

The Economics of Enhancing Accessibility

Estimating the Benefits and Costs of Participation

01

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Abstract

Inclusiveness affects the underlying thinking and consequential analysis of accessibility issues in transport. If the fundamental premise is that all people are equal and should be viewed as stakeholders in matters of public policy then it not only reflects international treaties, such as the Rights of the Child and the Rights of Persons with Disability, it encapsulates these and others in a broader perspective of equality. To claim that inclusiveness in transport policy is a paradigm shift may be an over statement, however, what seems self-evident in our discussion is not reflected in best practice at this time. It is important that some measure of the particular beneficiaries of investment in barrier-free transport is defined.

We propose that the use of observable mobility aids, by persons making all manner of trips as pedestrians and public transport users, can be incorporated into cost-benefit appraisal and to inform broader transport planning. The proportion of people using a mobility aid in catchment populations can be estimated so that gaps can be defined between current and desired levels of demonstrated inclusion in transport and especially accessible infrastructure. This indicator is readily operational to estimate benefits and comparative costs of trips not made. These methods ought to be refined to objectively assess accessibility in parallel with other objectives for transport.

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Introduction

In this paper, we discuss how inclusiveness influences the underlying thinking and consequential analysis of accessibility issues from a total community perspective. This is a significant advance in approach to transportation issues and potentially a whole range of other public policy concerns. For the purpose of this discussion, the focus is on transport. If the fundamental premise is that all people are equal and should be viewed as stakeholders in matters of public policy then it not only reflects international treaties, such as the Rights of the Child and the Rights of Persons with Disability, it encapsulates these and others in a broader perspective of equality. To claim that inclusiveness in transport policy is a paradigm shift may be an over statement, however, what seems self-evident in the discussion that follows is not reflected in best practice at this time. Through our discussion, we propose a more inclusive and readily operational approach. Making the goal of inclusion explicit is important so that we can start to measure the gap between an inclusive streetscape, and the status quo, in which many people are absent and unaccounted.

What do members of the public assume about new pedestrian and public transport infrastructure? Implicitly they may assume the design conforms to principles of best practice. Constraints in the physical environment, competing demands from road traffic, and compromises to meet constrained budgets require making concessions, which reduce any prospect of universal best design. Potentially, some planners may lack knowledge and understanding as to the nature of what is “best practice”.

Additionally, towns and cities across the world have a legacy of less than universally accessible infrastructure, particularly in terms of their extensive networks of footpaths and road crossings. To improve access so that more people can participate in our towns and cities, we need better ways to promote accessibility as an objective, so that new construction is more likely to be usable by as many people as possible. It is of fundamental importance to fairly prioritise upgrades to legacy infrastructure.

Notwithstanding recommended paths forward towards inclusion, there are two dangers to bear mind. First, policies to fix past failings are not the primary focus of inclusiveness and there is a danger that retrofitting becomes the way forward. There is no issue that improving accessibility may be good but it is not the beginning and the end of inclusiveness policy. Second, the unintended consequences are often much bigger than anticipated. In the mini case study below the examples are teased out further but suffice it to say that improving mobility for older people in an area may create an aged persons enclave, with declining maintenance of property, falling school rolls, and a great opportunity for either gangs or gentrification as a result of older people concentrating in this location.

Current context

In New Zealand, most nationally funded transport projects are prioritised according to three criteria: strategic fit (whether or not the project supports government objectives for land transport); effectiveness (whether the project will address the problem it sets out to address); and an economic benefit/cost appraisal. For better or worse, this assessment framework provides an objective approach for comparing

projects from different regions so that investment is prioritised toward continuous improvement for all road users. These criteria support the ranking of dozens of projects.

Usually, travel timesaving and road safety (with estimates of ‘value of a statistical life’ and assumed reductions in crash rate) form the majority of the monetised benefits. As a policy objective, accessibility (‘barrier-freedom’) is not typically valued as a standalone starting point for investment. Improvements to accessibility are usually funded through discretionary budgets or as part of safety or efficiency works. The benefits and costs of investment in barrier-free infrastructure, that is universally accessible, are not quantified. This may be because there is currently no accepted method to monetise the benefits of accessibility improvements. Budget fragmentation in respect of transport matters, interagency overlaps and lack of carry forward of funds does create uniquely poor outcomes.

An example of the struggle within transport economics to fairly compare access improvements relates to New Zealand’s Economic Evaluation Manual (NZTA 2016). Transport policy analysts and practitioners use this reference in appraising transport project benefits and costs for a consistent, objectively comparable methodology. This example discusses the issue of community severance, which happens when the traffic function of a road (typically a major arterial road) is elevated above any ‘place’ function inherent in the neighbouring land use. Severance makes crossing the road difficult; the community is ‘severed’ because it is not safe or convenient to participate in activities in segmented sections of the area:

Any areas affected by severance shall be identified, described and, if appropriate, mapped. The location of community facilities and the effects of the project on the accessibility of these facilities, particularly for pedestrians and cyclists shall be reported. Travel time changes for cyclists and pedestrians should be included with other road user costs in the economic evaluation.

