

Transit Oriented Development – making it happen

Conference paper submission

Paper title:

Rating the Transport Sustainability of Transit Oriented Developments: will developments achieve objectives?

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Abstract:

Transit oriented developments (TODs), be they greenfields developments, in-fill or redevelopments of existing sites, have been included as a key component within a number of recent metropolitan strategies within Australia, including the South East Queensland regional plan. Responding to increasingly extended journeys-to-work and other trip movements, TODs are one land use planning intervention that creates the potential for populations to make shorter journeys and to make mode shifts away from the private motor car and towards walking, cycling and public transport. Whether TODs are led by private developers, development corporations or other entities, the majority will involve the design of a comprehensive structure plan to coordinate development of the site. The skill of designers and planners will ultimately determine how conducive to sustainable travel behaviour the end result is likely to be.

Unfortunately, not all TOD designs will generate the desired outcomes and not all opportunities for travel behaviour improvements may be captured – reducing the effectiveness of the overall planning strategy. For instance, while there may be increased opportunities to reach line-haul public transport for longer trip purposes, designs could actually create less sustainable behaviours for other trip purposes, such as journeys to and from school or to and from local shopping. Part of the problem is that no decision-support tools are readily available to establish whether a specific TOD proposal actually provides the capacity for an improved mode share for sustainable modes, or for decreased journey lengths across a range of trip purposes.

The paper suggests a way forward for the development of a diagnostic tool that can assist TOD developers and decision-makers to quickly assess the potential of developments and the likely travel behaviour produced by their design.

Introduction

This paper relates to a project that is seeking to develop a diagnostic tool to rate the residential travel performance of land use developments, such as transit-oriented developments (TODs). The project aims to measure the extent of travel made and the modes of travel used by residential populations and, with the assistance of accessibility analysis techniques, to use this information as a means to rate the effect of a development's location and design on residential travel. This work is being undertaken to assist in influencing the location and design of urban development to ensure that their residential travel patterns contribute to sustainability objectives. As a form of shorthand we will refer in this paper to this project as rating a development's 'residential travel performance' for sustainability.

Critical to this task is a framework that isolates two specific issues relating to local area planning interventions, such as TODs, in terms of transport and land use planning relationships. Firstly, the *location* (or siting) of a large-scale development in relation to other elements of the urban area, such as shopping or employment centres, is known to influence travel patterns, particularly for trips such as journeys to work (Horner 2004:163-165). Secondly, the *design* of a development, including such matters as density, land use mixing and connectivity, is now generally understood to influence travel patterns, especially for local trips such as journeys to shops or to schools (Ewing and Cervero 2002). By altering either location or design choices it may be possible to increase the opportunities that future populations will have to access the goods and services they need.

Planning interventions to achieve better travel performance

TOD is a development form that seeks to use (primarily) the location of future development to influence regional travel behaviour. Neo-traditional development and the New Urbanist movement seek to alter the design of development. Both approaches have been incorporated as key land use planning interventions within a number of recent Australian metropolitan strategies, including *Melbourne 2030* and the *Draft South East Queensland Regional Plan* (Department of Infrastructure 2002:8; Office of Urban Management 2004:38-39).

Planning for changes to the built environment, such as via TOD, is a slow and indirect means to achieve change, but is proving more politically acceptable and achievable than even moderate taxation or charging schemes to discourage profligate road use. However, planning interventions for better travel behaviour have additional benefits in that they closely align with the growing field of environmental and policy interventions to increase physical activity levels in the population to improve community health. Conventional suburban development is being regarded as impacting on the potential for both adults and children to achieve required physical activity levels - primarily through reducing the potential of the walking mode for both recreational and destination-based trips (Committee on Physical Activity Health Transportation and Land Use 2005; Frank and Engelke 2001; French, Story and Jeffrey 2001).

Planning interventions to improve travel performance generally encompass a range of measures including encouraging employment and residential densification around public transport nodes, increasing street connectivity, reducing the length and number

of cul-de-sacs, and increasing land use mixing (see Cervero 2002; Dock and Swenson 2004; Greenwald 2003). All of these measures seek to increase the general accessibility of individuals, that is, their access via the transport system to the set of activities they may wish to participate in. Yet there are a number of problems emergent within this area including issues of inconclusive research findings into transport and land use relationships and the difficulties for designers and planners in identifying the potential and likely performance of specific designs in terms of residential travel performance.

