Land Transport New Zealand

Neighbourhood Accessibility Assessment Tool

Literature and Modelling Review for Steve Abley Transport Consultancy

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Executive Summary

This research identifies how to create a user friendly and intuitive tool, for assessing accessibility by local authorities in local areas of New Zealand.

Measuring accessibility without first clarifying policy on accessibility could inadvertently create unintended policies. Accessibility planning defines the processes to manage cross-sectoral working and close policy gaps, to identify how the long term decline in accessibility to local services can be tackled. There are as yet no core accessibility measures at a national level in New Zealand. However there are policies and performance measures which are consequential on accessibility policy including: increasing the amount of active travel, creating safer neighbourhoods, and improving air quality by reducing traffic pollution. Public transport accessibility aims are not implicit in the current national policies and need further development for practical modelling approaches to be developed.

Definitions of accessibility include three key elements:

- The category of people or freight under consideration.
- The activity supply point.
- The availability of transportation and connections.

To cover the full range of factors relevant to neighbourhood accessibility the measures need to include expressed, social, stated and comparative needs. Different indicators will be practical at national and local levels. A manageable number of indicators can be delivered by combining and weighting indicators for different groups of people, trip purposes, times of day and transport barriers and options.

Management and audit frameworks need to be clarified to ensure that the analysis requirements directly support active administrative structures.

To assist the development of an accessibility modelling toolkit, it should be possible for some of the functionality from existing models to be transferred to a New Zealand situation e.g. mapping of outputs and editing networks.

However, the time consuming part of accessibility modelling is the data assembly and management, and for this it will almost certainly be more efficient and practical to automate bespoke accessibility software to the available data and neighbourhood accessibility needs identified in other work-streams on this project.

Contents

1.0 Introduction

1.1 This research has been commissioned as part of work for Land Transport New Zealand to assess and measure the accessibility of neighbourhoods. The aim of the project is to create a user friendly and intuitive measuring tool for local authorities which produces:

- Clear, objective, quantifiable measures of how accessible an area is by walking cycling and public transport compared to car access.
- Provides sufficient detail to identify the nature of the problems so that improvement options can be developed and assessed for all modes.
- Identifies the key obstacles to greater use of active modes in the area.
- Takes into account the quality attractiveness, safety and legibility of the walking and cycling routes in addition to travel time.
- Is affordable enough that councils can use them.

Approach

1.2 There is much confusion about accessibility as a concept and its use in transport planning applications. The project:

- Reviews where and when accessibility analysis is needed and explains the terminology and components of accessibility measurement
- Reviews the measuring techniques and models available
- Suggests how model structure, indicators and evaluation might be tested and monitored

2.0 Concepts

Policies and indicators

2.1 Measuring accessibility without first clarifying policy on accessibility could inadvertently create unintended policies. The UK Audit Commission notes "that if an organisation does not measure what it values it will end up valuing what it measures". Transport markets and public agencies have a strong tradition of measuring the number of travellers and vehicles, but have been less good at measuring gaps in coverage and whether the network coverage allows customers access the places where they need to travel.

2.2 The starting point for measuring accessibility is therefore to establish to what extent policy is already in place. A recent review (BAH 2006) showed that although many statements were made about improving accessibility and mobility within policy documents, the terms were used without any clear definition. The review suggested that further work was needed to clarify accessibility policy, with the Ministry of Transport co-ordinating action and liasing with other Ministries and regional authorities on policy development.

2.3 In order to progress these actions within the context of improving neighbourhood accessibility, three main aims are identified to:

- Harmonise policy across Ministries and government including the specific roles at national, regional and local levels. This would include identifying and setting appropriate accessibility indicators, standards and targets.
- Specify approaches for measuring accessibility within transport planning and appraisal. This would then define the role for accessibility planning as a diagnostic tool and as a program/project appraisal tool including incorporating accessibility modelling within regional transportation models.
- Ensure that all needs are met by identifying specific action needed by location, age, culture, and gender.

2.4 Policy change needs to be carefully managed to ensure balance between the political, technical and economic impacts. Rebalancing mobility and accessibility aims could have major implications for investment programmes, so it takes time to manage this change to ensure that the new approaches are politically acceptable and affordable.

2.5 In most countries with well defined accessibility policies (e.g. Holland, Germany, UK) national accessibility policy defines detailed accessibility planning requirements for local authorities, rather than explicit quantified national targets and goals. In these countries national government also supports and undertakes analysis of accessibility change over time. Accessibility measures can then be used to identify relationships with wider social and economic trends informing national policy development (Hilber and Arendt 2004).

National, regional and local

2.6 The most common approach to national accessibility policy is to emphasise access to mobility (e.g. in the United States, Canada and Australia) (Litman, 2003). Such policies deliver targeted actions relating to groups of people that suffer from low mobility (e.g. facilities for people with physical disabilities, and subsidies for transport costs). The attraction of these policies is that they do not involve other sectors, since they relate solely to the transport sector. Although access to transport is a useful part of the accessibility policy mix, more integrated policies and measures are needed to ensure that accessibility planning delivers more sustainable and inclusive neighbourhoods.

2.7 It is through the development of detailed local policies that accessibility assessments have been most widely used to deliver these integrated approaches. This recognises that top down policies cannot succeed without bottom up ownership from local areas.

A cross-sectoral approach

2.8 Assessing accessibility has implications well beyond transport. Health, education and other departments have policies and statutory responsibilities for ensuring access. Ideally transport policies should be compatible with these, but this is rarely achieved in practice without an accessibility planning process to manage the partnership working (FIA 2004).

2.9 Non transport departments do not generally have well developed policies and mechanisms for improving accessibility, and responsibility for targeted action is generally perceived to be predominantly a transport issue. Leadership from within the transport sector is therefore needed to tackle the barriers to accessibility.

2.10 Accessibility indicators have been widely used in research for many decades but their breakthrough into policy has been more recent due to problems with managing cross-sectoral working (SEU 2003, Scottish Executive 2000) including:

- Cross sectoral indicators are not wholly within the control of any one policy making department - A health department might set a target that 90% of the population should be within 30 minutes of a health centre but experience shows that if road congestion grows making the target unachievable then the target tends to be abandoned rather than cross sectoral action being pursued to deliver change.
- Funding streams and progress indicators are closely linked but accessibility is not dependent on action in any one policy area but reflects both transport and other factors.
- Accessibility is a transparent and user orientated way of measuring transport which can be sensitive for other sectors if problems arise – e.g. it will not always be possible for accessibility to improve for everyone so

transparent measures can make the process of managing the politics of winners and losers more difficult.

