

Development and Trial of an Automated Open Source Walkability Index Tool through the Australian Urban Research Infrastructure Network's Open Source Portal

Billie Giles-Corti¹, Gus Macaulay¹, Nick Middleton², Bryan Boruff³, Carolyn Whitzman⁴, Fiona Bull³, Iain Butterworth⁵, Hannah Badland¹, Suzanne Mavoa¹, Rebecca Roberts¹ and Hayley Christian³

¹McCaughey VicHealth Centre for Community Wellbeing, School of Population and Global Health, The University of Melbourne

²NJM Spatial

³Centre for the Built Environment and Health, School of Population Health, The University of Western Australia

⁴Faculty of Architecture, Building and Planning, The University of Melbourne

⁵North West Region Victorian Department of Health

Abstract: Creating walkable environments produces a range of health and environmental co-benefits including increased physical activity, social interaction, sustainable living and environmental protection. This project developed, trialled and validated a 'Walkability Index Tool'. This is an automated geospatial tool capable of creating walkability indices for neighbourhoods at user-specified scales (i.e., suburb, Australian Bureau of Statistics (ABS) Statistical Areas (SA) and road network buffers generated around user uploaded points) for any Australian urban area. The tool is based on open-source software architecture, within the Australian Urban Research Infrastructure Network (AURIN) framework. Using this tool, user-specified areas can be compared using three key sub-components of walkability (street connectivity; dwelling or population density; and land use mix) as well as a composite index of walkability. The calculation of each sub-component of walkability can draw upon data currently residing within the AURIN Portal. However, if users have their own Geographic Information System (GIS) data, this can be uploaded to a secure user area within the AURIN Portal for use in the analysis, with the ability to download results to link to their own data sets. This paper provides details of the development of the tool and describes how it can be applied.

Introduction

Promoting active modes of transportation such as walking, cycling and public transport use, produces co-benefits across multiple agendas: Improved health, traffic management, environmental protection, and climate change mitigation (Woodcock et al., 2009, Giles-Corti et al., 2010, Department of Infrastructure and Transport, 2012, Transportation Research Board, 2005, National Institute for Health and Clinical Excellence, 2008). Yet individuals' choice to use active modes are affected by the level of integration of land use, transport and social infrastructure planning which together determine the proximity of housing to local employment, shops, services, and public transport infrastructure. At an international level, the Organisation for Economic Co-operation and Development (OECD) has called for leadership by transport, land use and health ministers to provide 'the necessary, legal, administrative and technical frameworks' to support and encourage active modes of transport such as walking (OECD, 2012).

A growing body of evidence shows that higher density pedestrian-friendly neighbourhoods with connected street networks and mixed land uses encourage more transport-related walking (Transportation Research Board, 2005, National Institute for Health and Clinical Excellence, 2008, Cervero, 1996, Cervero and Gorham, 1995, Cervero and Kockelman, 1997). Higher density neighbourhoods generally have more local destinations, and land use diversity and when combined with a connected street network, the number of local destinations is a key factor determining local walking (Ewing and Cervero, 2010, Giles-Corti et al., 2013). Similarly, areas with higher density housing and employment are associated with increased access to, and frequency of, public transport (Newman and Kenworthy, 2006).

In the last decade, these key built environment features have been incorporated into a measure of neighbourhood 'walkability,' measured using Geographic Information Systems (GIS). Frank et al., (Frank et al., 2005) pioneered the development of walkability indices in the United States, initially incorporating three sub-components (residential density; street connectivity; and land use mix), and later modified to include retail floor area ratio (Frank et al., 2006). Australian studies have replicated walkability indices including Adelaide's PLACE study (Owen et al., 2007) and Western Australia's RESIDE study (Learnihan et al., 2011, Christian et al., 2011a, Giles-Corti et al., 2008), as have studies throughout the world (e.g., the URBAN study in New Zealand (Badland et al., 2009) and the

international IPEN study (Kerr et al., 2013)). However, due to the lack of readily available retail floor area data, many studies outside the US, including Australia, include the three original measures only: residential density, land use mix and street connectivity.