Supporting empirical evidence

Firstly, the evidence that 'traditional' or transit-oriented layouts will outperform conventional suburbia in terms of key transport sustainability indicators has not always been supportive, though there is now general acceptance that they do offer at the very least the potential for reductions in vehicle kilometres travelled (VKT) and energy consumption, and that they offer decreases in the mode share of the motor vehicle. Partly these issues relate to the limitations of previous studies into transport and land use relationships. These have often featured significant theoretical limitations, such as the lack of a strong behavioral foundation in formulating hypotheses, and have also featured empirical limitations in their research designs and data collection methodologies (Rodriguez and Joo 2004:152). The problem of possible 'residential self-selection', where households with persons who prefer travel by particular modes make lifestyle-based decisions to reside in locations supportive of these modes, has proven difficult to overcome (Khattack and Rodriguez 2005:481). So has the issue of urban design and its relationship with short trips within activity centres - which tend to be under-reported in the travel diary surveys that generally underpin this type of research (Ewing and Cervero 2002:88,102).

Neither is the research yet clear as to exactly which land use planning interventions are most effective for delivering increased walking and cycling activity, or what neighbourhood design features governments should be demanding from developers or re-inserting back into existing urban areas. Few studies capable of demonstrating a causal relationship between physical activity and the built environment have as yet been conducted, and those that have reported findings tend to feature a similar set of theoretical and empirical limitations to those noted above. However, there is consensus about certain relationships, i.e. that the provision of parks and trail networks generally encourages walking for exercise; whilst the provision of footpaths and development of mixed-use nodes within urban areas generally encourages walking for more utilitarian purposes (Committee on Physical Activity Health Transportation and Land Use 2005). The recent realisation of the health professions of the importance of these relationships is leading to a burgeoning research effort in this area, with a number of studies now funded in Europe, North America and Australia (i.e. British Heart Foundation Health Promotion Research Group 2005; University of North Carolina at Chapel Hill Center for Environmental Health and Susceptibility 2005; University of Queensland Cancer Prevention Research Centre 2004; University of Western Australia School of Population Health 2005).

Relating to the limitations of the research base, designers and planning authorities have considerable difficulty in determining whether a proposed development's design really does provide the potential to provide for increased public transport trip making, walking and cycling by its residents and other users. For instance, while it may appear

obvious that densification around a public transport node should lead to changes in behaviour, relationships between that transport node, its service levels, the composition of the population and the location of surrounding land uses may all influence residential travel performance in ways unexpected.

The planning problem

An examination of current planning scrutiny of major development proposals for master-planned communities illustrates how little oversight of residential travel performance is occurring. A planner's role in overviewing transport issues within end-game development approval processes often comes down to little more than the traffic impact analyses conducted by engineers. These primarily assess developments to ensure that streets and access points do not impede motor vehicle movements within or outside the development, and ensure sufficient on-site parking is provided for motor vehicles. Where appropriate, these processes now also generally cover matters such as noise and visual disturbance, run-off and other immediate environmental concerns (i.e. see Main Roads 2000).

But there is little meaningful assessment made of the likely extent and mix of travel that will result due to a development. Despite the availability of New Urbanist design guidelines such as Western Australia's *Liveable Neighbourhoods* and Queensland's *Shaping Up* (Queensland Transport 1999; Western Australian Planning Commission 2000) there is no process or tool to determine the potential or the likely travel behaviour that may result. Thus, the majority of developments - however large - receive minimal scrutiny in terms of their residential travel performance. And opportunities to improve that performance may be lost.

The planning problem also involves the typical environment in which studies are prepared and planning decisions are made. This includes restricted budgets, limited timeframes, and few resources in local governments to carry out studies. Developers deplore methods that raise their costs excessively or delay planning decisions, yet are not averse to processes that increase certainty. And public authorities require methods that are scientifically defensible, of high quality, and useful in their decision-making processes (and hopefully are useful in strategic planning and policy-making too). Researchers should seek to advance qualitative prediction and assessment techniques that will provide information that can improve decisions made on issues such as residential travel behaviour (Devuyst 2001:149).

Advances in accessibility modelling

Recent advances in geographic information systems (GIS) applications and the development of geo-coded datasets of land use, travel and population related information have allowed for researchers to make considerable ground in the development of accessibility assessments. Advanced spatial analysis techniques are now available that can manipulate, arrange and investigate transport network, land use and travel data in order to identify areas with high or low accessibility - however 'accessibility' is conceptualised by those conducting the research. These advances open the way for the development of a specific application to allow for the rating of developments in terms of residential travel performance. However, such a tool needs to fit strategically within contemporary development processes in order for it to be taken on by target users.