- With simple accessibility indicators a very large number of measures are required to measure performance – but it is difficult to gain acceptance for more sophisticated measures.

2.11 Accessibility planning defines the processes that have been put in place to manage the cross-sectoral working and close this policy gap (SEU 2003). By identifying manageable goals, and using partnership approaches between the transport and non transport departments, the aim is that the long term decline in accessibility to local services can be tackled.

2.12 However non-transport agencies such as health and education will only participate in such partnership approaches if they also have a conducive national policy context within which to operate. The UK has made particularly notable progress in recent years on making these links. The national accessibility planning framework has been delivered across all policy departments and this has been underpinned by audits of accessibility related policies in health, education, regeneration, land use planning and other policy area (www.accessibilityplanning.gov.uk).

3.0 Indicators

Dimensions of accessibility measures

3.1 Definitions of accessibility include three key elements:

- The category of people or freight under consideration – Each section of the population has specific needs and desires to be involved in defined activities.
- The activity supply point –Opportunities are defined in terms of the land use supply which would allow any individual to satisfy their desire to participate in the activity under consideration.
- The availability of transportation and connections – This defines how an individual could travel to reach the relevant facility or make contact through electronic networks. In assessing the transport options it needs to be recognised that all stages of each possible journey by each available mode must be taken into account.

People and opportunities

3.2 The type of opportunities depends upon whether origins or destinations are being considered.

- Origin accessibility considers the opportunities available to an individual or a business. The opportunity term is therefore usually based upon the land uses at alternative destinations.
- Destination accessibility considers the catchments for a destination. The opportunity term is therefore usually based upon the land uses and type of person or traveller at alternative origins.

3.3 Types of person or traveller take account of:

- Mobility – car owner/driver, physical and sensory disability.
- Employment status – unemployed, economically active, job seeker, etc
- Age – Retired, adult, children, etc.
- Cultural factors – gender, ethnicity, faith, etc.
- Responsibilities – carer, lone parent, etc.

3.4 Each section of the population has specific needs and desires to be involved in activities. These activities are represented as types of opportunities and defined in terms of the land use supply and the location and timing of a range of local services and facilities, which would allow any individual to satisfy their desire to participate in the activity under consideration, this includes:

- Employment, Education and Training – Employment locations, job centres, childcare facilities, nurseries, schools, colleges, universities, training centres.

- Health and Social – GP surgeries, health centres, hospitals, dentists, social security offices, drop-in and day care, centres, youth services, citizens' advice bureaux, legal services, etc.
- Shopping and Leisure – Shops/shopping centres, cinemas, theatres, sports centres, outdoor activity opportunities, centres for religious activity, pubs, clubs, post offices, financial services, etc.

3.5 There are therefore a very large number of possible combinations of person types and land uses for both origin and destination accessibility. It is clearly not feasible to look at all such accessibility issues since the very large number of combinations of people groups and trip purposes required to represent all available opportunities would be very confusing.

Deterrence factors

3.6 The aim is to represent each deterrence factor or barrier, as they are perceived by each population group. This must include the relative deterrent effect of different types of travel, and the costs associated with each. (e.g. the greater deterrent effect of time waiting for a vehicle when compared with the same time spent travelling in a vehicle).

3.7 Deterrence factors can be categorised as shown in Table 3.1.

Table 3.1 – Deterrence Factors

Element	Factor
Time factors	Travel time including walk time, wait time, and in vehicle time Scheduling of activities and scheduling of transport services by time of day Time budgets available to each population group for each trip type
Cost factors	Public transport fares Fuel and vehicle costs Affordability for the people concerned
Reliability	Uncertainty about journey times Uncertainty about journey quality e.g. availability of a seat
Safety and security	Real and perceived safety Barriers during hours of darkness such as lack of street lighting Real and perceived in vehicle safety Presence of road crossing facilities Speed limits
Physical features	Kerbs and physical obstructions Steep hills and topographic constraints Surfacing and maintenance
Quality and environment	Attractiveness and aesthetics of walking routes Opportunities for shelter from weather and for rest points Comfort of waiting areas and vehicles Assistance and helpfulness of public transport staff Support services when travelling e.g. catering
Information and booking	Information availability from which to plan journey Time spent planning and booking journey Availability of information during journey

3.8 Although these factors are presented separately it should be noted that eliminating one barrier to accessibility will not improve access if other barriers remain (DHC 2002). It is therefore usually necessary to look separately at the deterrence factors by people group. For accessibility to be improved, all relevant barriers for the people group being considered need to be overcome. This means that public transport networks and network coverage is identified as an output from accessibility analysis rather than an input to the analysis.

3.9 Many trips will involve a combination of several modes, and for non-car available trips, the car options are excluded from the calculation. For example a car available trip to a city centre from a rural area may involve a car element to a park and ride site, a bus element from the edge of the city to the centre and a walk element from the bus terminus to the destination. The non-car available alternative would consider only the public transport, walking and cycling options to reach the city centre.

3.10 Operational factors, such as system capacity and congestion, need to be included in the analysis when appropriate.

3.11 The range of issues that can potentially be included in accessibility measures are broad and the number of accessibility indicators needed to represent people's experiences could be very high. Practical application of the measures depends on selecting the critical issues and measures to capture the significant effects.

Experience of accessibility indicators in practice

3.12 There are longstanding examples of accessibility indicators in many countries (e.g. regeneration in Germany, land use planning in the Netherlands). This discussion concentrates on the recent experience of indicator development in the UK which has sought to draw from the longstanding international practice (Scottish Executive 2000, 2003) and establish a culture of accessibility measurement at national, regional and local levels across the country.

3.13 The UK has made very substantial progress with:

- National core indicators agreed between government departments.
- Regional and local indicators developed through partnership working.

3.14 At all levels, data availability is one of the most important constraints. The selection of indicators is a balance between the optimal representation of accessibility problems and the data which is already available, or can easily be collected.

3.15 Table 3.2 shows the national core indicators in England covering education, health, employment and shopping trip purposes. The lack of indicators covering leisure trips is a significant problem but there are no consistent data sets that can be used to represent the wide variety of leisure trips being made.

3.16 The measures each have a target group at the origin and use both stepped and continuous deterrence functions for travel time. The thresholds set in the

stepped deterrence functions have been based on the distribution of observed travel time from the national travel survey (DHC 2004). The continuous functions are based on a negative exponential distribution.