Irrespective of whether retail floor area is included in the measure of neighbourhood walkability or not, studies consistently show it to be associated with increased levels of transport-related walking. There is also evidence that if the land-use mix component of the variable is modified to include public open space, (Christian et al., 2011a) a 'recreational walkability index' emerges which is associated with recreational walking, a popular leisure-time physical activity for adults. More recently, neighbourhood walkability also has been shown to be negatively associated with major chronic diseases and biological risk factors including cardiovascular risk (Coffee et al., 2013) and obesity (Müller-Riemenschneider et al., in press); and better self-reported diabetes outcomes (Müller-Riemenschneider et al., in press). From an environment and traffic management perspective, walkability is important because it is associated with reduced vehicle miles travelled (Cervero and Radisch, 1996, Cervero, 1996). Hence, creating more walkable surroundings is beneficial not only for health, but also the environment.

Indeed, almost two decades ago, transport and planning evidence emerged showing that active modes of transport (walking, cycling and public transport use) and less driving, were associated with living in more walkable environments (Cervero, 1996, Cervero and Gorham, 1995, Cervero and Kockelman, 1997). A comprehensive review of the evidence by the US Transportation Research Board and Institute of Medicine in 2005 (Transportation Research Board, 2005) concluded that there was sufficient evidence on the association between the built environment and active modes, to warrant moving towards creating walkable environments. Moreover, in the urban policy discourse, there is growing recognition that more walkable neighbourhoods are more 'liveable' offering a higher quality and more sustainable way of life than car dependent communities (Department of Infrastructure and Transport, 2011). In the face of rapid population growth and changing demographics in the next 40 years (United Nations Population Fund, 2011), there is also a growing commitment to rethink the way cities are built (OECD, 2012) in order to encourage alternative forms of transport to driving cars including: walking, cycling and public transport use (Department of Infrastructure and Transport, 2011). The relationship between walkability and liveability becomes particularly important as the population ages, with 'higher density liveable neighbourhoods a defining feature of ease of movement for people and goods via walkable proximity to transport, amenities and access to green space' (p1-2)(Vine and Buys, 2012).

In Australia, state and Federal government policies increasingly favour more pedestrian-friendly neighbourhood planning (Western Australian Planning Commission, 2007, Department of Infrastructure and Transport, 2012, Department of Human Services, 2001). Nevertheless, despite the widespread recognition of the benefits of 'walkability' there is little objective evidence to benchmark the walkability of neighbourhoods within and across Australian cities, to assess how much reform is required to achieve the objective of increased walkability, and to monitor the progress of planning and design interventions. In order to address these issues, readily available data on the walkability of Australian cities are required.

Measuring walkability requires appropriate spatial data as well as specialist GIS expertise. The required spatial data and relevant GIS technology can be difficult to source and expensive to use, and hence, to date there has been limited use of walkability measures to inform federal, state and local government health and planning policy and practice. Moreover, when used for research, there is considerable duplication of effort to make data fit for purpose, including cleaning the data and creating the measures.

Thus, the overall aims of this project were twofold: first to create a tool that would assist in the translation of existing research into policy and practice; and second, to facilitate future built environment research, by overcoming problems associated with: 1) poor access to spatial data to develop walkability indicators; and 2) lack of available expertise in GIS to calculate walkability measures.

Given rapid growth in the NW Region of Melbourne, it was undertaken in partnership with the Department of Health (North West Region) and the North West (NW) Regional Management Forum. It was funded by the Australian Urban Research Infrastructure Network (AURIN – www.aurin.org.au): a \$20 million initiative funded by the Australian Government's Super Science scheme. AURIN aims to provide built environment and urban researchers, designers and planners with infrastructure to facilitate access to a distributed network of aggregated datasets and information services. It also aims

to provide the mechanisms, protocols and tools by which data can be accessed, interrogated, modelled and/or simulated to assist in the improved design and management of Australian cities, by linking the physical and social aspects of the built environment.