Main crossing points shall be marked and the numbers of crossing movements indicated. In the case of projects, such as motorways, which create major barriers, their effects on overall community structures shall be reported. Where projects have incorporated features to reduce community severance, the incremental costs and benefits of these measures shall be reported. The benefits of reduced travel times, particularly for pedestrians and cyclists, and crash savings, shall be quantified to determine incremental BCRs of these factors. (NZTA 2016, p364)

This excerpt highlights two important points:

- 1) Issues such as accessibility and community severance are known to be related to transport; professionals try to incorporate them into decision-making; and
- 2) Measures to evaluate fairly the impacts of community severance and accessibility are not currently available; they can only be ‘reported’ in a qualitative manner, in conjunction with concrete analysis of more familiar indicators: in this case, monetised travel time and crash costs.

Because of a lack of economic methodology and no ready indicators to make trade-offs explicit, investment in accessibility and in particular pedestrian networks is prioritised based on ‘local knowledge’ using discretionary transport funds or as part of larger projects justified using economic appraisal for outcomes associated with safety or efficiency. For example, when a new school opens a discussion concerning road crossings within its catchment may occur at a meeting with improvements suggested. Consideration of benefits for pedestrians within larger infrastructure projects (for example redesign of a

signal-controlled intersection) progress with the scheme, according to the technical understanding of individual planners and designers involved.

At other times, the allocation of discretionary budgets for maintenance and minor works incorporates unsolicited or prompted feedback from local communities. While these processes usually result in incremental improvements to the overall network for all road users, there is no way of monitoring the investment's true effectiveness for all people, let alone the particular benefit to people who have a particular need for universally accessible environments, for example older persons, those identifying with disability, young children, and people encumbered with luggage.

Comparably little data about the number and nature of people and their mobility are used in transport project appraisal and investment decision-making, particularly when compared to the copious quantities of data collected about motor-vehicle traffic itself. Many cities and countries hold large databases of traffic volume data for each road link in their networks. They build and maintain complex models that use this data to predict traffic volume change for decades to come. Road traffic efficiency and safety objectives can readily trump 'accessibility' objectives in the absence of data about beneficiaries of this investment.

Despite best practice guidelines, the absence of data about people means that their needs cannot be transparently prioritised when trade-offs are made in new design. Furthermore, maintenance improvements that could result in accessibility improvements become ad-hoc, based on nebulous criteria. For example, footpath reseals may be scheduled to link with timelines for water infrastructure upgrades; the purpose of the footpath as a means for people to participate as pedestrians is not factored into any prioritisation calculation, so this investment is not necessarily targeted where needs of people are greatest. Consequently, outcomes of the process are that the social and health benefits to individuals and communities of accessible infrastructure are not explicitly considered. Invisible access problems, where infrastructure is not used because it is not accessible, remain unaddressed.

To summarise we contend that accessibility is an important objective in transport but it is difficult to measure, so it is typically not measured. This may be one reason why investment in accessible infrastructure for its own sake is relatively ad-hoc (Burdett, 2013) or justified using safety, for pedestrians and cyclists, etc., as the primary objective. The lack of effective, convenient and attributable ways to measure transport investment in accessibility also leads to reliance on best-practice standards. These act as a means to meet obligations under international conventions, such as the United Nations Convention on the Rights of Persons with Disability (United Nations, 2006). Application of these standards usually results in access improvements for new infrastructure and systems, but they do not help policy makers and other transport professionals prioritise areas of greatest need.

Approach

Measures of accessibility are essential to effectively prioritise universally accessible infrastructure. Beneficiaries of universal design ought to be included through measurement of their presence or absence. The purpose of this initial exploratory study is to suggest that people who use a visibly identifiable mobility aid can be counted as a proxy indicator of the potential and actual beneficiaries of investment in accessible transport infrastructure. Coupling observation with more refined census data in communities of interest will provide for more robust analyses.

There is no established and agreed way to even define beneficiaries of universal design, let alone measure their presence or absence. Considering beneficiaries as synonymous with a person identifying as having disability is common, which is a loose application of a widely used social model, defining

disability as ‘arising from the interaction of a person’s functional status with the physical, cultural, and policy environments.’