Table 3.2 – Core Indicators in England

Destination Definition	Population Group from PLASC data	Deterrence Function			Modes	
		Threshold (mins)		*Cont.*		
		Lower	*Upper*		*PT/ Walk*	*Cycle*
Primary School	Compulsory school age children (5-10 years)	15	30	√	√	
	Children (5-10 years) getting free school meals	15	30	√	√	
Secondary School	Compulsory school age children (11-15 years)	20	40	√	√	√
	Children (11-15 years) getting free school meals	20	40	√	√	√
Further Education College	Population aged 16-19 years	30	60	√	√	√
Employees in each COA (No.)	Population of working age (16 - 74 years)	20	40	√	√	√
	Population in receipt of Jobseekers Allowance	20	40	√	√	√
Hospitals with an outpatient department as defined by DfT	Households	30	60	√	√	
	Households without access to a car	30	60	√	√	
General Practitioners as defined by DfT	Households Population of working age (16 - 74 years)	15	30	√	√	
	Households without access to a car	15	30	√	√	
Supermarket	Households	15	30	√	√	√
	Households without access to a car	15	30	√	√	√

3.17 This process generates 59 destination indicators and 31 origin indicators:

- The destination indicators describe the number of people in the specified catchment e.g. 10,000 households within 3o minutes of a hospital
- The origin indicators describe the choice of options available from each origin location e.g. 15,000 jobs within 60 minutes.

3.18 A road based analysis has also been used nationally in England to compare access by car with access by public transport and walking. However this is not monitored. However the ratios of car to PT accessibility show the locations where PT improvements have the greatest potential benefits to improve

accessibility for both car and non car available trips, and to identify locations where PT is unlikely to be competitive for car owning households.

3.19 These national travel time based indicators are limited by the national data but a much wider range of indicators has been used at local level including:

- Community or social outcomes - Standards of accessibility to be defined in absolute terms based on an assessment of society's expectations of basic needs.
- Comparative measures - look at the distribution of access opportunities by people group and location.
- Stated perceptions - people's views often reveal needs which have not been identified or measured using other techniques.

3.20 These include:

- The ***frequency*** with which each service is accessed (expressed need)
- The ***consequences*** of the person not being able to access the services (social need)
- The ***concerns*** of the affected groups about not being able to access the services (stated need)
- The importance for ***equity*** of some people not having access (comparative need)

3.21 A selection of these indicators is shown in Table 3.3. Each regional and local authority has established their own basket of indicators and national government monitors local performance as much from the local indicators as the national ones. The examples in Table 3.3 are not consistent across the country but illustrate the range of indicators currently being used. As authorities develop their accessibility plans and establish data collection mechanisms it is anticipates that reliance on the local indicators will grow relative to the national core indicators.

Table 3.3 – Local Indicators in Accessibility Planning

Indicator	Uses
% of population able to reach city centre in 30 minutes	Core indicator to monitor impact of additional bus routes to city centre facilities and services
Number of daily bus journeys to city/ town centre	Monitor changes in bus use to access facilities and services
Number of pedestrian journeys into the town centre/ hospital/ school	Monitor impact of improvements to pedestrian environment e.g. improved street lighting
% total bus network served (by vehicle mile) by fully accessible low floor vehicles	Intermediate indicator (as defined in paragraph 8.2) to monitor progress in target to implement fully accessible low floor vehicles on whole network

Indicator	Uses
Number of bus stops and transport interchanges which meet good practice standards for access by disabled people.	Intermediate indicator to monitor progress with target
% of passengers satisfied with bus service (reliability, safety, information, condition, etc.)	Monitor impact of improvements e.g. improved reliability, information, bus stops
Number of referrals to Traffic Commissioner of bus reliability problems arising from complaints from users.	Intermediate indicator to monitor bus service reliability.
% of jobseekers citing transport as a barrier to employment	Monitor the consequences of changes to transport provision.
% of young people with access to public transport in the evenings and at weekends	Core indicator of access at these times
Cost of bus fare per mile to x destination relative to equivalent petrol cost and taxi fare	Monitor relative affordability of public transport services
Take-up of non-statutory concessionary fares by job seekers/ young people / carers/ etc.	Monitor impact of non-statutory concessionary fare interventions
% of bus stops with travel information displays	Monitor access to information
% job centres/ GP surgeries / in receipt of travel information	
Is information available in pictogram/different languages/ Braille/ Minicom? Yes/No	
Take up of the Hospital travel costs scheme by low income groups including activity on publicising scheme to these groups.	
% of hospitals offering travel information service to patients and visitors	
Accessibility of unemployed residents to regeneration areas (the DfT Economic Impact Reporting accessibility measure)	Monitoring accessibility of new job opportunities for targeted groups
% of population able to access the internet and use a credit card to order home food deliveries	Inform policy on the effectiveness of home delivery systems
Number of incidents recorded on public transport	Monitor effectiveness of measures to reduce crime and fear of crime on and around public transport
Proportion of people who feel unsafe walking in their neighbourhood at night	Monitor effectiveness of reducing fear of crime

Indicators and accessibility needs

3.22 It is necessary to use many different indicators of time, cost, user groups, trip purposes. The 90 national core indicators based on time are only the starting point. In addition to the existing local indicators there is a need to introduce multiple constraints to certain indicators e.g. access to employment for single parent households should also include time windows for access to childcare. For many practical applications it is therefore necessary to combine indicators into composite measures of accessibility to ensure a manageable number of indicators that reflect all of the local accessibility needs.

3.23 To achieve this requires:

- All the indicators to be in the same units
- The relative importance of each indicator to be clear.

3.24 For the core national accessibility indicators, each indicator has been normalised to allow trip purpose to be combined but appropriate weightings to allow these units to be combined are still being developed. To weight each trip type requires the frequency, consequences, stated concerns and equity issues to be included.

3.25 People may not need to make as frequent trips to hospital, but the consequences of not making the trip could be serious. Lack of equity in access to further education may not be a concern to some economically inactive people, but the consequences of this lack of equity can be to build in a life of dependency.

3.26 Table 3.4 summarises some of the most important services that people need to access, and identifies how this relates to the dimensions of need. This provides an overview of the types of issues. Reference should be made to the source documents for a more comprehensive description of the challenges.