Development processes

The developments of interest to the research are generally multiple lot, strategically planned developments such as 'master planned communities' and TODs. These differ from traditional ad-hoc subdivisions in that a broader range of planning elements may be considered in their planning and design, including matters such as community facilities, landscaping, pedestrian and vehicular traffic, and the nature, form and location of buildings. The process by which these developments of interest are planned and designed generally ensures such matters are considered simultaneously in a more integrated and comprehensive manner and developers have significantly more flexibility in how they approach environmental concerns (Blair et al. 2004).

Developers therefore have the capacity to work within guidelines or to work with specific tools to alter proposals to meet desired objectives.

Whatever entity undertakes the necessary planning and design, or brings the development to market, any master planned community or TOD will invariably require a coordinated *structure plan* that provides clear directions as to the location of the critical infrastructure, services and development patterns within the site, as well as the linkages to the surrounding area. Such plans guide the future development of the site into the long term and, must generally be approved by local and state authorities prior to development proceeding.

Structure plans normally provide information on the number of dwellings proposed for each lot within the development. And they also provide detail on the proposed location of key services, including fixed public transport sites. The information contained within and developed as part of a structure plan, including road network and land use information, may well be sufficient to provide a rating for the proposal in terms of residential travel performance - if this information can be entered, manipulated and modelled appropriately.

How could the task be approached?

The following section explores how a rating tool could be developed, drawing together the concepts of origin-based accessibility analysis, the use of multiple accessibility indices and the construction of a viable rating scheme.

Origin-based transport and land use accessibility

Perhaps the most promising area of inquiry in terms of the development of a tool is in the series of research studies that have investigated what may be termed origin-based accessibility. Whereas destination-based accessibility focuses on accessibility *of* services such as shops, workplaces or schools, origin-based accessibility focuses on the accessibility of households *to* these services. This is based on the core concept that accessibility is a function of opportunity and deterrence (usually travel times and costs). Therefore origin-based accessibility analysis requires methods to measure the distances from origins to services via the transport network and also mathematical functions that define accessibility in terms of opportunity and deterrence.

Two distinct approaches have been used in developing origin-based accessibility indices of this kind, each differing in how they conceptualise the transport system. The first approach - as used within the Metropolitan Accessibility/Remoteness Index

of Australia (Metro-ARIA) developed by GISCA at the University of Adelaide¹ - treats public transport infrastructure solely as a service or opportunity. As such, the only interest of analysis is in determining accessibility of population groups to public transport services - often using catchments of, say, 400m to a bus stop and 800m to a line-haul public transport stop. Analyses of this sort generally rely on spatial land use data along with the street and path network as key inputs applied via relatively simple (though transparent) models. This limits the outputs of analysis to more rudimentary applications though accessibility surfaces, indices and ratings may be computed using this method. In particular, such approaches may be limited in terms of the calculation of journeys to work, which tend to be longer and more complex than for other trip purposes.

The second approach treats public transport infrastructures and services as an essential part of a population's means to access other services such as education, health or employment. This more complex approach leads to analyses that consider the accessibility of population groups to other services via the transport system, including via public transport. Models of this sort tend to use both spatial land use data and household travel survey data, employ more complex modelling techniques including travel demand modelling and modal assignment modelling, and provide more detailed (though generally less transparent) outputs. This includes the capacity to provide a forecast of the 'likely' travel behaviour of a proposed development, which cannot be produced using the earlier method. It is this latter approach that we are seeking to utilise.

Development of an accessibility index and rating scheme

There are a number of options for the construction of accessibility indices and for the eventual development of a rating tool for residential travel performance. But it is hoped that our research will also provide ways to identify the deficiencies of a particular design and allow others to model modifications to the design of development proposals in order to improve performance.

First, our aim is to create a logical system for the calculation of accessibility indices for developments. One option is to take an aggregation of test results (each test consisting of, say, a model run for a particular population group, time of day, trip purpose and mobility status) to create an accessibility score or rating for each lot within a development. As dwellings may be ascribed to lots, so an accessibility score may be assigned to every dwelling within the development proposal. Users could then identify whether all the dwellings within the proposal meet a specified minimum accessibility standard, or perhaps identify what percentage of dwellings meet a particular accessibility standard. A rating could then be applied to the development as a whole that is comparable across developments and across geographic locations. Fig. 1 suggests how this conceptual model could be applied.