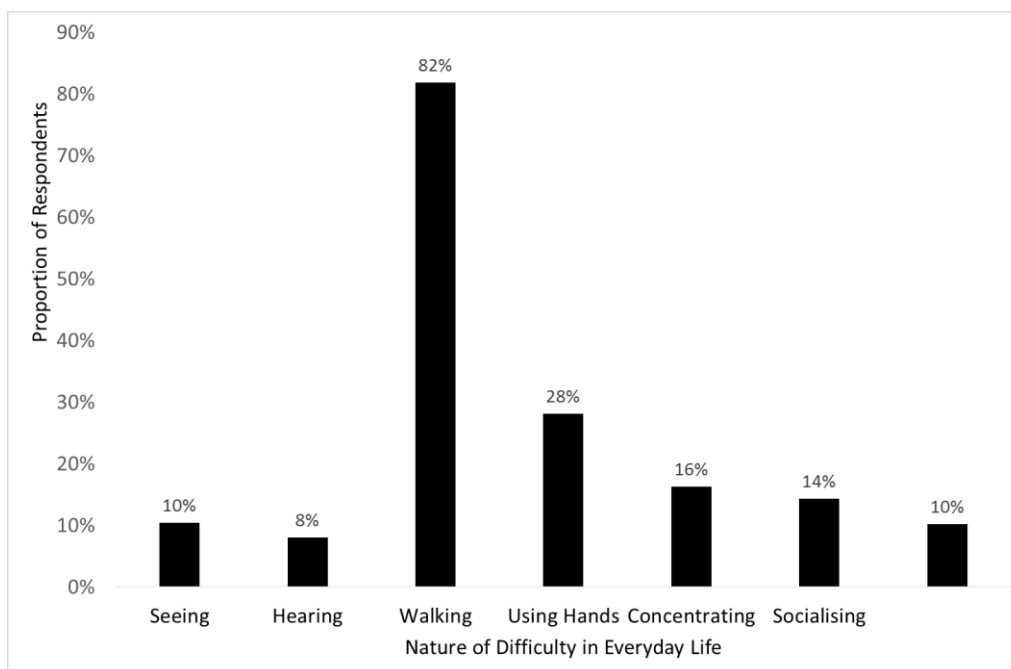
Many countries now use the ‘Washington Group Short Set’ questions to produce internationally comparable data about disability and its variation within a population. These questions include for example ‘Do you have difficulty seeing, even if wearing glasses?’ and ‘Do you have difficulty walking or climbing steps?’ (Madans, Loeb & Altman, 2011; Washington Group on Disability Statistics, 2009). Frye (2012) states that Census data such as the Washington Group Short Set responses are often too broad to be useful as a driver of policy change, and in any case there is too much lag between data collection and its publication for it to be a political lever. In some countries (including New Zealand), these data about disability are not disaggregated to anything less than national or regional level. Importantly, for this paper, lacking low-level spatial data about people and their diverse abilities means that local authorities who make transport investment decisions have no data at all about differences within their population; they cannot invest in accessibility improvements that would benefit particular groups with any confidence that the investment in that particular location is justified according to relative need.

Despite difficulties defining and measuring disability, given that arguably everyone is a beneficiary of universal design some of the time; that many factors influencing participation are invisible, such as mental illness or hearing difficulty, for example; if an observational measurement method is going to be used, then it must necessarily involve a proxy measure for ‘beneficiary of universal design’.

Almost by definition, people who use a mobility aid have more difficulty using transport as a means for participation than those who do not use any aid. Our previous research shows that there are differences for travel and in levels of participation by people who do and do not use mobility aids (Burdett, 2014).

More recently, we surveyed 2,952 New Zealanders about mobility aid use; their perceptions and use of different transport modes, and their participation in everyday activities. Our sample was intentionally biased towards people aged over 65 years ($n = 1,562$) and people identifying as having some disability ($n = 2,256$) so that we could instigate differences within these groups, and importantly, between them and younger people / those without disabilities. As well as asking about disability identity we included the Washington Group Short Set of Questions to understand any correlation between mobility aid use and general difficulty in everyday life. Figure 1 indicates responses to the types of disabilities respondents face.

Figure 1. Types of difficulties mentioned by survey respondents



As expected due to intentionally biased sampling, the data in Figure 1 show typically much higher proportions of people with stated difficulties than present in the New Zealand population. For example, approximately 4% of New Zealanders have difficulty seeing, and 13% have some mobility difficulty (Statistics New Zealand, 2013). The statistical analysis of these data, not reported at length in this paper, commences with conventional diagnostic checking, consideration of the distributional nature of the data and use of various parametric and nonparametric analyses involving univariate and multivariate methods. The data are available from the lead author on request.

Some salient points coming from the survey are that the types of disabilities faced by men and women differ very little, there is not a large difference between regions and not surprisingly, they do differ with age. The type of activities, for which mobility is desired, varies in a statistically significant way between, gender, region and age as does the type of transport used. In non-suburban areas in New Zealand, such as rural communities, there is no public transport and recreational facilities are less abundant.

The lack of universal inclusiveness is obvious, demonstrated by differences in participation between people with and without disability. This is a major contribution of the survey: robust statistical analyses confirmed what common sense might have conjectured. Additionally, it leads to clarity of some of the economic issues involved, which have not surfaced previously in the public policy debate. As an example, multivariate regression for the various forms of mobility assistance using the gender, disability form, age, region etc. provides clear indications of what is statistically significant.¹