Table 3.4 – Accessibility Needs and Priorities

Service	Why is it essential			
	Frequency of access required	**Consequences of lack of access**	**Stated concerns of people**	**Equity**
Local shop, shopping centre	High frequency and fastest growing trip purpose	Poor eating habits leading to poor health	Concern about the loss of local stores.	Low income groups make more frequent short trips and pay more e.g. taxis.
Post Office Banking/ Cash machine, legal services	High frequency	Higher costs resulting from the need to use more costly sources for cash such as pay for use cash machines	Concerns about declining local provision	Low income groups make more frequent trips and pay more for their banking.
Leisure, sports, clubs and societies	Medium frequency	Weak social support mechanisms for people who cannot participate		Low income groups spend less time travelling for sport and leisure activities and make less frequent trips than for the population as a whole.
Hospital	Low for most people	High for some services – can core services be defined	People do not generally choose where to live	Poor people pay the highest costs for getting to

Service	Why is it essential			
	Frequency of access required	**Consequences of lack of access**	**Stated concerns of people**	**Equity**
			because of proximity to a hospital so transport to hospital is relatively important for accessibility	hospital Choice in healthcare requires more travel favouring mobile groups.
GP	Medium	Delays in seeking help resulting in greater problems and higher costs	Largely a concern for low mobility group	Poor health and poverty are closely linked.
Community/ day centre/social services	Frequent for a small number of people	People can become unable to live independently without making a call on social services without social interaction.	Type of transport is very important since these services target low mobility groups.	
Schools and colleges	Frequent for those in full time education	Some children are be unable to participate in discretionary, non-core activities (e.g. breakfast clubs, homework clubs and after-school activities)		Fewer trips to colleges from lower income groups.
Childcare and nurseries	Frequent for those with children	Restricted time budgets in single parent families can make access to childcare difficult.		Fewer trips to nurseries from lower income groups.
Employment	High frequency	Work is central to social inclusion. The inability to access employment as lower value activities move out of town centres to less accessible locations. .	Choice of residence location closely related to employment	Low income groups travel less far to work and transport costs can be a barrier to take up of low paid jobs.

3.27 Key points from Table 3.4 are that:

- Expectations of society move on, so perceptions change and generally rise. Trip lengths and frequencies have been increasing fastest for

shopping and leisure trips and the accessibility gap has been growing fastest between low mobility groups and other for these trips.

- Low income groups make trips on a similar frequency as for high income groups for access to most public services. Further and higher education is the main exception to this, but the high degree of choice for this trip purpose makes it more similar to market based provision than for other public services.
- For access to work, and access to private services such as shopping, low income groups show different travel behaviours from higher income groups. Lower income groups spend more time than higher income groups travelling for shopping and personal business (the largely market based services), but spend less time travelling to work and education. Low income groups spend less time travelling for sport and leisure activities
- The implications of these differences are important for public policy since the consequences of lack of access for some people, impact on the whole of society.

3.28 The relatively similar behaviour demonstrated for access to public services regardless of income, will be heavily influenced by the way that these services are provided (e.g. travel to school or hospital is still only marginally influenced by consumer choice). In contrast, customer choice has a major impact on market based provision.

Accessibility outcomes

3.29 Evidence from the US shows that the built environments and travel behaviour are closely related (Handy 2002). Policy aims which emphasise neighbourhood accessibility have the greatest potential for maximising interaction between people and activities within communities. Where people can access opportunities closer to where they live they do so, they also tend to use slower modes.

3.30 Improving access is implicit in most transport planning and infrastructure investment. However this implicit treatment is sometimes insufficient for transport planning since:

- There can be unintended consequences from transport investment. For example, when a road is upgraded to a rural community, the shops and services in the rural community often close (Scottish Executive 2001, SACTRA 2000) resulting in reduced accessibility for the rural area for some trip purposes.
- The impacts of the change are different by population group and area so distributional effects need to be understood (UK Treasury 2003).
- There is a close relationship between transport supply and demand so both accessibility and mobility need to be considered (Hansen 1959).

- Public acceptability is critical, but technical concepts such as speed/flow relationships and supply/demand interaction are poorly understood by the travelling public. If it is proposed to restrain the supply of opportunities for one mode to improve accessibility overall (e.g. a pedestrianisation scheme), then it is necessary to describe impacts on people rather than modes to ensure broad support for the proposal (Halden 1996).

Managing progress and accessibility audits

3.31 The widest application of accessibility indicators has been where there are clear legislative and management structures to support their delivery. In Holland there is a well established culture of accessibility audits within land use planning (Dutch Government 1994). Accessibility audits for low mobility groups in place in many countries are underpinned by equity aims recognising the difficulties that people with physical disabilities face (FIA 2004).

3.32 In contrast, where neighbourhood audits have been proposed to improve access to local services but without a delivery framework there has been limited action (Handy 2002).

3.33 Recent approaches to accessibility planning in the UK have sought to close this gap by:

- Making accessibility audits a core function of local transport planning (DfT 2004). These plans define how transport is integrated with other policies to deliver better access for all people and all trip purposes.
- Segmenting the population to recognise that accessibility varies significantly between different mobility groups. For each trip purpose, the groups of people most likely to face exclusion on grounds of accessibility are considered.
- Introducing audit requirements to transport appraisal (Scottish Executive 2004) to ensure that improvements in access for one group of travellers are packaged with measures to mitigate negative accessibility impacts on others (e.g. a new road might improve accessibility by car but can also sever communities requiring new pedestrian facilities)

3.34 As noted above, the greatest challenge for these audits is that it is not practical to consider the many hundreds of potential combinations of people groups, trip purposes and travel options in every assessment. Successful audits therefore require a high degree of skill by the auditor to target analysis and ask the right questions. Experience shows that these are not strong skills within the transport sector, so some prescription is needed to ensure useful outcomes.

3.35 However prescription within audit processes can potentially distort the aims of accessibility planning to ensure the needs of all people are met. Successful policies provide clarity on complex issues such as:

- The need to package investment to ensure balance and equity in programme delivery raises questions about the scope and geographical level for the audits. It is not possible for every group to benefit from every change, but overall it is reasonable to expect that the needs of all groups are considered and reasonable action is taken to mitigate adverse consequences of change.
- The priority given to accessibility within different local neighbourhoods will vary. Rural dwellers choose to sacrifice accessibility for other benefits of rural life but in all neighbourhoods the greatest problems arise from unplanned or unexpected changes. For example, pressures within healthcare to provide specialised services at centralised locations often mean that local centres can close. This can create accessibility problems for low mobility groups. A neighbourhood accessibility planning process needs to foster the cross-sectoral co-operation to ensure consistency and equity at local, regional and national levels.
- At a project level, the needs of minority groups are only understood if detailed accessibility audits are undertaken (Litman 2007, Scottish Executive 2003) but an alternative easier goal achieves balance at a more strategic policy or programme level (DfT 2004).
- Seeking to resolve issues about winners and losers at a project level can make the packaging of transport delivery very complex, and lead to poorer value programme delivery (small amounts of landscaping, shelters, road markings etc are disproportionately expensive). However, if equitable solutions are not delivered at a scheme level then it can be difficult to guarantee that the parallel investment will take place at the same time.
- Accountability and funding are managed within narrower boundaries than accessibility. Results of accessibility audits can therefore be more of a problem than an opportunity, unless the partnership working arrangements are in place to deliver multi-disciplinary solutions. In most countries, narrow high level accountability means that national or regional partnership structures have proved elusive. However community and neighbourhood planning has proved to be a much more practical level to deliver partnership solutions.