The projects specific aims were to develop, trial and validate an automated open-source tool capable of creating walkability indices at user-specified scales (i.e., suburb, ABS Statistical Areas and user-specified road network buffers) for any Australian urban area. The tool was designed to allow researchers, government agencies (at all levels) and interested community groups to undertake a rapid assessment of the walkability of user-specified catchments or 'service areas'. It will be possible to measure walkability using existing data available within the AURIN portal (e.g., Public Sector Mapping Agencies (PSMA), ABS and other state and Federal agencies), or users may upload their own detailed data (e.g. land use, street and/or pedestrian networks). In addition, the tool allows researchers to upload geocoded addresses from survey data, assess the walkability of service areas around these addresses, and to download results for further interrogation.

Walkability Index

Full details of the methods and decisions made to create the walkability indices used for this project are described and available elsewhere (Christian et al., 2011a). Briefly, three environmental characteristics were used to construct the walkability index: street connectivity; residential or dwelling density (with the potential to generate either a gross density or nett density value); and land use mix.

Street connectivity measures the inter-connectedness of the street network as a ratio of the count of three (or more) way intersections over the area (km²). Areas with higher street connectivity ratios are more traversable by pedestrians, allowing for movement in a number of directions, as opposed to low connectivity areas with few intersections and less options for pedestrian movement.

Residential or dwelling density measures people per unit area (hectares) or density of dwellings respectively. In the AURIN Portal the user can choose to calculate either nett dwelling density, which summarises the amount of residential land within an area divided by the number of dwellings that fall within the residential land, or residential density (gross dwelling density). Gross dwelling density calculates the average number of people or dwellings as a ratio to the total area (in this case, of a 'service area'). Whilst gross density is not used extensively in empirical research, it is used for policy and practice (Churchman, 1999) and provides an alternative means of assessing density for users that do not have access to detailed dwelling location information. Moreover, it can be calculated using readily available data such as the Australia Bureau of Statistics' Mesh Block dwelling and person counts (<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/2074.0main+features12011>). Both street connectivity and nett dwelling density measures were based on methods used by Frank et al. (Frank et al., 2005), and replicated in Western Australia (Christian et al., 2011a).

Land use mix examines the heterogeneity of land uses (of interest) within an area. The land use mix component of the walkability measure used in the AURIN system, was calculated using a variant on the original formula used by Frank et al. (Frank et al., 2005), and is the same as that used by Christian and colleagues (Christian et al., 2011a).

Land use mix was calculated by first extracting the area of each land use of interest for each service area. This was then used to calculate the proportion of each land use as the ratio of the area of a land use of interest, over the summed area of all land uses of interest within a service area.

$$LUM = - \sum_{i=1}^n (p_i^* \ln p_i) / \ln n,$$

where p_i is the proportion of a land use, and n is the number of land uses.

The Tool was developed to enable users to: (1) select land use information provided by AURIN; (2) upload their own land use information; or (3) construct their own land use classification using tools within the AURIN Portal (see description below). The land use data set must contain land uses codes, from which a subset of land use classes can be selected providing a range of options for the user to test various combinations. The area of each land use is summarised for each service area and provided as inputs into formula above.

Often there is a lack of detailed polygon land use data for urban areas in Australia. The workflows in the AURIN Portal provide a tool to construct a land use polygon data set from a point data set

representing built or natural features. For example, Valuer General's data – a set of point which identify rateable features - can be combined with a set of polygons (e.g. the cadastre) to constrain land use extents.

This process was based on work undertaken at The University of Western Australia's Centre for the Built Environment and Health at (CBEH) for the RESIDE study (Christian et al., 2011a), which used the Western Australian Valuer General's Office, Val Sys data base and developed a process to convert rateable features (as points) to areal land use types (with cadastral parcels acting as areal units) via a point in polygon allocation process. Because more than one type of feature (e.g. a retail shop and a residential dwelling) could be contained within a single cadastral parcel, CBEH used a priority allocation process based on a priority nomination system. For example, if the priority dictated that retail was more important than residential, any cadastral parcel that had both a retail and a residential point feature falling in it would be classified as retail. In the AURIN Portal this is called 'Priority Allocation'.