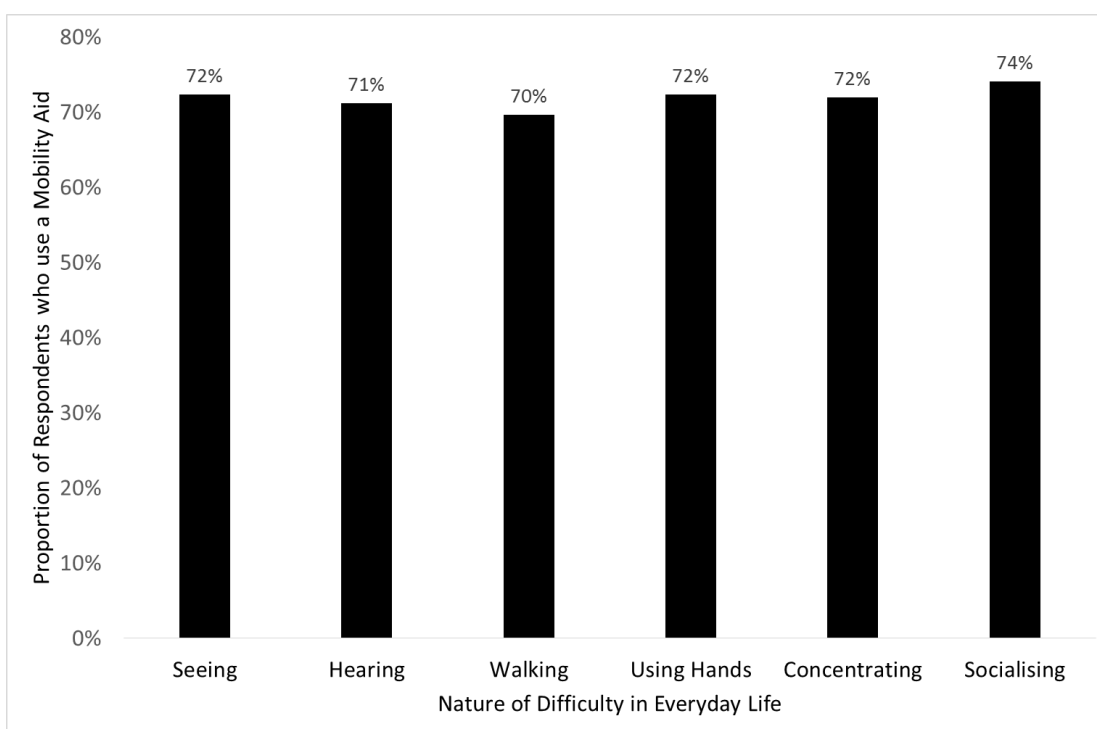
Perhaps most usefully for the current discussion are links found between mobility aid use, and all manner of difficulty in everyday life. Our data reveal that more than two thirds of people identifying with

¹ The initial study showed that regional differences between bus and train use were statistically significant and taxis while uniformly popular were less used where buses were available.

particular need across all of the ‘Washington Group Short Set’ questions also report using a mobility aid when traveling outside their home. That is, mobility aid use is not an indicator of mobility impairment alone, but may also be a useful indicator of general difficulty. Our data is biased by a high proportion of older age groups, and therefore a higher than typical proportion of people who have difficulty walking (in particular), and this may be reflected in respondents reporting multiple difficulties - however, as a visible indicator of human diversity, mobility aid presence or absence among participating populations could nonetheless be genuinely useful for professionals to understand whether or not environments (including transport systems) are inclusive in their design and operation. Figure 2 indicates responses to the question ‘Do you use a mobility aid [of any kind]’ according to peoples’ stated difficulty in everyday life.

There is a significant positive correlation found between mobility aid use, and some stated difficulty with everyday activity according to New Zealand’s adaptation of the Washington Group questions; $r(2952) = .32, p < .001$. Interestingly however, a person who uses a mobility aid is no less likely to travel at all on at least five days per week ($\chi^2(1, N = 2752) < .01, p = .999$); therefore their presence or absence at a particular location may be attributable to the relative accessibility of the transport infrastructure and the place, than to any inherent lack of motivation for travel.

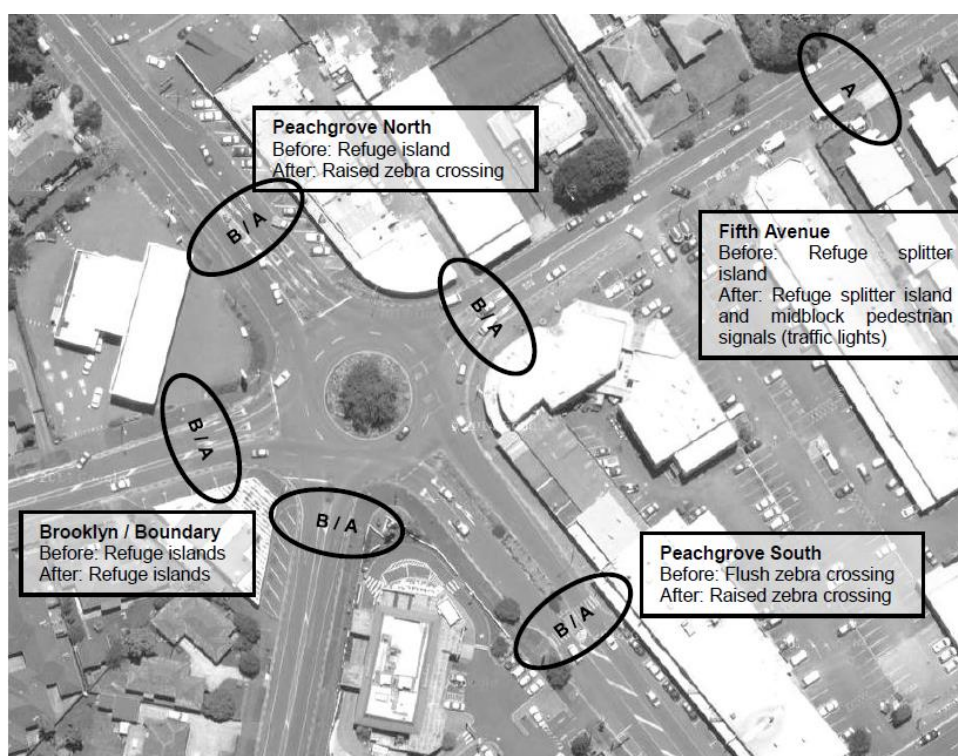
Figure 2. Proportion of respondents with different difficulties who use a mobility aid



Case study

A recent package of accessibility improvements to pedestrian infrastructure in an area of Hamilton (NZ), a city of approximately 140,000 people, in an area known as Five Cross Roads provides a useful context as a case study. The site is a suburban intersection within a low to medium-density residential area. Within 100m of the intersection of five approaches are dozens of shops, a medical centre, social service offices, cafes and restaurants. Figure 3 depicts the location, including changes made to road crossings.