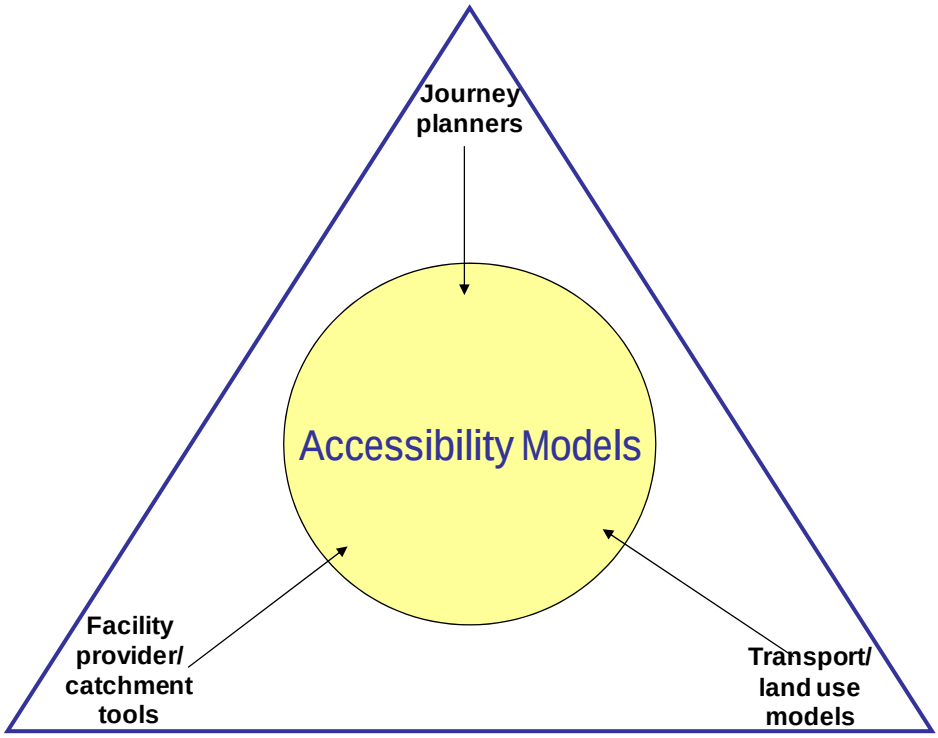
3.36 Where top down policies foster and support bottom up action then accessibility planning can thrive. The UK approaches have moved some way towards this but experience is growing internationally and practice has substantial room for improvement.

4.0 Modelling Approaches

Types of Model

4.1 The tools available internationally for modelling accessibility fall into three categories as shown in Figure 4.1.

Figure 4.1 - Types of Accessibility Model



4.2 The models used by facility providers such as retailers and public transport operators generally start from the analysis of the local population and output information on the potential client mix within the local catchment. This allows providers to plan appropriately for the people able to access their services.

4.3 Some models have been derived from road or public transport journey planners and tend to be restricted to an analysis of the time it takes to reach different destinations.

4.4 Although transport and land use models tend to be much more complex than the journey planners or catchment tools they do not necessarily provide better information for accessibility planning unless linked with other models. These network and transport system models tend to have very few user groups. It is therefore necessary to use travel time information from these and link them with separate accessibility models to generate high quality accessibility measures.

4.5 Due to the extremely different functionality of the different types of model available there is much confusion about what an accessibility model comprises.

4.6 It is more useful to specify what indicators are needed and then identify what tools can be automated to calculate these. The standard functionality

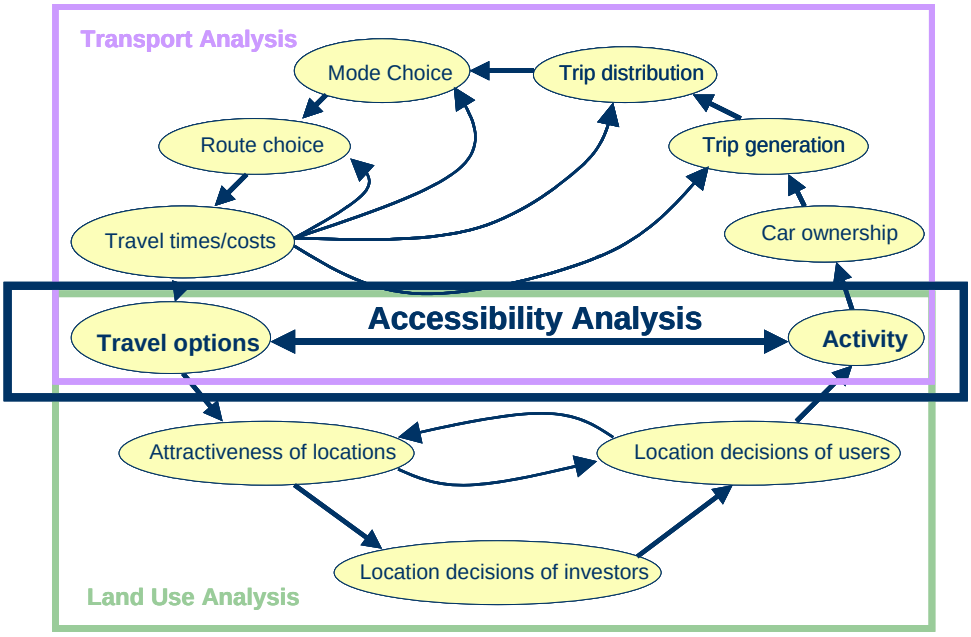
available in today's databases and GIS systems is usually more than sufficient for most modelling applications, and by adding some macros to these, repetitive indicator calculation can be automated.