A number of combinations were tested by Christian et al (Christian et al., 2011a) and only some combinations of land use showed a statically significant relationship with walking behaviours (i.e., walking for transport and recreational walking respectively). Thus, while the tools within the AURIN Portal allow users to develop and analyse any array of land use classifications and combinations, it is recommended that, as a starting point, users examine the following combinations of land use which represents a very similar list of land uses as those used by Christian et al. The final list used, was based on those classifications available at the national level:

- Land uses of interest to examine **Walking for Transport** include: Commercial, Hospital/medical and education, Residential and Non-usual Residence land uses; and
- Land uses of interest to examine **Walking for Recreation** include: Commercial, Hospital/medical and education, Parkland, Residential and Non-usual Residence land uses.

Open Source Tool Development, Trial and Validation

The project consisted of three phases: development, trial, and validation of the Walkability Index Tool. **Phase one** comprised the development of an open-source web-based spatial analytic tool to examine walkability at varying scales across Australia. As noted above, the Walkability Index Tool was based on analytical tools previously developed for RESIDE by the CBEH, which were built using ESRI's commercial ArcGIS software package (ESRI, 2006) using state government datasets. ArcGIS software is not open source, however the scripts developed by CBEH, which were written in the Python programming language, provided a base structure for the migration of these tools to open source Java based programs. The Walkability Index Tool in the AURIN Portal was developed in the Java programming language using the open source Geotools spatial library. The tool is designed as a number of separate modular components (such as connectivity, density, land use mix, land use priority allocation), which can be configured in different workflows according to the needs of the user. The code is released under an open source licence and available through the GitHub software repository (Github).

Phase two trialled the Walkability Index Tool using data from Western Australia and Victoria. The respective datasets from each state in Table 1 were used within the AURIN Portal to create walkability indices for Perth, Western Australia based on network service areas for a cohort of participants in the RESIDE study (Christian et al., 2011a) and for the NW Melbourne study area in Victoria based on ABS Level 1 Statistical Areas (SA1) administrative units and the available state level data.

Table 1. Walkability sub-component measure data sources

Walkability measure	Western Australia	Victoria	National Data
Street connectivity	2012 Landgate – Road Centre Lines	2011 PSMA – Transport and Topography: Transport lines	2011 PSMA – Transport and Topography: Transport lines
Residential or Dwelling density as a Nett or Gross Value	2012 Landgate – cadastre 2012 Western Australia Valuer General’s Office – ValSys database; rateable features; dwellings	2011 ABS Mesh blocks: dwellings	2011 ABS – Mesh blocks: dwellings
Land use mix	2012 Landgate – cadastre 2012 Western Australia Valuer General’s Office – Val Sys database; rateable features; land use	2010 Victorian Valuer General’s Office - valuations database; land use	2011 ABS Mesh blocks: land use

The **third** phase validated the open source Walkability Index Tool. This was done by running both the ArcGIS based tools created by CBEH for RESIDE (Christian et al., 2011b) and the AURIN Walkability Index Tool with state and national datasets respectively, to test the ability of the AURIN tool to replicate the RESIDE walkability measures using national data. The results were compared for three walkability sub-components (dwelling density, connectivity and land use mix) and the composite Walkability Index using data from a sub-set of RESIDE participants (n=561).

Both versions of the Walkability Index tool (i.e., the ArcGIS CBEH RESIDE version and the AURIN open source version) were used to create 1600m service areas around each RESIDE study participant. Notably, the service areas differed slightly depending on which tool is used. On investigation we found that the main reason for the difference being that the ArcGIS service area function is proprietary software and therefore impossible to replicate in an open source tool. However, the approach used in the Neighbourhood Generator component of the AURIN Portal tool was based on a ‘sausage buffer’, acknowledged as a valid and appropriate approach in health research of this nature (Forsyth et al., 2012).

The correlation between the variables produced using the ArcGIS CBEH Walkability Index method and the AURIN open source Walkability Index Tool measures were assessed using SPSS (version 21.0.0.0).