Figure 3. Intersection (junction) detailing road crossing locations before (B; above) and after (A) improvement works.





Our study, which is for demonstration purposes only of the counting approach, examines what happens in terms of accessibility resulting from the new pedestrian infrastructure. Surveys of pedestrians using this suburban intersection before and after improvements to road crossings at the site assist in testing its usefulness. In particular, this involved counting people who use a mobility aid at the intersection, as a proxy indicator of the beneficiaries of investment in accessibility. The sample is small and accordingly no real statistically significant conclusions can be drawn. However, the indicators are in the anticipated direction.

Three primary research questions require answers:

1. Do more people use the formal road crossings after upgrading of the crossing to be more universally accessible?
2. Are people who use a mobility aid more likely to use a formal road crossing?
3. Do more people using mobility aids use the intersection post improvements?

Before the improvement works, the roundabout essentially provided one zebra crossing flush with the surrounding road surface (on the southeastern approach only), and one refuge crossing point per approach, within the splitter island that serves to provide deflection for on-road traffic entering and leaving the roundabout circle. Roundabouts are notoriously difficult for any pedestrians to cross, particularly without any more than splitter island refuge points (Schroeder, Roupail & Hughes, 2008).

Table 1. Pedestrian traffic before and after infrastructure upgrade

Approach (Clockwise from Peachgrove Road North)	Before			After		
	Crossing type	Number using crossing	Number crossing informally	Crossing type	Number using crossing	Number crossing in- formally
Approach road						
Peachgrove Road North	Refuge island	60 (1)	53 (1)	Raised zebra crossing	116 (4)	23 (0)
Fifth Avenue	Refuge island	84 (0)	325 (5)	Refuge island + signalised crossing	91 (4)	314 (7)
Pachgrove Road South	Flush zebra crossing	113 (5)	45 (0)	Raised zebra crossing	142 (8)	13 (0)
Brooklyn Road	Refuge island	39 (4)	5 (0)	Refuge island	49 (4)	21 (1)
Boundary Road	Refuge island	24 (1)	27 (0)	Refuge island	48 (1)	59 (1)
Total per approach		320 (11)	455 (6)		446 (21)	430 (9)
Total overall		775 (17)			876 (30)	

Note: Numbers in brackets represent number of people using a mobility aid

The improvements include two raised tables with zebra crossings, to provide safe and accessible crossing points on Peachgrove Road north and south, as well as a signalised crossing northeast of the intersection on Fifth Avenue. Provision of tactile ground surface indicators for people with visual impairment is in place on most crossings. No major changes were made to crossing points on Boundary or Brooklyn Roads. These design decisions were made using discretionary budget in the absence of any explicit analysis of the likely benefits for people of this investment.

Pedestrians crossing the road on each approach to the intersection were counted for four hours in April 2014 before improvements were made, and for four hours in February 2015 after changes were constructed. Counts were conducted on a Wednesday in each case, from 8am – 10am, and 2pm-4pm. Count data are summarised in Table 1, including the number of people crossing each road; whether or not they used a formal crossing or crossed the road informally i.e. jaywalked and the number of people using a mobility aid in each case.

Results were analysed to answer each of the research questions as follows. All statistical tests were analysed using Chi-squared tests of independence with 2x2 contingency tables and a 5% significance level.

1. Did more people use the formal road crossings after crossings were made more universally accessible?

Yes: before improvements were made, 320 out of 775 people (41%) used formal crossings. After the improvements, 446 out of 876 (51%) used formal crossings. This change in proportion from 41% to 51% was statistically significant ($\chi^2(1, N = 1651) = 15.31, p < 0.001$).

2. Were people who use a mobility aid more likely to use a formal road crossing?

Yes: of 47 people using mobility aids overall across both count sessions, 32 (68%) crossed at a formal crossing, with 15 crossing informally. Of 1604 people without a mobility aid, 734 (46%) crossed at a formal crossing. This difference was significant ($\chi^2(1, N = 1604) = 9.15, p = .002$).

3. Did more people using mobility aids use the intersection after improvements were made?

Yes: 17 people using mobility aids were counted before improvements were made compared with 30 after, an increase of 76%. However, compared to the overall growth in people counted at the intersection after improvements were made (an increase of 12%, from 758 to 846), this increase in the counted numbers of mobility aid users was not statistically significant ($\chi^2(1, N = 1604) = 2.25, p = .133$).