4.7 For this reason there is very little transferability of models between areas. Most local authorities in countries with well developed accessibility planning approaches have automated calculation procedures to meet their needs, and in some places these have been "branded". These brands have been important to give the models credibility within an industry that has been traditionally heavily dependent on sophisticated models.

Model Functionality

4.8 At its simplest level calculating accessibility measures requires only some travel time data and some land use data so that the two can be linked to calculate an integrated accessibility measure as shown in Figure 4.2. Alternatively the accessibility analysis can be linked into highly sophisticated land use and transport analysis and forecasting.

Figure 4.2 – The Classic Stages in Transport Modelling



4.9 To illustrate the functionality provided towards accessibility indicator calculation by a range of existing models, Table 4.1 compares the capabilities of a selection of models in terms of:

- Transport analysis – the functionality that allows the journey times and costs to be calculated.
- Land use analysis – the way that location choice and land use affects travel including feedback loops from transport to land use.
- The ability of different groups of people to access particular activities

4.10 The selection of models seeks to illustrate the range of features available in existing software products.

Table 4.1 – Examples of Demand Models with Accessibility Indicator Functions

Model	Estimation of travel time and cost	Land use interaction	Accessibility indicator calculation and output
Transport demand models			
OmniTRANS (Omnitrans International – Netherlands)	Outputs average times by all modes and real time simulations for traffic, but not clock time public transport options. Costs estimated from distance.	Database functionality allows accessibility impacts of land use scenarios to be compared.	Optimised to compare access for different people groups using "cube" functions and mapping interfaces.
Visual-TM (Peter Davidson Consultancy, UK)	Outputs average times for trips by all modes. Costs estimated from distance.	Land use as an input but not interactive	Use of Map-point GIS software provides a visual interface and data management for comparing impacts on different people groups.
Cube (Citilabs, UK)	Outputs average times by all modes and real time simulations for traffic, but not clock time public transport options. Costs estimated from distance.	Land use as an input but not interactive.	ArcGIS interface provides mapping options for indicators.

4.11 Although these demand models have fairly sophisticated accessibility indicator and mapping functions there are many potential users of accessibility analysis who are unable to justify the expense of a demand modelling. As a result markets have developed for a larger and more diverse group of tools to analyse other influences on accessibility. A selection of these is described in Table 4.2.

4.12 The demand models rely on public transport frequencies to estimated travel times by time of day but most of the models in Table 4.2 use actual service schedules and output accessibility results for a specified time of day and day of the week.

Table 4.2 – Examples of Models with Accessibility Indicator Functions but no Demand Modelling Capability

Model	Estimation of travel time and cost	Accessibility indicator calculation and output
Destinations are specified by model users rather than being considered as trip attractors		
Accession (Citilabs, UK)	Calculates journey times based on scheduled arrival and departure times.	Various contour and continuous functions are optimised for indicator and mapping outputs.
ICON (MCRIT, Spain)	Time and distance using average speeds using road networks	GIS based model to optimise regional accessibility indicator calculation
AccessMAP – (CSIR Transportek, South Africa) the AccessMAP	Based on distance using GIS systems	GIS based with indicators originally designed for planning new public facilities such as health centres but extended to investigate transport investment options
ABRA (Colin Buchanan and Partners, UK)	Scheduled journey times from public transport timetables.	Spreadsheet based accessibility indicator calculation.
ACCALC (Scottish Executive, UK)	Travel times and costs not calculated but taken as outputs from transport models.	Functions to assist users specify and output indicators for analysis and mapping.
Capital – "CalculAtor for PublIc Transport Accessibility in London" (TfL, UK)	Public transport times from strategic public transport model for London and walking times estimated using GIS from distance from origin to the nearest modelled node.	Links to London's Planning and Development Geographical Information System for indicator calculation and output
PTAM (West Yorkshire Passenger Transport Executive, UK)	A hierarchy of public transport nodes is determined and walk times to these from small local areas are calculated.	Travel time for users to services.
AutoPTpath	Highly optimised routing algorithms to be able to calculate optimal journey times for very large numbers of zones. Uses scheduled departure and arrival times for public transport	Links to GIS for mapping
WALC (University of Westminster, UK)	ArcGIS based with travel times for walkers being estimated and weighted based on obstacles faced (e.g. including steep hills).	Population catchment indicators are output based on a set of destinations.
Amelia (UCL, UK)	GIS used to allow user defined attributes to be allocated to links in the network to calculate travel times.	User consultations and focus groups being used to define parameters for indicators.
NAMTRAC (DHC, UK)	AutoPTpath routing algorithms used (see above)	Database used to manage indicator calculation and GIS used to output results.

4.13 All of the models in Tables 4.1 and 4.2 include three main components:

- A relational database
- A GIS system
- Some bespoke programming or macros to optimise functionality for a perceived market or planning need.

4.14 The balance between these three varies. The demand models rely more heavily on bespoke programming. On some of the simpler models the database functionality within proprietary GIS packages has been sufficient to allow the first two elements to be combined. However for more substantial applications a separate database is needed.

4.15 Accessibility models can involve very large travel time matrices in order to provide spatially detailed zoning systems. File sizes limits in the software restrict the capabilities of most of these models. For example the Citilabs Accession model can cope with about 2 million origin/destination pairs (i.e. about 1400 zones when mapping access to other people).

4.16 Travel time is considered in some detail within most of the models. Cost is also sometimes included but generally uses simple distance based proxies rather than actual fares for the group being considered. Other deterrents on travel are largely ignored. Models such as Capital, PTAM, WALC, Amelia, and NAMTRAC allow other deterrents to be included within the analysis (e.g. to exclude links without street lighting from trips at certain times of day).

4.17 When considering neighbourhood accessibility the non-time factors can be particularly important so it is worth considering the relevant parameters in more detail.

Potential capabilities

4.18 Rather than looking at model "packages", an alternative way of looking at model functionality is to consider all of the elements currently included in any model. Then by selecting the functions that are of most value to neighbourhood accessibility in New Zealand a model design can be established which is both practical and optimised to local needs.

4.19 Accessibility indicators define whether any user or group of users can get to any destination or set of destinations. The capabilities therefore relate to three main components:

- The level of detail with which the user groups can be identified and their capabilities established e.g. how far they can/will walk.
- The types of destinations to which people are travelling and the way that quality and choice are perceived by each group.
- The means by which each group of people reach each set of destinations.