Results

Table 2 shows the correlation between the Walkability Indices created using CBEH ArcGIS RESIDE version and the AURIN open source Walkability Index Tool. As can be seen there was a high correlation ($p<0.000$) between the measures of connectivity and density which exceeded $r=0.80$. However, the correlation between the CBEH land use variable derived using the state-based Valuer General’s data and the national data for both the transport and recreation land use mix based on ABS MESH blocks, although significant ($p<0.000$), were deemed unacceptably low at 0.270 and 0.242 respectively. Nevertheless, when combined into composite measures both the transport and recreation walkability indexes calculated using CBEH’s state level data and the transport and recreation walkability index calculated using PSMA and ABS national level data were moderately correlated at 0.724 and 0.765 respectively ($p<0.000$).

Table 2. Correlations between CBEH's and AURIN's open source Walkability Indices and its subcomponents

	PSMA connectivity	PSMA gross density	AURIN transport land use mix ²	AURIN transport wakability index	AURIN recreation land use mix ²	AURIN recreation wakability index
CBEH connectivity	0.999					
CBEH net density		0.804				
CBEH transport land use mix ¹			0.270			
CBEH transport wakability index				0.724		
CBEH recreation land use mix ¹					0.242	
CBEH recreation walkability index						0.765

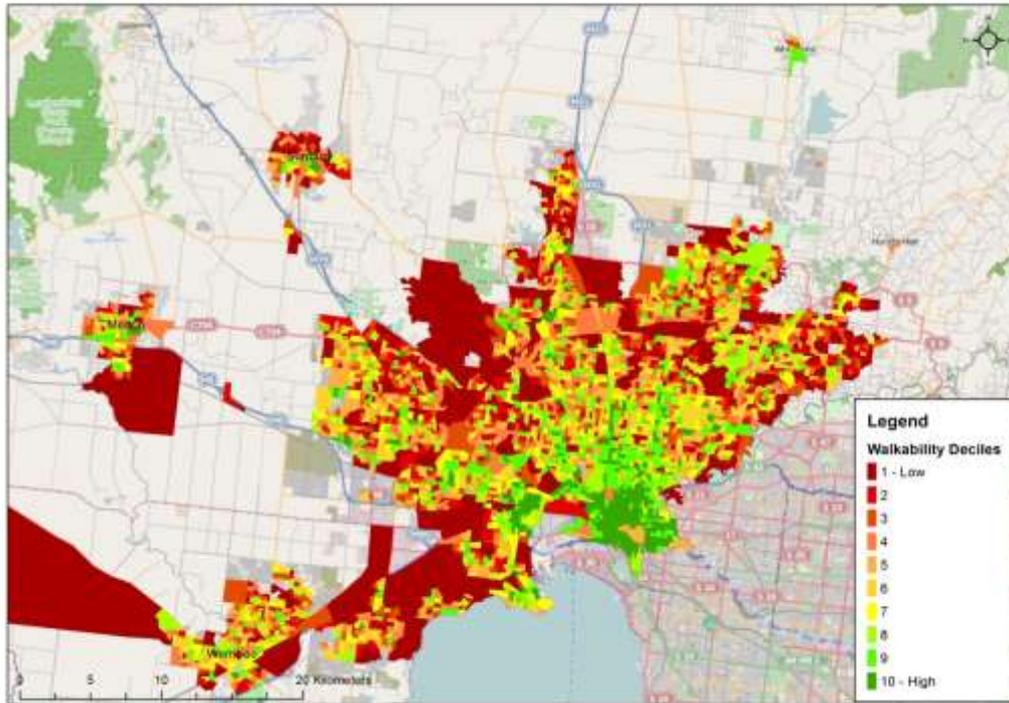
NB: All correlations significant at the 0.01 level (2-tailed). ¹Developed using the WA Valuer General's data. ²Developed using ABS Mesh block data

We wanted to visualise the walkability of the NW Region of Melbourne for our industry partners, the Department of Health NW Region and the NW Regional Management Forum. Hence, a map of the walkability for this region was developed (see Figure 1). For this map, we used the state-based Valuer General's data, since during our validation work using Perth data (see Table 2), we found that the correlations between the national ABS MESH block or PSMA data and the more fine grained Western Australian Valuer General's data was unacceptably low. However, in Victoria the Valuer General's office only gave permission for our team to use the NW Region Valuer General's data for the demonstration project (i.e., we did not have permission to use data for the whole of metropolitan Melbourne).