The main advantage of using an indicator population such as mobility aid users is that planners can estimate the opportunity cost of trips not made. This is because a desirable or target proportion of mobility aid use, based on analysis of catchment demographics, can be used to estimate the number of people not counted. These differences in proportions of people using a mobility aid between different locations are useful to infer gaps in accessibility, so long as mobility aid use in the catchment populations are similar.

Data about mobility aid use in different geographic areas are not collected in New Zealand, but rates can be estimated based on known rates of use according to age and gender profiles. Using this method (available from the authors on request), it is estimated that mobility aid use by people living in New Zealand typically varies between 1% and 4% of any catchment population, with older populations showing the highest rates. These data can then be compared to proportions of transport users observed 'on the street' in different situations.

The key learning that comes from this observation is that without data questions cannot be answered and typically they do not get asked. Counting mobility aid users is only one method available to transport planners to improve equity in prioritising new investment. It is useful because it is a more direct indicator of participation than more technical measures of accessibility, or walkability, that combine various details such as pavement quality (width, crossfall, smoothness etc.), aesthetic components (such as the presence of greenery) and security measures (such as lighting). These measures, while useful to monitor asset performance or maintenance requirements, provide no direct indication of the value of the infrastructure for the intended beneficiaries.

Discussion

The results of this study show that counting people using the transport system, and including the proportion who use mobility aids as a subset, can provide information about inequity of access,

particularly when compared to underlying proportions of people living in a community of interest. Where the proportion of people using a mobility aid is significantly different on different crossing points at an intersection such information can inform future investment for accessible infrastructure.

There are at least two further important aspects worthy of consideration:

1. Why did the person using a mobility aid cross the road, and
2. If they crossed the road, then so what?

In the context of our mini case study we know more people using mobility aids did cross the road once an impediment of unsafe crossing opportunities were removed and they were placed on a more equitable plane with other citizens. However, there is no apparent increase in their opportunities to jaywalk. Were the users of the crossing going shopping, attending medical appointments, socialising for coffee with others, attending a card afternoon at the social club, or purchasing a flagon of wine to drink in the park? In some instances, there are clear shadow prices, which are available as proxies in the estimation of value. If carers no longer need to go for shopping then their time-saving is of value in a market where there are not enough carers. Social engagements keep the spirits up and may improve the quality of life and reduce the need for medication. Playing scrabble or cards may assist with reducing loneliness and depression salon keep the mind a little sharper to postpone or ward off dementia. These have value. Drinking to excess with buddies or by oneself has negative benefits.

Having crossed the road, access to shops and other venues may still be a challenge. Once in the shop, is it feasible for everyone to navigate freely along the aisle, between displays and select items from a shelf? Having crossed one road to visit the pharmacy is it possible to get across the next street should it be necessary? There is little advantage in improving accessibility at one juncture if it not adequate to serve the needs of those in search of particular products or services.

If we ease access in one area, do we attract people who need accessibility to the area? When new schools are built or have excellent reputations people move into the zone, or rent a mailbox in zone, in order to be able to enrol their children at this top school. So we might expect if we build one accessible area in a city then we create a park for people with disabilities. Over time does this become a ghetto, or are the benefits to all people of more inclusive design enough to attract a broad spectrum of residents? One of the consequences of selective interventions is that people move to take advantage of short-term opportunities but the longer-term produces quite adverse outcomes.

What of those who did not cross the road?

A crossing suitable for all is desirable but there are many who cannot get to the crossing. Most obviously, they may not know of its existence and so the lack of signals has an economic cost. Physical barriers are likely to imprison people with disabilities and reduce their social engagement. If footpaths are not suitable and constructed appropriately then some people cannot get to the crossing. If ground floor dwellings have steps for access and egress then these are as good as iron bars around the dwelling for many.

As most dwellings in city regions now have access to ultrafast broadband, and 97% of the country is covered by 3G or 4G mobile it is possible that shopping online, chatting online, medical prescriptions online, kindle for books, and interactive exercise games on UHD television monitors means the prisoners/ persons with disability no longer need to leave the property. It may result in recluses who live and die alone.

The majority of dwellings and businesses carry numbers on the front, e.g. 22 so we know the bungalow is 22 Arthur St. Of course, this assumes we know it is Arthur St and can read the 22. In New Zealand, domestic pets are chipped and livestock similarly have an identifying signal under a scheme called NAIT. Traceability is important for agriculture produce and government takes this seriously. School education is compulsory through to age 17 and at the end of this most people can read and count. For those with disabilities do we consider the use of numbering properties with identifying chips? Compulsory identification of property addresses in an appropriate form may well be another component of future inclusive communities.

As noted above there are sources of data such as access to internet. However, breakdown of demographic information to small units is not general available. In the case of Five Cross Roads, the number of people identifying as having disability is not readily available to those who see their responsibilities as encompassing promoting accessibility.

The economic model

The conceptual analysis of “inclusive” development requires translating into empirical analysis if it is to be useful in informing public investment decisions. This analysis starts using traditional approaches to benefit cost analysis adjusted to incorporate adequately non-market values as presented in standard text such as Freeman (1993).

To estimate the economic net benefit of the intersection upgrade considered above we estimate the value of additional trips undertaken post the investment relative to the number prior to the investment. Here we refer to trips by people with disabilities, as estimated using our proxy measure of mobility aid use.