4.20 The first two of these are constrained largely by data availability as discussed in Chapter 3. However model capabilities also affect the ability to represent travel options. Based on an analysis of journey planners, Table 4.3 shows the capabilities of different types of model.

Table 4.3 – Capabilities of Accessibility Models

Journey Planning Functions	Accessibility Models with a demand modelling capability	Accessibility Models without a demand modelling capability
Opportunities and activities at the destination	Often included in add-in modules	Increasingly assisted data import facilities for a wide range of data sets.
Travel time calculation	Times between centroids of zones with zone connector times being calculated from the area of the zone.	Times between either points or centroids of zones
Scheduling e.g. target departure or arrival time or both, arrive before, depart after, departure or arrival during a specified period	No	Yes – specified by user
Travel cost and fares taking account of travel cards and concessions, fares restricted by quota, season ticket options and time of day restrictions.	General and broad assumptions rather than actual ticket costs	Data problems
Interchange points by facilities available e.g. shelter, information, staffed/porters, availability of luggage trolleys, CCTV.	No	No
Interchange options e.g. minimum time accepted for interchange, restrict interchange options between modes or operators, restrict the number of interchanges acceptable, availability of guaranteed connections.	Can sometimes be specified.	Can generally be specified
Route choice: minimum time, minimum cost, least amount of walking, include or exclude modes, avoid a location, route via a location or locations, etc.	Route and mode choice usually based on generalised cost so average values of time can reduce accuracy for some groups. However minimum time routing often possible. Limited trip chaining allowed.	Route and mode choice generally minimum time path.
Mode choice, bus, rail, ferry, air, bespoke services (school transport, patient transport)		
Day of the week, seasonal variations	Not explicit unless user seeks information	User specified.
Real time updates and reliability	No	No

Journey Planning Functions	Accessibility Models with a demand modelling capability	Accessibility Models without a demand modelling capability
e.g. congestion, roadworks, delays		
Health information e.g. calories used	Occasionally	Occasionally
Environmental information e.g. emissions associated with the journey		
Confidence building information e.g. to confirm the validity of the results with map based presentation, emergency telephone numbers in the event of problems	Yes	Yes
Type of vehicle e.g. low floor bus, luggage carrying capability	No	No

4.21 The most comprehensive approach to an accessibility audit is to examine all of the factors that affect an individual's ability to travel. However in practice the simple accessibility analysis tools provide a broad sift which can be used in conjunction with the transport and land use models to add detail. To check the results for elements of accessibility not considered in these models, some sample audits can be undertaken. This is often done through the consultation with local people.

5.0 A Practical Approach for New Zealand

5.1 Improving access to local services is inclusive, efficient and has many wider benefits in sustainable community development. However markets operate within narrower contexts than social need, so these wider benefits are often not reflected in the provision. This chapter explains how accessibility measures could be used to help secure wider benefits from more sustainable and inclusive neighbourhoods.

5.2 Each person and organisation has different preferences and goals. To improve neighbourhood accessibility beyond the lowest common denominator of these aspirations, relies upon raising the common understanding of what an attractive neighbourhood might comprise and the sort of solutions which can be delivered to foster:

- An inclusive society
- More active travel
- Local economies of scope through partnership working.

5.3 In Chapter 3 it was shown that this evidence base requires:

- Stated views of accessibility as the platform from which to build
- Social indicators quantifying as far as possible the accessibility opportunities available
- Comparative measures showing the extent to which the neighbourhood caters for the interests of all groups.

Possible indicators

5.4 Before looking at how these options might be delivered in New Zealand the indicators highlighted in earlier research (BAH 2006) provide a starting point for discussion.

5.5 Comments on the experience internationally with such indicators is summarised in table 5.1. It can be seen that although many of these indicators have been used successfully elsewhere, there are significant limitations since they do not directly describe the opportunities available for different users to access services.

5.6 It is therefore preferable that any new neighbourhood accessibility measurement should build up locally relevant indicators based on available data as described in the remainder of this chapter.

Table 5.1 – Review of Indicators Previously Proposed

Indicator	Type of indicator	Successful Examples and Experiences
Access to Private Motor Vehicles	A measure of mobility which identifies the people who are most likely to suffer accessibility problems	Many examples throughout the world allowing accessibility improvements to be targeted where there is low car ownership. However does not help to identify what improvements need to be made.
Access to Public Transport	An indication of network coverage, particularly where the services being accessed are categorised by frequency and destination type.	PTAL in London works well in a very densely populated area with frequent public transport and a large choice of destinations for each trip purpose. However can be misleading outside urban areas. Can also be as complex to calculate as integrated accessibility measures so is losing favour relative to indicators which measure access using public transport.
Activity by cycling and walking	A measure of expressed accessibility	Generally a good proxy indicator of the health of a neighbourhood and widely used internationally. However does not help to identify what improvements need to be made.
Transport behaviour	A measure of expressed accessibility.	In a highly segmented analysis travel demand is a good indication of accessibility i.e. if many low mobility people are travelling to the shops then there is likely to be good access. This type of measure is widely used internationally. However does not help to identify what improvements need to be made.
Satisfaction with Transport Options	A measure of stated accessibility	Essential type of measure whether or not other quantified measures are used. In all parts of the world local people understand their accessibility problems.
Aspects of Infrastructure such as proportion of public transport fleet with enhanced access features	A transport accessibility measure	These are widely used to describe the product offered by transport providers. However such measures do not directly indicate whether anybody benefits from the features or what people can access
Travel expenditure such as proportion of income spent on travel	A social accessibility measure	This sort of indicator is very useful, but has not been widely used since there are few places in the world where data on personal expenditure can be obtained at a level useful for accessibility planning.

National policies

5.7 There are as yet no core accessibility measures at a national level so it is not yet clear what elements of accessibility need to be measured. However there are policies and performance measures which are consequential on accessibility policy including:

- Increasing the amount of active travel
- Creating safer neighbourhoods
- Improving air quality by reducing traffic pollution

5.8 These provide a clear policy context for improving access by non motorised modes to the local services that attract the most frequent trips. If more of these trips are made by walking and cycling then the consequences of the improved local access will be the delivery of the national policies.