Hence, Figure 1 shows the resulting walkability index for SA1s with a population density greater than five dwellings per hectare in the NW Metropolitan Region of Victoria. It was created using three data sets: roads from the 2011 PSMA transport and topography dataset, dwellings from the 2011 ABS mesh block data, and land use categories from the 2010 Victorian Valuer General's Office valuations database. The Walkability Index presented in this map was created using a variation of the Land Use Mix measure available in the AURIN Portal. For the walkability index in Figure 1 it was important to adjust for the large variation in size of the SA1 in the NW Melbourne study area. The Walkability Index Tool in the AURIN Portal calculates land use mix using a single formula (described above), however it is possible to download the areas of land uses and use these in alternate formulas. In this case, we calculated Land Use Mix using the proportion of land use in relation to the *total area* of the SA1 based on another formula used by Frank and colleagues (Frank et al., 2007). This differs slightly from the Land Use Mix formula in the AURIN Portal where the proportion of land use is calculated in relation to the summed area of *only* those land uses of *interest*.

Levels of walkability are presented as 'deciles of walkability' in Figure 1, with the more walkable areas in Melbourne NW Region indicated in shades of green, and the most walkable areas, in darkest green. Low walkable areas, on the other hand, are shown in shades of orange (i.e., less walkable) to red (i.e., least walkable). As can be seen, most of the outer growth areas of Melbourne generally exhibit low walkability, while inner Melbourne is generally shown in shades of green indicating much higher walkability.

Figure 1. North West Metropolitan Region walkability index



Discussion

Increasing the walkability of cities is becoming a global objective, and a growing concern in Australia in the face of population growth, an ageing population, traffic congestion, rising fuel prices and low levels of physical activity coupled with high levels of obesity (Giles-Corti et al., 2010). Despite the rhetoric of the need for more walkable and thus more 'liveable' cities, low density development on the urban fringe are a common feature of Australian (and North American) cities. There are few objective neighbourhood walkability benchmarks against which policy-objectives and built environment interventions can be measured. AURIN's open source Walkability Index Tool fills this gap, by providing a tool that will allow the walkability of areas to be easily assessed.

This paper presents a map of the walkability of areas in Melbourne NW Region, one of the fastest growing areas in Australia (ABS, 2012). It shows that these areas generally have low levels of walkability, particularly compared with inner urban areas. This suggests that for many outer suburban areas, consistent with the evidence (Cervero, 1996, Ewing and Cervero, 2010, Giles-Corti et al., 2013, Frank et al., 2006, Christian et al., 2011a, Badland and Schofield, 2005, Kerr et al., 2013, Coffee et al., 2013, Müller-Riemenschneider et al., in press, Transportation Research Board, 2005) one would expect that the odds of walking and public transport use would be lower, while the odds of obesity and vehicle miles travelled would be higher. Previous research has shown that these are also mortgage and oil vulnerable suburbs. This is because when, fuel prices rise in response to peak oil, these suburbs have very poor access to public transport increasing their vulnerability to mortgage and oil-related stress (Dodson and Sipe, 2007, Dodson and Sipe, 2008). Hence, outer suburbs are doubly disadvantaged: residents have no public transport, nor are they easily able to walk to local shops and services. They have no choice but to drive, hence their vulnerability when fuel prices rise.

AURIN's open-source tool was developed to assist translating into policy and practice existing findings on walkability-based research. It provides policy-makers and practitioners with a tool that can be used to assess the walkability of specific areas and to monitor change over time in response to policy and built environment interventions. The AURIN Walkability Index Tool can be used to assess the overall walkability of cities, suburbs or neighbourhoods or even the walkability of the specific neighbourhood surrounding a single home or destination (e.g., a school or aged care facility). It can therefore provide a baseline measure prior to the implementation of built environment modifications, allowing change to be monitored over time and evaluation of infrastructure investments to be determined. For researchers, it can facilitate built environment research by providing access to spatial data that can be used within the AURIN portal, or the ability to download walkability measures (as an index and its sub-components) for analysis with other data sets (e.g., travel behaviour or health outcome data). Moreover, the tool is flexible to enable other measures to be added or different algorithms for

developing sub-components of the walkability index (e.g., the land use mix variable) to be tested. In so doing, it is sufficiently flexible to facilitate further research in this area.