¹ See <http://www.gisca.adelaide.edu.au/>

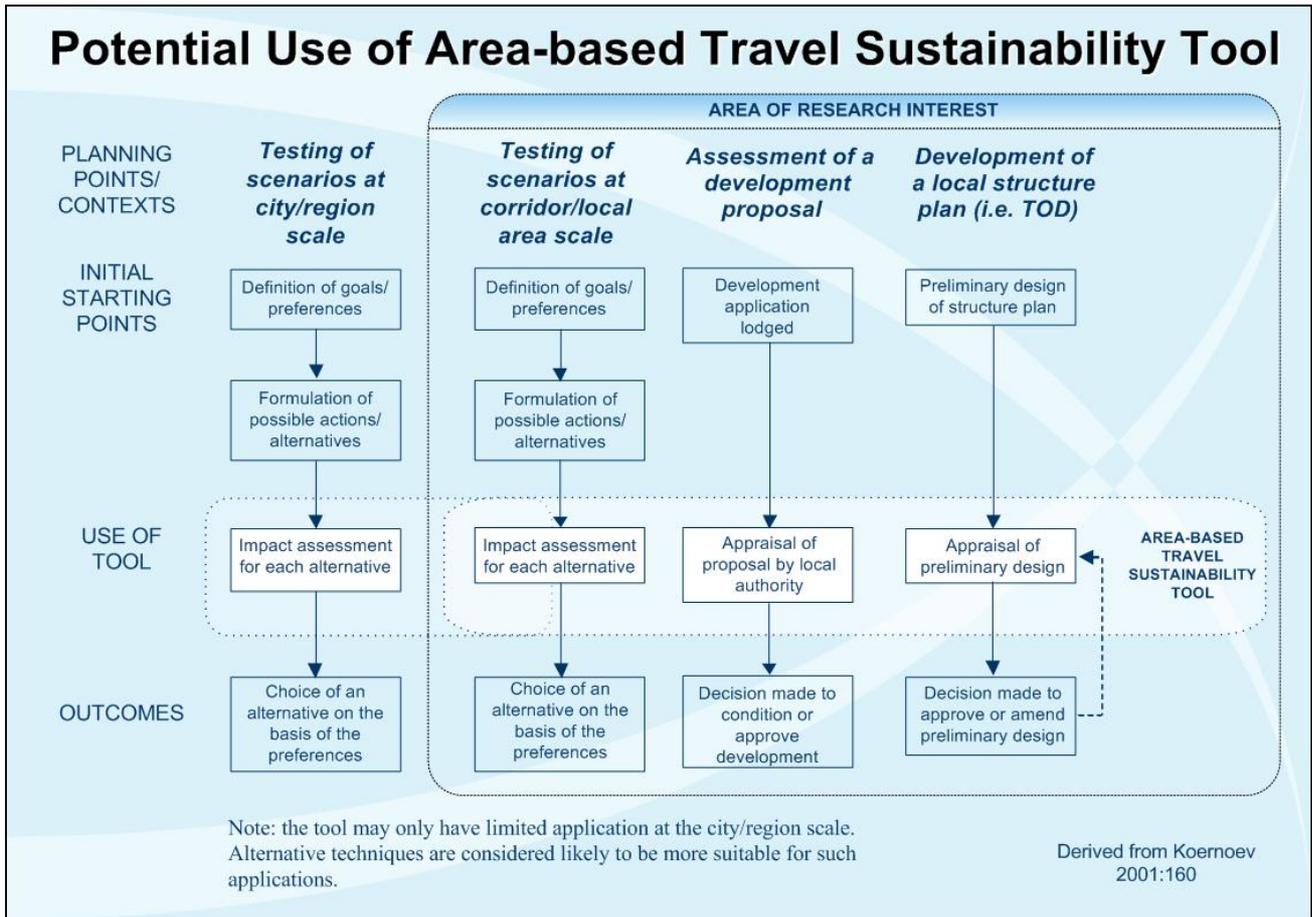


Figure 1. Potential use of decision-making tool

Secondly, it would be particularly advantageous to be able to identify the key weaknesses in a design's predicted travel performance. To achieve this, the results from the accessibility analysis need to be disaggregated to a level that allows for the user to identify the strengths and weaknesses of the proposal in terms of the different trip purposes that are included within the testing. In this way, if a proposal performs especially poorly in terms of, say, journeys to school, this could be identified, raising awareness of travel sustainability outcomes across a range of trip purposes.