The Net Present value of the investment is $\sum (\text{Net Benefits}) / (1+r)^n$ where r is the discount rate and n = the number of time periods considered.

The gross benefits are estimated as the sum of [(additional trips by people using mobility aids * the value per trip) + (additional trips by people not using mobility aids * the value per trip)]

The net benefits are the gross benefits less both the initial capital investment costs and additional annual costs.

Estimation of the gross benefits requires careful attention to the number of trips and who takes them. For this paper, estimating the number of annual trips is for two categories of people – those who do and do not use a mobility aid. More sophisticated analyses for larger projects would estimate trip numbers for multiple categories of people, including for example those encumbered with luggage or caring for small children; those with difficulties that are not visible, such as deafness or mental illness; and those people who always travel with a carer or assistant.

Given that trip numbers are estimated by surveys of people movements for a limited number of hours in a day or week it is important to be careful in the translation of trips in a 4 hour window to annual data which incorporates weekend and week days in all seasons of the year. The specific value for the

trips depends on who is taking the trip and for what purpose. Trips will have different values pertaining to their purpose such as work or education; meeting basic needs as in shopping or visiting medical facilities or for other purposes such as travel for leisure and recreational purposes. Estimates of these values is achievable through undertaking choice experiments such as those made popular by Hensher et al (2012). Given no choice modelling this paper drew on earlier approaches to estimating benefits as described and utilised by Hufschmidt et al. (1983) that provided mechanisms for benefit estimation based on costs associated with alternative mechanisms for achieving the benefits.

For the Five Cross Roads case benefits are estimated conservatively as being \$10 per trip (a minimal taxi fare) for people who use a mobility aid. For people without a mobility aid the benefit was assumed to be only 20% of that given they are more likely to have other opportunities for travel. The benefits for people with mobility aids are expected to grow at 1% per annum given projected demographic change while benefits for people without were held constant.

For the Five Cross Roads case, the investment is assumed to have resulted in extra trips. An estimate of the initial investment is NZ\$400,000 and this analysis assumes an additional NZ\$20,000 per annum of maintenance costs beyond what would have occurred in its absence.

These assumptions form the basis of reporting the estimated benefits in Table 2.

Table 2. **Preliminary estimates of benefits from Five Cross Roads investment**

Increase in person with mobility aids trips per year	147%
Increase in person without mobility aids trips per year	12%
Increase in trips by people with mobility aids	8,475
Increase in trips by people without mobility aids	62,856
NPV of investment	NZ\$1.27m
IRR of investment	48%

Sensitivity analysis

Clearly, the results are very sensitive to assumptions. It is feasible to utilise a range of estimates for key variables such as estimated number of trips, estimated value of trips, interest rates, and costs.

The purpose of this example is to assert it is feasible to produce economic estimates that are plausible and that can be refined as further data are collected and analysis undertaken.

Conclusions

As accessibility (barrier-freedom) is adopted as an important policy objective in transport, we need a means to estimate the gap between what is currently provided, and what we want the transport system to look like. To demonstrate inclusion, we need to start with an understanding of who we are not

including and to what extent this is attributable to investment in more or different transport infrastructures.

Central to this paper is the issue of awareness of accessibility among professionals who plan for and design our built environments. This includes new infrastructure, but importantly it also includes the extensive upgrades required to bring our towns and cities up to universally accessible standards. As well as site-specific implications, data about people who use mobility aids generally can help to improve understanding of accessibility among transport industry practitioners. The accessibility of different types of crossings is measurable according to actual use, and differences in footpath use and are then compared based on factors such as path width, grade, crossfall and quality.

Counting users of mobility aids as a subset of all users of transport provides a means to make links between transport outcomes, social wellbeing and public health. Central to its uptake and effectiveness is a high-level directive, so that the transport industry begins to measure accessibility as part of its decision making process. Without indicators of accessibility in transport, social and health objectives relating to active and independent participation have no means of being realised. As noted by Rickert (2005), “The recent emphasis on inclusive transport occupies an intersection between the interests of urban infrastructure workers and social development workers. These two groups understandably look at indicators and performance measures from different perspectives.” (p13). Currently in New Zealand, government priorities for transport are dominated by traffic efficiency and general road safety, which is itself biased towards car crashes because of inherent under-reporting rates of incidents involving pedestrians. The importance of accessibility for non-transport outcomes (aside from economic development) is largely ignored.

The proxy measure of people who use mobility aids is an indicator of relative accessibility, and not a means of capturing all potential beneficiaries of best-practice transport systems and infrastructure. Counting mobility aid users to infer costs of trips not made provides a method to link transport and social objectives at a high level. It also enables universal design decisions to be prioritised with an objective assessment of relative costs and benefits. The benefits of universal design are relevant for all people. These outcomes are becoming increasingly evident with population ageing. The number of New Zealanders aged over 65 years was 12% in 2006 and is projected to increase to 21% by 2031. This means that users of mobility aids will increase as a proportion of all New Zealanders.

As well as providing information for road controlling authorities and private interests at particular locations, walking data as a whole can build to provide a detailed picture about variation in access to the transport system. Given that transport exists to support peoples’ active participation in life, this data has potential to provide a strong link between transport objectives, and social and economic outcomes.

It is important that planners, policy makers, investment managers and disability advocates invest more effort in refining economic valuation models that can enhance the evidence gained from survey data concerning individual travel choices.