Indeed, the tool has been designed with a number of features to maximise its use and applicability for both researchers and policy-makers and practitioners. First, to enhance users' functionality and experience, the Walkability Index Tool allows users to specify the scale of analysis. This can be based on an ABS set of geographies, user-uploaded areas or as a set of street network buffers generated at a user specified distance from a set of uploaded points. Once an area of interest has been established, the Walkability Index and its subcomponents can be calculated.

Second, the calculation of each component can draw upon data which currently resides within the AURIN system or, if the user has their own specific GIS data, the AURIN portal will allow the upload of user-specified data which can then be used within the Walkability Index Tool. Examples where a user might want to upload their own GIS data include: a road network dataset which includes road centreline information as well as footpaths, and point locations of residences in a survey for walkability index data may be required.

Third, for the more advanced user, the tool provides more sophisticated GIS capabilities such as point in polygon spatial joins (which can be used for developing a count of dwellings on a cadastral parcel as an input for the residential density calculation) and the priority allocations of land uses from a point data set to a polygons data set (used in the Priority Allocation tool to create a land use data set) and tabular joins (which can be used to reclassify complex land use types to higher level aggregations to use in land use mix analysis via a look-up-table).

Finally, the tool allows users to decide which land use land cover categories will be used in the calculation of the land use mix measure and allows advanced users to download land use areas and use these to link to their own survey data, or to trial alternative Land Use Mix formulas. Given that the use of walkability indices are a relatively new phenomena and the field is constantly evolving, this will provide the advanced user with maximum flexibility to modify the tool as required.

Nevertheless, there are a number of limitations associated with the tool and, in particular, the data used to create the walkability indices. First, the tool is a measure of neighbourhood walkability and its use should be restricted to urban environments in cities and regional towns. For rural areas, measuring and mapping walkability is likely to provide skewed results especially when calculating deciles of walkability for the composite measures. For the map in Figure 1, we restricted SA1s to those with densities of at least five houses per hectare. However, this has limitations and another approach may have been to exclude, large, low density SA1s.

Second, at this stage it is not possible to create a national walkability index. Despite a number of attempts, a comparable land use mix variable could not be derived using national data (e.g., PSMA and MESH block data, or a combination of the two). This appears to be because of the way the land use data are coded within these data sets, i.e., insufficient precision to make the land use variable meaningful for the purposes of measuring the variety of land uses in an area. Thus, for the land use mix variable in the walkability map presented, it was necessary to use state-based data (in this case the Valuer General's data set). The Valuable General's data provide a very useful data set of land uses because it is dynamic, changing in response to changing land features and land sales. However, using state-based data sets to create a national index is time consuming and restricts the ability to compare results across the country. A national source of land use data is preferable, and sourcing such a data or modifying the coding of future national data sets, warrants further exploration. It would be preferable, for example, if the ABS and PSMA could modify their coding procedures to maximise flexibility in the use of these data for this purposes of measuring walkability.

Finally, in this paper the visualisation of walkability in the map was restricted to the NW region of Melbourne. This was because this research was based on a demonstration project in the NW Region, and these were the only data we had permission to use at the time of writing. Restrictions on the use of data will hamper urban research, and increasing access to data through portals such as AURIN is to be encouraged.

Despite these limitations, the development of the AURIN open source Walkability Index Tool, provides valuable evidence of the potential benefit of having a tool that measures walkability across Australia. This could provide a benchmark that could be used to influence planning and policy decisions at the local, state, and national government levels; and also provide a benchmark against which progress could be assessed. It also highlights the value of making data available for research purposes. The

next step is to expand this index to the rest of metropolitan Melbourne. However, the next major research challenge, is to upscale the AURIN Walkability Index to measure the walkability of all Australian cities, allowing comparison within and between cities. However, beyond research, the policy challenge is to go beyond the rhetoric of the benefits of 'walkability', and to use this evidence to influence decisions that create walkable neighbourhoods and determine the health and wellbeing, environmental sustainability, and economic resilience of Australians.

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