An important distinction can be made between a development's likely performance in terms of its energy consumption (or greenhouse gas production) versus its potential to generate health benefits given its capacity to stimulate local trip-making by walking and cycling. For instance, a TOD development that encourages a significant share of journey to work trips to be made by public transport may have a very high performance in terms of energy consumption, but may not rate quite as well for health if a broad range of opportunities for local trip-making and leisure walking are not included within the design. Further research is needed to determine the sensitivities of design towards these separate issues and the validity of using each approach as part of a ratings tool for development proposals.

Finally, it is hoped that such a tool could provide means to model changes to a proposal's design so as to overcome these concerns. This is most likely to be in terms of which particular tests (i.e. primary school student journeys to school, or adult journeys to local shopping) raise potential problems in terms of forecast travel

behaviour. Simple changes in design could be identified such as the addition or relocation of services, or changes to the transport network, so that the performance of the proposed development may be improved at low cost to the developer.

Fig. 2, below, suggests a possible means to display this information, illustrating how a development's attributes may be used to develop multiple indices, and how modelling could be used to identify the impacts of modifications to the development's location or design.

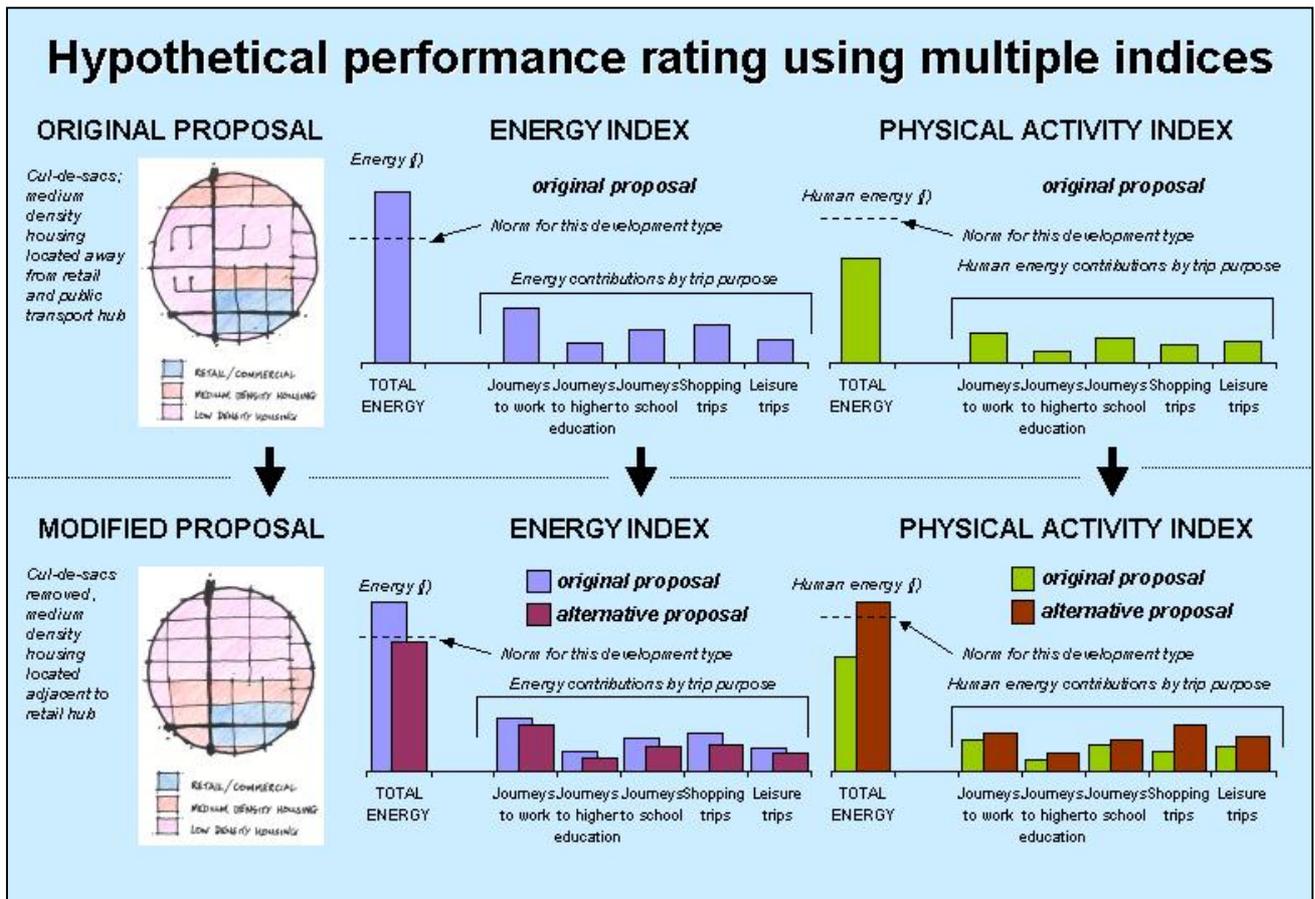


Figure 2. Possible outputs of accessibility analysis

Issues to be confronted

There are a number of problems that emerge at this point. These include problems involving the complexity of traditional travel demand models, the identification of the set of tests that really matter in terms of identifying differences in travel behaviour across urban environments, the issue of calibrating any tool to the city-region for which it is proposed for application, and the issue of the potential vs. take-up of opportunities in physical environments. To summarise some of these issues:

- Developing travel demand models is problematic as these require considerable resources in terms of data, computing capacity, modelling capabilities and skill.

The outputs of these techniques may be questioned by developers given the number of assumptions and generalisations that underpin them.

- There is a tension between the number of tests (and therefore the number of variables) included within any model and the complexity of the information eventually provided. Yet it is important that disaggregate tests are performed to identify important impacts for particular groups of people, for particular trip purposes (Halden 2002:318).
- It is not yet understood what set of 'tests' really matter in terms of residential travel performance. It is not yet certain which particular population groups, times of day and trip purposes are those that are most sensitive in affecting a development's performance in particular areas. Further research is necessary to confirm which sets of tests the tool should focus upon.
- There is a need to calibrate any model to the city-region within which it is proposed for use. This is especially true if decision-makers should seek to use this tool within planning approvals processes. Research is therefore needed to identify what the current levels of accessibility are within these parameters in present urban environments, across a range of varying urban forms and locations, including TODs.