Implications for transport planning and practice in New Zealand

Our findings show that counting mobility aid users is an authentic and practical way to build economic models to prioritise accessible transport. It is recommended that while the industry continues to advance ‘best practice’ in terms of accessible built environments, issues of inclusive access for all people should be tackled through cross-sector initiatives at local, regional and national levels. Involvement by health, social service, transport and non-government sectors (including community

groups and advocates) is encouraged, to deliver real change so that every New Zealander can live a meaningful life.

The model detail could be easily and readily incorporated into process manuals and software New Zealand transportation professionals use to appraise transport project benefits and costs. However, the central issue is not whether the model could be used, but how to foster a cultural shift within the transportation and other sectors so that the information is sought and the right questions asked. Specific recommendations to build this economic model and its premises into local, regional and national professional transportation practice are as follows.

Transport funding in New Zealand is prioritised based on ‘strategic fit’ which links funding activity classes with government priorities for transport. The current government priorities for ‘high strategic fit’ are based on reducing congestion to support economic development directly, and reducing the incidence and severity of crashes. This research demonstrates that at a national level, there are economic benefits linked to healthy participation, supported by accessible transportation networks. An ability to demonstrate high ‘strategic fit’ supporting investment across different ministerial portfolios is a high-level recommendation. In this way, a transport activity class supporting investment in accessible transport could be justified with high health strategic fit. Therefore, this work can be used to bridge different sectors, particularly where the outcome benefit (for example, health and social development) is in a different sector from that investing (for example, transport).

At a regional level, evidence about inequity of participation could be used to inform Regional Land Transport Plans, and as a tool in development of Regional Public Transport Plans to identify areas of relative disadvantage. The model could be adapted to provide regional indicators of participation and absence of people from society. With refining, the model could be used in a predictive way so that changes to population structures over time (most urgently with issues of ageing populations) can be incorporated and accessible transport funding prioritised.

Locally, City and District authorities can use these findings to investigate inequity within their own communities according to community demographics. It is recommended that City and District Councils work with local disability sector representatives (and their own Community Development teams) in the short-term to provide their own local data about areas of greatest need. It is also recommended that street accessibility audits be used to prioritise maintenance spending to remove built environment barriers. Trained auditors can identify details such as kerb cut locations and suitability, and footpath conditions compared to best practice, and then provide councils with a prioritised list for routine improvements.

Over time, the importance of accessibility as a policy objective in transport may grow such that specific training is warranted. In road safety, for example, we have extensive training courses and separate groups within our national agencies developing road safety-specific policy. This “Safe System” approach could be readily adapted to address accessibility, where transport professionals could work with health, community and social sectors to improve participation outcomes. Clearly this level of investment would require changing political approaches. However, the ageing population and diversity of access to a traditional independent motor vehicle-based transportation may necessitate such changes to thinking in coming years.

Limitations and unintended consequences

The survey data reveal taxis are a preferred form of transport for those with disabilities. The provision of taxis promotes accessibility to shopping, employment, accessing community and health services and many more components of life. While this may appear desirable, it may lower the degree of

exercise obtained. If taxis are not available to travel to a community centre for recreational activities (ranging from wheelchair basketball to book clubs), those conditioned to taxi use may just choose not to participate.

The unintended consequences of public policy are plentiful when it comes to accessibility. Economists often refer to Adverse Selection and Moral Hazard as two forms of market failure typically resulting from public policy. Two examples of unintended outcomes provide illustrations. For several years there has been support for a programme of expanding the use of internet facilities by the aged, known in New Zealand as Senior Net. This encourages emailing, online banking, online shopping, social media, and even self-diagnosis of medical conditions. The unintended consequence is promotion of house boundedness and less exercise, contributing towards increased prevalence of obesity and conditions such as diabetes.

A second example is the greater availability and use of mobility scooters. As kerbs are improved, more mobility scooters use the footpaths, especially around shopping centres. Scooters and pedestrians are not necessarily highly compatible and definitely, the synergy effect with teenagers on skateboards is not apparent.

The main limitations of this approach are data collection costs, and meaningful interpretation of findings. Manual pedestrian counts are relatively expensive compared to not collecting any data. However, the data presented in this paper shows that there is benefit from even a one-off count of four hours at a site of interest. Compared to the investment in data about motorised traffic, the cost is relatively low. Interpretation of this data relies on understanding of community demographics. This information is not always collected as part of transportation assessments, so requires a new approach.

The big limitation is mindset and associated capacity building among professionals as well as advocates for individual groups of need. The physical environment and social environment are not separate spaces. To move forward professionals need to embrace the social outcomes of inclusiveness, diversity and sustainability. Engineers' participation is pivotal to building an inclusive society. Can they step up to the challenge, or do they necessarily need more enforcement of specific pieces of legislation or a new level of social planner to supervise them?

Advocates for individuals with particular needs have long approached issues of inclusiveness as a basic human right. While this is understandable, the problem is perhaps best addressed by working in genuine collaboration with the professionals who do their utmost to build a better world. Mutual understanding between advocates and professionals is essential, so that engineers and planners have a mandate to ask different questions and seek different data; and so that advocates can build effective relationships with those whose assistance they seek.

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