5.9 The public transport accessibility aims are less clear. Particularly away from major urban centres difficult trade-offs need to be made in planning public transport networks including:

- There is a balance between network coverage and fares. Public transport networks all rely on some degree of cross subsidy between services by location and time of day. Higher frequencies to improve journey times need to be traded against the higher costs of provision.
- Good accessibility for higher mobility groups will generally involve longer walks to high frequency core routes. However, people with lower mobility prefer slower services that come closer to the origin and destination of their trip. Public transport markets tend towards the latter type of service, due to the stability of demand from this group amongst other factors. Making mainstream provision available to all mobility groups can therefore reduce accessibility and the competitiveness of public transport for higher mobility groups. However if core routes can be developed that help to grow public transport markets overall, then the revenue available for public transport increases and this can result in more and better services, improving accessibility. These are complex issues where accessibility policy needs to be significantly developed to allow the components of access that are valued to be measured.
- There is a balance between providing door to door demand responsive services and fixed route provision. In rural areas, best value delivery of improved accessibility can often be achieved through supported taxi services/taxicard schemes and community transport development (Scottish Executive 2001).

5.10 Public transport accessibility aims are therefore not implicit in the current national policies. The accessibility planning process can be used to define more clearly the role of public transport so that clear accessibility outcomes can then be measured (DHC 2003). In the meantime the modelling techniques

should not make assumptions about what sort of public transport system is needed until policy has clarified the role of public transport in improving accessibility.

Trip purposes

5.11 Earlier research (BAH 2006) has suggested that based on the experience of indicators in other counties the following trip purposes might be useful for accessibility indicators in New Zealand:

- School education (separately for primary and secondary schooling).
- Further education.
- Work.
- Hospital
- Doctor or PHO (Primary Health Organisation).
- Supermarket (urban) or food-oriented convenience store (rural).
- Petrol station.
- Pharmacy.
- Bank.
- Public transport.

5.12 This is a reasonably comprehensive list but for the purposes of neighbourhood accessibility it might be worth adding:

- Leisure centres and facilities
- Sports facilities
- Cinemas
- Community centres/cultural and religious activities
- Police stations/consumer protection agencies/legal advice

Data sources

5.13 All indicators need to be based on readily available data and in each local area there may be rich data sources not available nationally. The toolkit for measuring accessibility should therefore have the flexibility to use a wide range of local sources but should also allow the national data to be incorporated easily.

5.14 National data sources identified in the earlier work (BAH 2006) include:

- Census
- The Household Travel Survey
- Supermap
- Local surveys

- Transport provider data
- LTSA travel survey
- Regional council commuter surveys in major centres

5.15 These are typical of the data sources in use in most countries but it is likely that accessibility indicators and data collection would need to be developed in parallel to ensure that relevant data were being collected to allow the accuracy and scope of the indicators to be enhanced. Key data includes:

Transport

- Electronic timetable data
- Electronic databases of fares
- Geo-coded location data for bus stops and rail stations referenced to the timetables and fares
- Databases describing the attributes of the road, footpath and cycleway network by link

Activity and people

- Census of population
- Census of employment
- Health, welfare and other indicators of population characteristics by small area locations.
- Geocoded locations of all services to be included.
- Data allowing the quality and size of activity provision to be measured – e.g. floorspace, turnover, number of customers.

A typology of neighbourhood accessibility measures

5.16 In order to reflect the policies and available data the starting point for neighbourhood accessibility measures recognises that transport is a derived demand and both the supply of opportunities and the supply of transport need to be included for each population group.

5.17 Accessibility measurement needs to be able to be optimised locally but the measures fall into three main categories:

- Decision about the local street environment - Accessibility by walking and cycling to local facilities
- Decisions about transport investment - Accessibility to and of public transport systems
- Cross-sectoral decisions about accessibility plan delivery - Access to and of opportunities using road and transport systems

5.18 There are a very large number of combinations of people, activities and links that define accessibility in any individual situation. A practical approach to measurement in the toolkit must help the assessor to:

- Define activities to represent quality, choice, scale, need, restrictions on availability, opening times, scheduling and other factors relating to the service provision.
- Segment the population to reflect abilities and perceptions, given that these are often specific to individuals or small groups.
- Ensure a broad enough view of all transport and communications options, which reflects all aspects of modal choice, telecommunications, and quality in terms of speed, cost, prestige, security, comfort and other factors.

5.19 Where quantitative data is not available on any aspect, then the toolkit needs to allow qualitative measures to ensure that the toolkit assists the user to make the best decisions. One of the greatest concerns problems with accessibility analysis and modelling is that it is very data hungry. Although data availability has increased very rapidly in recent years accessibility analysis is still dominated by tools that consider only travel time and in some cases cost.

5.20 The above parameters can be used within the toolkit to assist users in selecting and inputting the best available data set or prompting for the collection of data where there are none available. The outputs can then ensure that accessibility planners tackle all of the critical barriers to access and provide relevant information to support fund assembly and project delivery.

Reporting accessibility findings

5.21 The breadth and flexibility of accessibility analysis opportunities are both an opportunity and a threat. Providing useful and relevant indicators and results is a powerful was to support the delivery of improvements and partnership working. However it is very easy to output vast quantities of data which can cause more confusion than benefit.

5.22 The user interface therefore needs to help define what information about accessibility, or the potential to change accessibility, will be most useful. The design of the interface should be informed by the policy requirements but is likely to include at least the following capabilities:

Community or social outcomes

- The choice of opportunities available for shopping
- The travel time and cost to the nearest opportunity
- Information about the catchment population able to access shops, health centres and other local facilities using active travel modes.
- The catchment population able to access shops, health centres and other local facilities using non car modes including public transport.

Comparative measures

- The ratio of travel times by different modes to assess the potential for modal shift.
- Accessibility for low mobility groups compared to higher mobility groups – e.g. non car/car, mobility impaired/fully mobile.

Stated perceptions

- Perceived barriers to reaching neighbourhood services.
- Cultural factors affecting travel choices e.g. car dependence.
- Levels of knowledge of travel choices available.

6.0 Conclusions

6.1 Accessibility measurement has the potential to help deliver improved neighbourhood accessibility in New Zealand. However the starting point is to clarify accessibility policy. Modelling quickly becomes unmanageable if the policy context is not clear.

6.2 Accessibility measures need to include expressed, social, stated and comparative needs. Different indicators will be practical at national and local levels.

6.3 Management and audit frameworks should be clarified to ensure that the analysis requirements directly support the administrative structures.

6.4 To assist the development of an accessibility modelling toolkit, it should be possible for some of the functionality from existing models to be transferred to a New Zealand situation e.g. mapping of outputs and editing networks.

6.5 However, the time consuming part of accessibility modelling is the data assembly and management, and for this it will almost certainly be more efficient and practical to automate bespoke accessibility software to the available data and neighbourhood accessibility needs identified in other work-streams on this project.

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