
<td>Internet Connection (Yes/no)</td>
<td>Med Rise Apartment Block (4 - 8 storeys)</td>
</tr>
<tr>
<td>Fax</td>
<td>High Rise Apartment Block (over 8 storeys)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>H4 Transport (ask respondent)</th>
<th>H5 Use of Private Open Space (ask respondent – Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Cars available to HH</td>
<td>Do you have a Swimming Pool?</td>
</tr>
<tr>
<td>No of people with licences</td>
<td>Does your household spend a lot of time gardening,</td>
</tr>
<tr>
<td></td>
<td>working around the house, having bar-b-q’s etc</td>
</tr>
</tbody>
</table>

INTERVIEWER DECLARATION

I have conducted this interview. To the best of my knowledge, it is a full and accurate recording and has been completed in accordance with my instructions

Signed..........................................................