Finally, even if a forecast is made of the likely travel behaviour of the population in a proposed development, there are many confounding factors that may influence these travel choices. Putting aside the spurious claims from opponents that transit-oriented developments force people to behave in a particular way (Dittmar and Poticha 2004:26) it must be recognised that New Urbanist and transit-oriented design features only provide *opportunities* for more sustainable behaviours. It is not always the case that residents in an urban development will take up these opportunities. The take-up of opportunities is reliant not only on the physical environment but also on the physical capacities of the population and the attitudes and perceptions held by that population, especially towards such matters as their attitudes towards walking and public transport in their area. Other factors in the success or otherwise in the take up of opportunities include:

- the quality and perception of public transport services,
- the quality and perception of community amenities and local destinations,
- the specific mix of land uses and their capacity to create synergies and to provide the types of services residents and employees need, and
- the quality and perception of the pedestrian environment, especially at and around key locations (Daisa 2004:124-125; Dittmar and Poticha 2004:26, 29-30).

Clear understandings of these relationships are outside the envelope of current research and cannot be considered for inclusion within such a tool. Regardless, it is considered futile if we seek to address these attitudes and perceptions, without ensuring the physical environment is conducive to more sustainable travel patterns.

Desired outcomes

In summary, our desired end result is the production of a tool that can provide the following benefits:

- providing for increased access to opportunities for future populations,

- increasing the potential of nonmotorised modes as a means to access local opportunities including access to public transport,
- ensuring greater consistency in the integration land use planning with the transport system,
- identifying cost-effective means to improve travel sustainability via changes to specific land use and/or transport elements within a development to planners and developers, and
- providing a means to quantify the value of any changes to specific land use and transport elements in terms of their travel sustainability.

This may be accomplished by furnishing users with:

- a means to produce an accessibility surface that notes the accessibility index 'rating' for each lot within a development proposal,
- a method of rating a development proposal as a whole under a scheme that is calibrated for that specific city-region, and
- a way to identify and model cost-effective changes to a proposal's design in order to increase the take-up of all the opportunities for improved travel behaviour that TOD and other planning interventions provide, across a range of trip purposes.

The intention is that this research will produce a tool that will provide the potential for improved planning interventions by use of rigour and quantification and by explaining causal relationships between location, design and travel performance.

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